EXPLORING TEACHERS'AND STUDENTS' PERCEPTIONS ON ASSESSMENT FOR LEARNING IN SCIENCE: HOW CAN STUDENTS' SELF-DIRECTED LEARNING BE ENCOURAGED?

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Abstract

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Assessment for learning remains under-utilized in the science classroom in North Carolina as greater emphasis is placed on assessment of learning. The aim of this paper was to find out how teachers and students perceived assessment for learning and how self-regulation in the learning of science can be enhanced. For this study, interviews were carried out with six, 7th grade science teachers from three middle schools out of the eleven middle schools in the county. The study also included focus groups with 50 students aged between 12 years and 15 years from the three schools. Results showed that assessment for learning positively impacts on students' motivation, engagement, self-efficacy, autonomy and improves the quality of lessons and teacher preparation for such lessons. Most of the teachers reported that using formative assessment for their students was effective in improving students and their own perception of assessment, they also pointed out that the use of formative assessment improved students' self-efficacy and self-regulation. Most students indicated that assessment for learning promotes cooperation with peers while making assessment interesting and stress free. Most students also reported that formative assessment provided them with platforms for self-assessment and self-feedback as they compare their work against set standards and criteria for success. Results from the study also showed that most of the students involved felt comfortable working as individuals when teachers had provided adequate criteria for success. Students highlighted the importance of recognition for their effort from their peers and teachers. Students further stress that lack of adequate feedback and encouragement from teachers is demotivating. The impact that assessment for learning has on students' self-regulation should be further investigated. Findings from this study may be used in improving science assessment in secondary schools. Recommendations and suggestions for policy makers are further suggested.

Declaration

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where states otherwise by reference or acknowledgment, the work presented is entirely my own.

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Table of abbreviations

Afl	Assessment for learning
NCDPI	North Carolina Department of Public Instruction
SRL	Self-regulated learning
USA	United States of America
NCFALCON	North Carolina Formative Assessment Learning Community and Online Network
PA	Peer Assessment
PBL	Problem Based Learning

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CHAPTER 1: INTRODUCTION [ASSESSMENT]

1.1: Introduction

The issues and debates of assessment, teaching and accountability have gone beyond the classroom and entered the political playing field. Students' results from schools have become a campaign tool among politicians seeking to remain in office and those angling to make it into political office. In most cases there is little or no consultation with teachers and students, both of whom are directly impacted by the process. With this development they have become less nuanced as broad generalizations and policies are sought. What sometimes gets lost in many of these discussions is the fact that the school system in particular, and the educational sector in general is incredibly varied by ethnicity, by gender, by grade, by subject, and by instructional format (Stull, 2013). Assessment is the process of gathering evidence of student learning to inform education related decisions. The quality of assessment and associated practices determines the quality of the evidence gathered, which in turn affects the impacts of those decisions (NWEA, 2020).

This study seeks to explore the way teachers and students perceive formative assessment as well as how this can be used to encourage self-regulated learning. Assessment is formative when the evidence is used as an on-going process within the classroom to adapt the teaching to meet student needs as well as providing feedback to the students (Black and Wiliam, 1998). Specifically, according to Heritage, Kim, and Vendlinski (2007), formative assessment is a systematic process to continuously gather evidence about learning. The data are used to identify a student's current level of learning and adapt lessons to help the student reach the desired learning goal. In formative assessment, students become active participants with their instructors, sharing learning goals and understanding how their learning is progressing, what steps they need to take and how to take them. Assessment can reinforce the efficacy of teaching and learning. It also encourages the understanding of teaching as a formative process that evolves over time with feedback and input from students. This creates good classroom rapport (PISA,2012).

This study was carried out in a county in the Coastal region of the State of North Carolina in the United States of America. According to Garcia Laborda et al., (2015) assessment is a systematic process which takes place throughout the entire teaching/learning act. The process is designed to judge and make decisions about students' performance and improvement regarding one or multiple skills. Torres (2019) pointed out that while assessment tools and methods have been evolving over time, their effects have rarely changed in the students' minds as they keep feeling threatened by the risk of failing their courses, especially on the summative stage. While formative assessment and summative assessment should complement each other, teachers and students are under a lot of pressure to show progress in the later (Stull, 2013). Some educationists have indicated that the time has come when formative assessment, occurring within the learning process, needs greater prominence to ensure that learners and teaching professionals focus more on the needs of learners than on the needs of politicians (Black and Wiliam 1998; Layng, Strikeleather, and Twyman 2004). Learning should focus on knowledge building instead of regurgitating what has already been established, our schools should generate new ideas, but we are spending time encouraging students to reconstruct what has already been established (Stull, 2013).

It should be noted that assessment is not testing but, testing is just one of the components of assessment. Testing is an event that comes in during the process of assessment, yet many students view assessment in the same way they view testing (Saddler, 1989). The process of assessment includes all the steps of teaching, observing, testing, judging, making decisions, feedback and re-teaching while focusing on students' areas of need and cementing areas of strength (Torres, 2019).

According to Saddler (1989) the intention of formative assessment is to generate feedback on performance and to accelerate learning, as learners begin to take charge of their learning. This research intends to discuss the extent to which assessment for learning or formative assessment reinforces self-regulated learning among students. The study also intends to explore how assessment for learning can improve self-efficacy, motivation, and autonomy in students in the learning of science. Nicol and Macfarlane-Dick (2006) pointed out that assessment for learning and feedback generated by teachers, peers and self are inherent in learner self-regulation. They went on to argue that formative assessment ensures that students are always actively involved in their learning and are therefore drivers of their own academic destiny, vision, and achievement. This study will therefore explore how formative assessment assists in ensuring that there is indeed active student involvement in the science classroom and science laboratory. Pintrich and Zusho (2002) suggested that the construct of self-regulation refers to the degree to which students can regulate some phenomena of their thinking, behavior, and motivation during learning. Nicol and Macfarlane (2006) also pointed out that formative assessment can be useful in creating a sense of interest-based learning among students as the student has in mind some goals to be achieved and works towards achieving the set goals. The authors suggested that students will generate internal feedback as they actively interpret feedback from teachers and from other students in relation to their internal goals.

Formative assessment and feedback are inherent in learner self-regulation since students are assumed to occupy a central and active role in their learning processes (Nicol and Macfarlane, 2006). Clark (2012) argued that formative assessment provides for a good platform for effective feedback for students. The author pointed out that effective feedback forms the core of formative assessment, and this encourages learners to articulate their tacit knowledge. Voogt and Kasurien

(2005) emphasized the importance of tacit knowledge, “Formative assessment may consist of hard data, but more often and more importantly of ‘tacit knowledge’, i.e., knowledge that both the teacher and student obtain through discussion, reflection and experience” (p. 154). Clark (2012) further suggested that in the formative classroom, tacit knowledge is made explicit and accessible to the learning community through active participation and mutual discourse. It therefore shows that the use of formative assessment in the classroom encourages active student participation and interaction with all members of the learning community. This was also supported by Zimmerman (2002) who also revealed that formative assessment encourages self-regulated learning as individuals are meta-cognitively, motivationally, and behaviorally active participants in their own learning process. Assessment for learning creates a symbiotic classroom ecosystem which is mutual for all members of the classroom ecosystem (Stull, 2013). Bandura (1997) was of the opinion that assessment for learning or formative assessment creates a conducive environment for the learner to explore and expand on what would have been introduced in the classroom. Learners become more independent and more likely to be innovative and creative. Fox and Riconscente (2008) pointed out that the significance of others in the development of self-regulation is explicit in the seminal work of both Piaget and Vygotsky. Formative assessment, therefore, ensures that the learning process does not occur in a vacuum.

Nicol and Macfarlane (2006) noted that studies by scholars in the USA have proved that learners who are more self-regulated are more effective learners, who are more persistent, resourceful, confident, and higher achievers. Feedback from those who are part of the learning environment provides for the opportunity for self-regulated learning as students take time to self-review (Zimmerman and Schunk, 2001).

As Stiggins (2002) pointed out that summative assessment and assessment for learning are both important. The main variation is between assessment to determine the status or level of learning and assessment to encourage deeper learning experiences. Assessment of learning provides a summative component of evidence of achievement for public reporting while assessment for learning assist the student to learn more from an educational process hence providing the formative component of evidence of learning progress. Nicol and Macfarlane (2006) noted that formative assessment provides the student with a platform for self-assessment and peer assessment in a way that is more effective than teacher assessment which is more prevalent in summative assessment. They went on to state that formative assessment increases dialogue through feedback and this ensures that students can engage their teachers in discussions about feedback. This stimulates response and continuing dialogue and as the student discuss with the teacher, resulting in greater understanding of the learnt concepts, (Freeman and Lewis, 1998).

1.2: Background of study

The need to improve students' performance and quality of public examinations results has brought a lot of pressure on teachers (NCDPI, 2018). Both stakeholders and stockholders are demanding for improved learner performance in final public exams yet ignoring the fact that results of summative assessment reflect on formative assessment. Students have a negative perception towards assessment as they feel that assessment is meant to penalize them on things that they would have missed during lessons. Students are not motivated about assessment with some students even absent themselves from school due to fear of testing. Assessment is perceived as a stumbling block among students as they perceive it to be a separation tool that puts boundaries on learning instead of an enabler of learning. According to Pitt County Schools (2019) almost 5% of students deliberately miss school when there are State assessment.

Teachers tend to utilize assessment for learning with less vigor than the ways they plan and implement assessment of learning. Due to the pressure from school management and parents many teachers tend to focus more on summative assessment than formative assessment thus encouraging rote learning at the expense of knowledge development. As a result, self-regulation and self-efficacy among students in learning science is compromised.

Formative assessment is given a lesser role in students' learning resulting in schools producing half-baked science students who can only recite what would have been taught yet failing to think outside the box. This negatively impacts on students' motivation and innovation in science.

There is increased demand to maximize students' achievement, yet focus is directed on summative learning (Zimmerman and Schunk, 2002). Records from Pitt County schools showed that county had science proficiency percentages of 55.4% (2017), 55.7% (2018), and 70.3% (2019) against the average State proficiency of 70.2% (Pitt County Schools, 2020). These percentages indicate students' proficiency in assessment of learning through standardized tests, yet schools recorded higher percentages of student achievement in school-based assessments which follow the assessment for learning approach. The promotion of formative assessment in schools from 2019 resulted in a major improvement of the science proficiency in 2019.

Dispelling a widely held view that learning can only be judged from summative assessment is one of the myths that the study intends to unmask by understanding how teachers and students view formative assessment. The way children learn from cartoons does not involve pressure they enjoy what they watch and easily understand the progression of the cartoons, yet most children struggle with classroom-based instruction and assessment. Chin and Teou (2009) found use of concept cartoons effective with middle school aged students. Furtak and Ruiz-Primo (2008) found formative assessment could be effectively used to improve students' reasoning, writing, discussion and intellectual capacity skills.

Saddler (1998) and Zimmerman and Schunk (2002) argued that students can improve achievement in all manner of assessment if our learning and teaching processes address the concept of self-regulated learning. Giving too much attention towards summative assessment dilutes students' self-regulation and innovation. A major problem associated with lack of concern towards formative assessment is that junior secondary school students are less independent or autonomous learners but rather more teacher dependent learners who struggle to operate without teacher input. Learners must oversee and control most of their learning while teachers should facilitate the learning process in the right direction. When students are less dependent on teacher input and more dependent on what they discover in their own learning and research, they become more confident to answer any related material as they will be drawing from their own experiences (NCDPI, 2019). The science North Carolina Middle school science curriculum dictates on what students should learn and leaves a lot of gaps in promoting self-regulation, autonomy and formative assessment. Students' learning and assessment is yet to reflect on the democracy expected in society as their input during the learning process is overshadowed by what they produce in summative assessment. Many students still struggle with intrinsic motivation towards assessment due to their negative perceptions towards assessment and this has created non conducive learning environments where self-regulation and self-efficacy are almost non-existent.

Proust (1999) coined the statement that 'a real voyage of discovery consists not of seeking new landscapes but of seeing through new eyes.' Stiggins (2002) explained this in terms of our failure to find a potent connection which has resulted in a deep and intensifying crisis in assessment in American education.

The role of assessment has been taken away from teachers and this has in-turn alienated students from their assessment of learning. As a result, students are passive participants in the assessment process with most students lacking even the reasons why they have to be assessed in the first place. As a result of focusing more on summative assessment, schools are no longer functioning as centers of independent and innovative learning but rather centers that produce dependent learners who may not be able to produce anything from their own thinking without the support of their teachers in most instances.

Stiggins (2002) and Torres (2019) agreed that our assessment system has been failing to balance the use of standardized tests and classroom assessment thereby causing harm to a huge number of students. They concluded that when it comes to assessment, we have been trying to find answers from the wrong questions hence the need to adopt a paradigm shift in the way we assess our students. In all these, the role of the students in their assessment has been largely ignored. The challenge with this could be that our school systems could be awarding those with the ability to remember phenomena from what others have already established yet penalizing those with independent and divergent thought. Nicol and Macfarlane (2006:200) concluded that ‘if formative assessment is exclusively in the hands of teachers, then it is difficult to see how students can be empowered and develop the self-regulation skills needed to prepare for learning outside the school system and throughout life’. The way how students perceive assessment may be altered if self-regulated learning is given its rightful position in student learning. Students need to be allowed to construct their knowledge from their experiences, assessment should be a vehicle for learning and not an instrument used in grading students (NCPDI, 2016).

Assessment in education has generally reflected a measurement driven approach that serves purposes such as ranking students and keeping schools accountable (Popham, 2014, Carless and

Lam, 2014 and Watt, 2005). This paradigm has been challenged due to new knowledge and understanding of how children learn hence the need to change the way children are assessed in line with the way they learn (Willis and Cowey, 2014). Using Standardized test results from summative assessment to measure teacher accountability and students learning is like a mirage, as this falls short in revealing how much students have learnt (Ahmed, 2019). Lastly the learning of science is being overshadowed by the teaching of science, our problem is that teachers and education authorities prescribe a prescription of learning yet the process demands a practice of teaching. The school curriculum expects independent learners from a dependent system.

1.3: Statement of the problem

The purpose of this study is to explore the perceptions of teachers and students in Pitt County, North Carolina, regarding assessment for learning in science, with a focus on how students' self-directed learning can be encouraged.

Although assessment plays a vital role in guiding and evaluating students' learning progress, there is a need to investigate how assessment practices align with fostering self-directed learning in science education. Traditional assessment methods often prioritize summative evaluations, which may not fully support students' active engagement and self-directed learning processes. Thus, it is crucial to examine the perceptions of both teachers and students in Pitt County schools to understand the current assessment practices employed in science classrooms and their impact on students' ability to take ownership of their learning.

There exist a lot of disparities in terms of students' performance during their learning processes when compared to their performance in public examinations. Observations form Pitt County middle schools' science grades in the school gradebooks shows that school-based assessment tend to have on average higher grades than those students attain in the End of Grade (EOG) assessments. In some instances, students who had all As or grades above 90% for science throughout the year did not get the highest possible grades at the end of the year or in the State administered quarterly assessments such as the State Science Check-Ins. For classes which would have school-based assessment scores of on average 80% the achievement rates would fall to below 50%. Such disparities result in teachers and students perceiving assessment differently from learning.

Students are generally motivated to learn science and random discussions with students about their expectations and their understanding of the subject shows that they are motivated to learn about science, they have great expectations about the lab activities. However, the same cannot be observed when students are informed of science assessments. Their motivation fizzles out, as fear and anxiety replace their confidence and their eagerness. There certainly appears to be some negative trigger effects towards assessment. The talk of assessment with students replaces students' innovation, motivation and self-regulation with anxiety, fear of failure and hopelessness. Most students perceive assessment negatively, they tend to associate assessment with rote learning where their search for new knowledge is replaced with the search for what has already been established.

While teachers make use of formative assessment during their teaching, they tend to under-utilize it due to the value attached to summative assessment. More could come from teachers in terms of how they implement assessment for learning.

To address this problem, this study will gather data from teachers and students in Pitt County, utilizing qualitative research methods such as surveys, interviews, and focus groups. The research will involve a diverse sample of teachers and students from various grade levels in both urban and rural schools to ensure comprehensive representation.

The study aims to identify the prevailing assessment practices in science education in Pitt County and examine their effectiveness in promoting self-directed learning among students. By exploring teachers' and students' perspectives, the research seeks to uncover any gaps or areas for improvement in the current assessment approaches. Additionally, it will investigate the strategies and recommendations that can be implemented to encourage students' self-directed learning through assessment practices in Pitt County schools.

1.4: Purpose of the study, Research Aims and Objectives

The purpose of this mixed methods constructivist theory study is to probe the way teachers and students perceive assessment for learning as well as how formative assessment can be used to promote autonomy, motivation, self-efficacy, and self-regulated learning in science. The impact of teachers' and students' perception of assessment on the learning processes will be investigated. In addition, this, the study will also be used to finding out new or alternative ways that can be used in the science classroom to encourage science students' self-regulation in Junior secondary schools. This study will also seek to understand how teachers' perceptions of assessment for learning impact on how they implement it during the learning process and the ramifications this has on students' learning. This study also seeks to investigate how self-regulated learning can be promoted using formative assessment. This study will also attempt to establish and discuss any relationships among the various factors that may be impacting on formative assessment and self-regulated learning from students' points of view. This study used a constructivist approach using interviews with 7th grade science teachers, focus groups with volunteer students, observation of lessons and questionnaires. The study may also provide some new ways of improving students' autonomy, self-regulation and motivation as they learn science. The other aim of the study is also to establish contemporary ways of assessing students that encourage learners to look forward to each new school day with hope and eager to share their findings from autonomous learning activities. The study also aims to reveal how teachers perceive formative assessment in relation to how they plan for the same. This study also seeks to establish if there is any links between learners' self-regulation and the way they are assessed and how assessment for learning could be used to promote their autonomy in learning.

The objectives of this study will include examining the current assessment practices employed in science education within schools in Pitt County, North Carolina. This will involve conducting a comprehensive literature review to identify existing assessment methods and their alignment with promoting self-directed learning in science.

The study will also investigate teachers' perceptions of assessment for learning in science. This objective will involve administering surveys to teachers in Pitt County schools, exploring their understanding, beliefs, and practices related to assessment in science education. Interviews will also be conducted to gain deeper insights into their experiences and perspectives on fostering self-directed learning through assessment.

The last objective would be to identify the factors influencing students' self-directed learning in science. This objective will involve analyzing the data collected from teachers and students to identify key factors that facilitate or hinder students' ability to engage in self-directed learning. These factors may include classroom environment, teacher-student interactions, student motivation, and access to resources

1.5: Nature and significance of the study

An effective science and engineering workforce is critical to the United Sates if the country is to remain relevant and competitive as a global economy and sustain the capability to continue technical and innovative advancements (Cordero, et al., 2010, Lowell, 2010, Fitzpatrick and Liu, 2012). For innovation to be meaningful and relevant to the needs of the ever-changing world, the process of learning and assessment should be structured in such as a way that all students are motivated, self-regulated, and autonomous in their learning. The US government enacted the National Science and Technology Council (NSTC) and had a committee dedicated to STEM Education (NSTC, 2013). If the aims of STEM education are to be realized, there is need to address and modify the way assessment is perceived by both teachers and students to ensure that both groups have positive perception towards assessment and STEM education. Formative assessment could then help in encouraging self-regulation in the learning of science in middle schools. Lawmakers and communities have been demanding for improved scientists who can drive economies into the future from the school system. Such demands may not yield anything positive if there is no change in the way learners perceive assessment and the way their teachers perceive and implement assessment. The current way of student assessment puts more emphasis on scores and grades, thus producing academics who are excellent in knowledge recall but fall short of creativity and innovation. This study may help in promoting inclusive and all-embracing methods of assessment for learning that encourage competent science students from secondary schools. The way students perceive assessment may go a long way in shaping the way students will work towards being independent and innovative individuals. Teachers' perception and implementation of assessment for learning also has a bearing on the whole process of learning and generation of new ideas and knowledge. The role and effectiveness of formative assessments to gauge student understanding has become more important than ever during the COVID-19, when many teachers and students are working in blended learning environments that included synchronous and asynchronous processes (NCDPI, 2021). Focusing on learning and student-oriented learning techniques like formative assessment may be a bit more strenuous for teachers and require some extra strategy, but the results are worthwhile for the effort (Jackson, 2009). This study may unearth and promote new ways of ensuring that science students are autonomous and motivated in their search of knowledge. A possible outcome of such a process may be improved student performance in all manner of assessment and deeper understanding of science in general

When teachers constantly monitor their students' academic growth and adjust instructions it helps in improving students' progress and confidence in their work. By understanding exactly what students know before and during instructions, teachers will provide learning-focused feedback which would enhance academic progress (NCPDI, 2019). Students who perform on the outer edges of the normal curve such as those who are academically gifted and the those who are struggling are most likely to benefit from formative assessment (Jackson, 2009). Formative assessment has the potential to meet students at their performance level and help them achieve their learning goals. Formative assessment may benefit learners by helping in defining their learning goals, increasing their rigor in learning, as well as their motivation and engagement (Greenstein, 2010). The use of formative assessment allows teachers to use data from frequent learning checks to make sound and informed decisions that is data driven (Black and Wiliam, 1998). This has the potential of generating lessons and interventions that are data driven thus ensuring that individual strengths and challenges are incorporated.

According to Bekoe, Eshun and Bordoh (2013:28) "knowledge is constructed during the learning process and that a student discovers knowledge for him/herself, rather than receiving knowledge, and this inspires the notion of performance-based assessment." Nicol and Macfarlane (2006) believe that if students are to perform to the best of their abilities, there is need to motivate them toward being self-regulated learners who think outside the box. Angelo and Cross (2012) reasoned that classroom assessment is an approach designed to help teachers find out what students are learning and how well they are learning it. This study may also create learning platforms that results in improved and refined student centered and student initiated assessment where everyone feels they are in control of their learning and assessment processes. While parents and schools put a lot of emphasis on students results from public exams such as EOGs, EOCs, MAPs, NCCheckins as these are used in placements in various sectors of the curriculum and the economy at large. Assessment for learning or formative assessment unlike assessment of learning (summative assessment) is not given its true value and relevance in the learning process within schools (Ampiah et al., 2003). Assessment in schools is mainly about what examiners want to hear from the students, with little regard being given to what students may have to offer that may be outside of what we already know. Assessment for learning may be the missing link between innovation and contemporary education. When students are assessed it is mostly done using the summative assessment approach, which brings in a lot of anxiety, fear of failure and over-reliance on teachers and other external support structures. This study is meant to explore how teachers and students perceive formative assessment and how self-regulated learning can be encouraged. There may be some change in how assessment is perceived from being a fear inducing phenomenon towards being a motivation inducing phenomenon.

There is a lot of pressure on school personnel from their superiors and politicians who are mainly concerned with end of grade public examination results (NCDPI, 2019). Societies around the world tend to pay less attention to the learning processes compared to the end-product in our school set up. Stiggins (2002) postulated that our concern for test scores must be preceded and informed by a consideration of more fundamental questions such as: Are our current approaches to assessment improving student learning in any way? Might other different and unexplored approaches to assessment have a greater impact? Can we design State, district and school based assessment systems that have the effect of helping our students to be intrinsically motivated to be able to want to learn and feel able to learn? There is need to come up with ways that remove the barriers towards students' attainment in assessment of learning through formative assessment.

While there is a federal philosophy that no child is left behind, the current use of assessment of learning is doing the exact opposite, (NCDPI, 2018). A lot of students become hopeless after failing to meet the local tests standards, often leading to high rates of dropouts among students of color. As a result, most of the affected students would either drop out of school after the age of 16, or enroll in short courses to enter into basic wage jobs thus limiting their chances of an equal footing for professional training and higher education. Stiggins (2002) went on to suggest that summative assessment, through standardized tests have been blindly accepted as a measure of success in the learning process. The gaps created and left behind by this approach have formed the basis for this study. The main challenge with summative assessment is that the diagnosis does not help students as the assessment comes after a year hence students have little to learn from the diagnosis, on the other hand formative assessment provides the tools that are required for students' improvement. Diagnosis of any problem may only be useful if it is given within a practical timeframe. The time frame between diagnosis from summative assessment and the next levels of learning in science do not seem to be compatible as learners are getting feedback of courses that they may not cover in their new semesters. In most cases, summative assessment feedback is usually overtaken by events and curriculum demands.

When properly used, at controlled frequencies formative assessment can improve learner performance and quality of grades in public examinations or external summative assessment. This study attempts to come up with ways that classroom modified, learner centered, and learner driven assessment may be included in school curriculum to make learning more relevant, engaging, meaningful, exciting, and beneficial to students as they transition towards self-regulated learning. The use of summative assessment has come under a lot of criticism in recent years and one of the trends in educational assessment that has put the spotlight on formative assessment, is the development of more valid assessment procedures (Bell, Bell and Cowie, 2002). The criticism has not offered viable and realistic solutions toward the challenges. There is need to assess a wider range of science learning skills and outcomes such as performance of investigation skills (Johnson, 1989) and multiple forms of intelligence (Gardener, 1985). Formative assessment is weakly conceptualized, and hence it is likely that the contributions of formative assessment to student learning and retention is not being optimized or fully utilized (Yorke, 2010).

According to Polly et al., (2017) and NCTM (2014), the use of formative assessment and data on student performance can result in long-term gains on class assessments. Formative assessment is significant because it is integrated within the learning process and is not meant for summative measurement (Black and Wiliam, 1998). It is an assessment for learning, with teachers and students as the target audience, while summative assessment is an assessment of learning that provides updated information to stakeholders about teacher and student performances (Burke, 2010; Heritage, 2013). However, the implications of formative and summative assessments differ. Formative assessment is strongly linked to the local curriculum and administered based on students' needs (Shepard et al., 2018), while summative assessment uses data to evaluate students' knowledge (AERA, APA and NCME, 2014). The pressure to cover all curricular objectives to prepare for end-of-year summative assessments may influence teachers' formative assessment practices (Box et al., 2015; Govender, 2019).

Formative assessment is an essential and effective tool for enhancing and promoting student learning (Bell and Cowie, 2001) and reflects the paradigm shift or directional change in pedagogical strategies and technology use for effective instruction delivery in distance education. Embedding formative assessment in teaching and learning is thus viewed as necessary in contemporary students' learning platforms (Black et al., 2003; McTighe and O'Connor, 2009; Shepherd and Hannafin, 2008; Wiliam, 2011).

Therefore, utilizing formative assessment and effective use of data can lead to long-term academic improvements. Teachers and students are the primary audience of formative assessment, while summative assessment provides updated information to stakeholders. It is essential to align formative assessment with local curricula and administer it based on student needs. The need to embed formative assessment in teaching and learning is crucial, especially in contemporary students' learning platforms.

This study is to explore how teachers and students perceive formative assessment and identify ways that encourage self-regulated learning where the students begin to take control of the destiny. The results from this study may be used in revisiting the way students are assessed to ensure that schools assess students in the knowledge they hold from academic growth and experiences instead of how much they can recite from literature alone. Such initiatives may lead to more innovation and independence of the students thus making the process of learning science both creative and meaningful to the students. This could also help in promoting students' autonomy, self-efficacy and self-regulation. Learners are likely to be more independent in their approach toward science in particular and learning in general. The study may also help in encouraging the learning communities to bring about some robust changes in the way students are assessed and how they learn free from fear of failure but with hope of expanding on their knowledge thus making more appealing to those it is intended for. It may therefore be possible that the results from this study could also form a basis for future research into how to bridge the achievement gaps in science through intentional shifting in assessment.

1.6: Research questions

The research questions for this thesis are:

1. What are students' experiences and perceptions of the way formative assessment is used in science in Pitt County NC, USA?
2. How do teachers interpret and implement assessment for learning in Middle School science?
3. How can assessment for learning be used to encourage students' self-regulation in Middle School science?

1.7: Conclusion

This Chapter defined assessment and differentiated it from testing. Perceived challenges and problems associated with stakeholder expectation were highlighted. The link between the research topic and statement of the problem was also discussed. There was also some clarity given on what makes formative assessment or assessment for learning different from summative assessment or assessment of learning. Stakeholder expectations and teachers' roles in students' assessment were briefly discussed as this formed the basis of the research. The role of formative assessment in meeting parents and community expectations was also introduced and will expanded upon in the relevant chapters. There was some introduction into what other scholars have written about the effects of assessment on both students and teachers. This study will focus on answering the questions about how students perceive and experience formative assessment as they learn science as well as how science teachers interpret and implement assessment for learning. This study will also answer the question about how self-regulation, self-efficacy and motivation are influenced and impacted by formative assessment. The next Chapter will dwell more on formative assessment, self-regulated learning, self-efficacy, autonomous learning and related literature.

CHAPTER 2. LITERATURE REVIEW

2.1: Introduction

In this Chapter the topics of constructivism, formative assessment and self-regulated learning will be discussed. The theoretical framework of study will also be presented. The theory of constructivism in learning and how it is linked to formative assessment and self-regulated learning in secondary school science will also be discussed. Additionally, the theory of constructivism in learning and how it is linked to formative assessment and self-regulated learning in secondary school science will also be discussed. Different types of the constructivist theory will also be discussed. Understanding what other researchers have discovered in the related studies will be of great value to this study as this study will try to address the gaps found in previous literature. More focus will be on those aspects of formative assessment that have not yet received much research and how student autonomy and self-efficacy impact on their perception of assessment.

2.2: Context

The State of North Carolina has a State approved curriculum which can be modified by individual counties (districts) and Independent Charter and Private schools to meet their local demands without compromising on the State standards which are otherwise known as the Common Core State Standards (NCDPI, 2019; Venkatesh, 2017). Students follow an education system that is compulsory from pre-K through 12th grade otherwise known as K-12. Assessment is both continuous and summative with formative assessment being encouraged for teachers. However, continuous assessment is usually more of assessment of learning than assessment for learning.

Teachers rely more on grading students' work from written tests than directing students on how best they could accomplish tasks (The National Forum for Assessment, 2019).

Venkatesh (2017) noted that the science curriculum is broken down into smaller grade level units known as North Carolina Essential State Standards. Different counties can opt to set district (county) level summative assessment known as District Common Assessment (DCAs) or allow their learners to sit for NC State Check-ins a form of the State summative assessment at every 9-week interval for core subjects such as Math, English Language Arts and Science. However, some schools especially the Public Charter schools and Private schools may also use the Measure of Academic Progress (MAP) or the Next Generation Science Standards (NGSS) tests (NWEA,2018). At the end of each school year learners are subject either to End of Grade level (EOGs) or North Carolina Final exams (NCFEs) both of which are summative assessments with similar academic weighting. All the mentioned forms of assessments are summative in nature, there is no real plan for formative assessment. Formative assessment is encouraged as teachers can grade some work through formative assessment and adjust students' grades in class summative assessments which carry a value of 50% of the final grade (NCDPI, 2019). However, the reality on the ground is different, as formative assessment is misconstrued and is generally low stakes, with little or no point value because many teachers do not understand it (Regier, 2012). Only the master teachers whose mindsets are on their way of thinking about instruction, about students' learning that makes their learning effective and responsive to their needs create time to plan for formative assessment (Jackson, 2009). The National Forum on Assessment (1995) acknowledged that many teachers underutilize formative assessment, yet it can be used to support learning during the learning process while allowing for differentiated instruction and improved student understanding. They contended that this underutilization of formative assessment has more to do with the way teachers perceive and prepare for formative assessment.

Dodge (2018) stressed that teachers fear planning for formative assessment and rush to complete the syllabi when students are learning less thus sacrificing reflection and interaction which are essential to motivation and self-regulation. This is usually because of the pressures of the demands and expectations of the school leadership as teachers' effectiveness is judged on the results of summative assessment than from summative assessment (Mangwaya, 2014). Instead of teachers spending their time refining their inquiry skills on how to provoke students toward deeper thinking, increased motivation, and more student ownership over their work, teachers rush to find quick solutions of making them pass the summative assessment (Jackson, 2009). The result has been the over-production of half-baked and paper qualified science students with no clue about how to create solutions to scientific problems (Black and Wiliam, 2009).

The current assessment processes in our schools have led to many students suffering from anxiety and assessment related depression due to fear of failure, yet assessment should never be about failure but learning (Dodge, 2018). This deprives students the chance to be self-regulated and to learn as learning rarely takes place with learner independence in the absence of properly modelled assessment for learning (Jackson, 2009).

The curriculum 7th Grade science curriculum is divided into four sections which are assessed using both formative and summative assessment methods at school level throughout the school year and Statewide summative assessment is done at nine-week intervals (Pitt County Schools, 2019). Students use the semester format where results from previous assessment are kept as GPA and accumulate over their school years. The State of North Carolina prescribes the philosophies of 'No Child Left Behind' and 'Race to the Top where formative assessment is encouraged for students with academic challenges to ensure that they can provide evidence of their comprehension of the learning materials (NCDPI, 2019). Lack of grade value on the formative assessment has been a major challenge for both teachers and students as school is designed in such a way in which there must be a certain type of value that has to be attached to students' work (Jackson, 2009). It is this lack of value that drives students' and teachers' perceptions towards the different forms of assessment.

According to Brunetti et al., (2019), a reliable assessment system that generates relevant and timely data on student development and competency is crucial for ensuring a solid foundational education for all learners. The outcomes of high-quality assessments, combined with a well-designed accountability system, can furnish essential insights into students' academic advancement, and inform decision-makers about the effectiveness of policies and practices. An excellent assessment system must meet the requirements of various stakeholder groups, by providing critical information to promote the achievement of a sound basic education throughout all tiers of the education system. They further argued that high-quality assessment system should include different types of assessments and processes, each used for different purposes at different levels of the system ranging from individual schools to school districts and even up to State level. To realize the benefits of formative assessment school districts and individual schools need to ensure that teachers are well prepared through training on how to implement formative assessment in their classrooms in a way that benefits the learners (Jobs for the Future, 2018).

The Council of Chief State School Officers (2019), stated that formative assessments are an essential component of ongoing teaching and learning, used by both students and teachers to gather and use evidence of student learning for improving their comprehension of intended disciplinary outcomes and promoting self-directed learning. This process collects detailed information about the status of student learning, which informs the teaching and learning process in real-time, utilizing feedback and evidence to adjust learning strategies, goals, and next steps. While tests that assess content knowledge and cognitive skills are critical for determining college and career readiness, a more comprehensive understanding of students' abilities and limitations requires other forms of data. Conley (2018) emphasizes that to improve performance, it's necessary to understand what students know, why they perform as they do, and how their background influences their motivation to learn and their interests. From this approach one may use the constructivist approach to learning as prior knowledge is taken onboard.

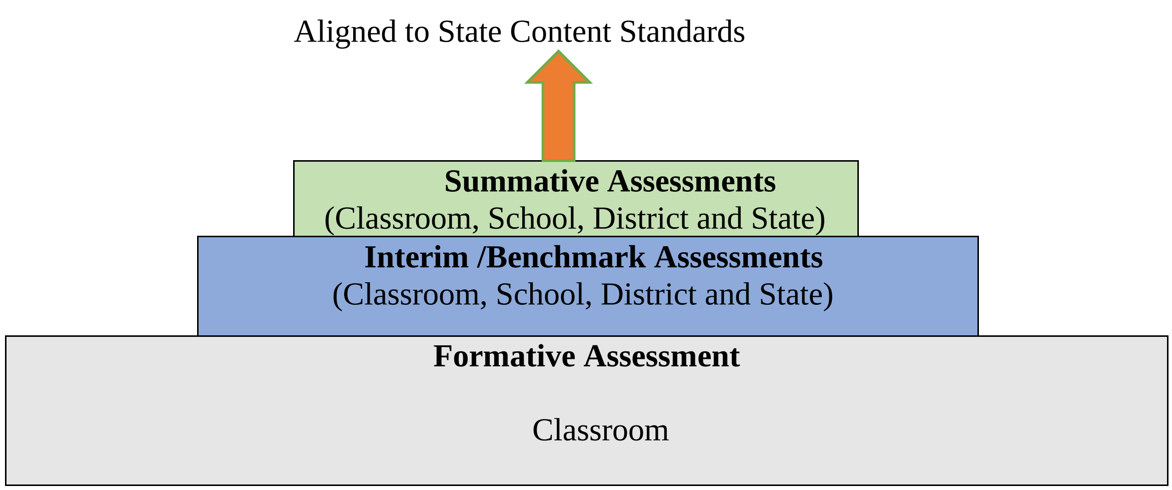
The use of summative assessment still carries more weight than formative assessment. Until recently formative assessment carried only 15% of the student assessment value with interim and summative assessment carrying 15% and 70% respectively (Darling-Hammond, Wilhoit, and Pittenger, 2014). A paradigm shift is required in the way students are assessed and the NCDPI has proposed that at least 50% of the school assessment should be done through formative assessment (NCDPI, 2019). However, the modalities of how this is going to be possible remains unclear. The Council of Chief State School Officers (2015) stated that as States and districts explore how to balance assessments within their current systems, they must carefully evaluate each assessment's purposes, usage, intended beneficiaries, implementation costs, and potential benefits to stakeholders. Additionally, when introducing new assessment tools, States must review their purpose and use in relation to existing assessments. Such reviews are crucial for ensuring an efficient system, but they may entail challenging decisions, especially when a new assessment tool or strategy is intended to replace a well-liked but obsolete or misaligned one. To make informed decisions, stakeholders must be aware of the available options and evaluate each one's strengths and weaknesses. Consequently, such assessments should be chosen based on alignment with intended outcomes and that are most beneficial to the stakeholders.

North Carolina assessment systems

The State of North Carolina has standardized Statewide assessments which generally follow the pyramid shown as Figure 2.1 below. While formative assessment is widely used in schools, there is however more value is placed on summative assessment than on formative assessment in most school districts.

Figure 2.1

North Carolina's Balanced Assessment System. Adapted from the Council of Chief State Schools Officers (CCSSO).



North Carolina's Statewide Balanced Assessment System for Schools K-12

The State acknowledges the importance of formative assessment from the Pre-K through K12 educational program. In 2006, the Council of Chief State School Officers (CCSSO) developed and adopted the following definition of formative assessment:

Formative assessment is a process used by teachers and students during instruction *that provides feedback to adjust to adjust ongoing teaching and learning to help students improve their achievement of intended instructional outcomes (CCSSO, 2008)*

The State recognizes the four key words in the way formative assessment was defined with the first word being ‘Process’. Formative assessment is a process rather than a product and CCSSO encourages teachers to limit testing when implanting formative assessment due to its lack of barrier for students. Formative assessment is a continual process that occurs minute by minute, day by day (Leahy et al., 2005). Formative assessment, therefore, allows for constructivism in learning since the process builds knowledge from what is already known.

The second key word is ‘*during*’. Formative assessment according to the State of North Carolina occurs during instruction when students should be expected to make mistakes. Hence teachers should plan ahead and anticipate mistakes students will make and be ready to address misconceptions and gaps in understanding. Formative assessment does not take place after instruction (CCSSO, 2005).

The third key word is ‘feedback’ which helps in redirecting students and motivate them to explore deeper into concepts (NCDPI, 2013). The fourth key word is ‘students.’ It is important for students to be engaged in their learning through participation in formative assessment. This engagement allows students to answer three questions (Sadler, 1989) about where they are going, where they are now and how they could close the existing gap or advance in what they already know. By looking at Saddler’s ideas about the three questions, there is a strong relationship between formative assessment and constructivism in learning (Magwaya, 2014).

Marzano (2006) reported that the North Carolina State Board of Education and Department of Public Instruction is committed to developing a K-3 assessment system that is comprehensive and identifies the needs of individual students, thereby informing instruction and promoting academic success. According to Black and William (1998) and William and Thompson (2007), formative assessment use by teachers significantly enhances student engagement and produces significant academic gains, particularly among low-achieving students. This method has been shown to have the most significant effects among all education interventions ever reported. Thus, it is essential to implement such assessments to support students' academic progress and ensure that their individual needs are met through instruction.

Formative assessment has been taken seriously from the early years to ensure growth with sustainability (NCDPI, 2012). Numerous studies indicate that a strong foundation during the early years (Pre-K – Grade 3) can decrease the achievement gap between low-income and middle-class children (Graves, 2006; Reynolds, Ou, and Topitzes, 2004). Additionally, academic achievement improves when programs adhere to a Pre-K – Grade 3 philosophy that fosters continuity and consistency in learning experiences and expectations (Graves, 2006). Formative assessment is a crucial tool that supports and guides effective learning and teaching in real-time.

The approach to learning that a child adopts has a significant impact on their physical well-being, which is crucial for cognitive and language learning, as well as social-emotional development, which in turn influences their approach to learning (Dweck, 2006). Thus, progress in one area is interconnected with development in other domains (Copple and Bredekamp, 2009).

Therefore, it is essential to provide children with a solid foundation in their early years to ensure that they have the necessary tools and resources to succeed academically and socially. Educational programs should incorporate formative assessments, and educators should have a Pre-K – Grade 3 philosophy to provide consistency and continuity in learning experiences. By addressing the interconnectedness of various domains, children's holistic development can be fostered, resulting in well-rounded individuals. Formative assessment in North Carolina is rooted in five domains of learning from a child's early years in school as illustrated in Figure 2.2 below. These domains demonstrate the importance of formative assessment in students' learning by involving their socio-emotional, cognitive, language and physical skills. The socio-emotional domain may be useful in establishing how students perceive assessment for learning.

Figure 2.2

North Carolina developmental progression for formative assessment. Adapted from EdNC

Domain	Developmental progression towards formative assessment
Social-emotional	• Manages feelings. • Responds to emotional cues. • Interacts with peers. • Solves social problems. • Follows limits and expectations.
Cognitive/ Mathematics	• Counts. • Quantifies. • Connects numerals to quantities.
Cognitive/ Approaches to learning	• Attends and engages
Language and literacy	• Notices and discriminates rhythms • Notices and discriminates alliterations • Tells about another place and time

	• Follows directions
Physical	• Uses fingers and hands

Note. North Carolina envisioned stages of formative assessment in schools

The State currently has five online modules to assist teachers in transitioning towards formative assessment (NCFALCON, 2020). There is also a movement which is gaining traction in the State legislature that is hoping to reduce the number of summative assessments and have students being assessed formatively to reduce school induced mental stress (NCDPI, 2019).

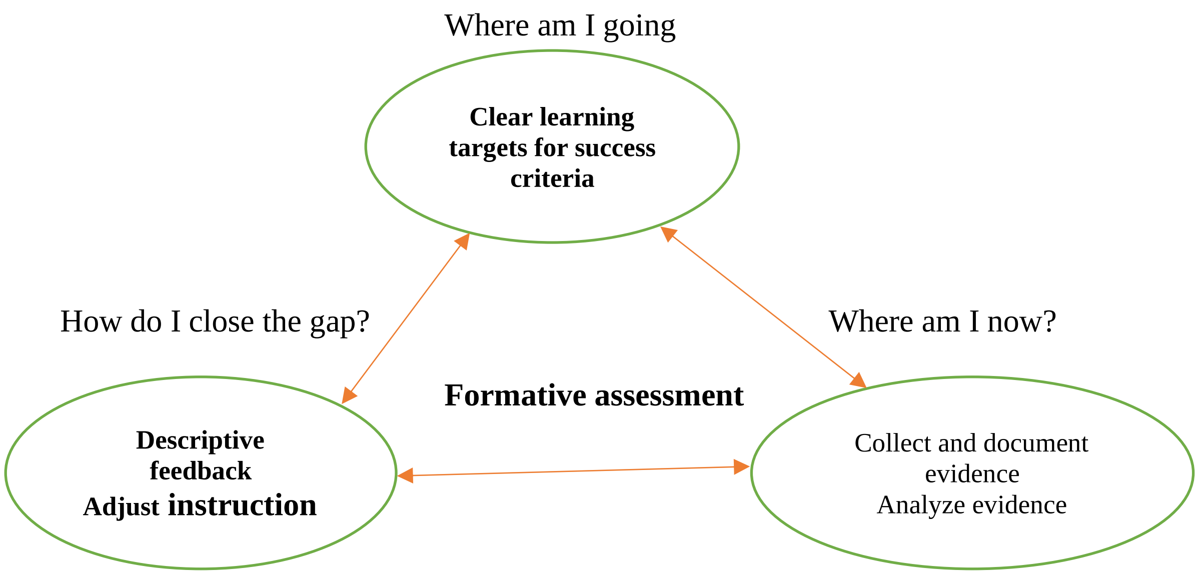
Formative assessment models

The North Carolina Formative Assessment Learning Community and Online Network (NCFALCON) came up with a model to explain formative assessment in the State public schools as shown in Figure 2.3 below. The model is a tri-cyclic one with each part of the model responding to questions that are related to the learner's levels of mastery of concepts (NCFALCON, 2019). Formative assessment allows you to evaluate students' performance in real-time and improve the course content and delivery during the learning process. It makes it easier for teachers to track the performance of students during a course or training program (NCDPI,2016).

Since formative assessment happens on the go, it is best described as a quick-fire method of monitoring the learner's progress (Branham and Johnson, 2014). The model by NCFALCON takes on board the needs of both the teacher and the student as each question on the model may be adapted to fit for either the student or the teacher as formative assessment is designed to inform or generate data which could be used to improve students' performance (Pitt County Schools, 2019). The model may be used to appreciate how students' self-regulated learning can be achieved. This could be at the levels of the “Where am I going and how do I close the gap?” from the learners’ perspective.

Figure 2.3

Formative assessment model. Adapted from NCFALCON (2019)



Note. A triadic linkage of factors influencing formative assessment in schools.

Branham and Johnson (2014) came up with a more detailed model of formative assessment which has more stages that include the pre-assessment stage up to until where the student is able to reflect on performance based on success criteria and instructions. Although the two models are different, they can be used comparatively to understand the development of formative assessment. Figure 2.4 shows the linkages of concepts in the process of formative assessment. The Branson and Johnson model states that formative assessment cyclic and interconnected with learning outcomes being connected to student data, and the student data linked to informed instruction and data analysis. Such a connection leads to self-reflection. The model has a strong relationship to the

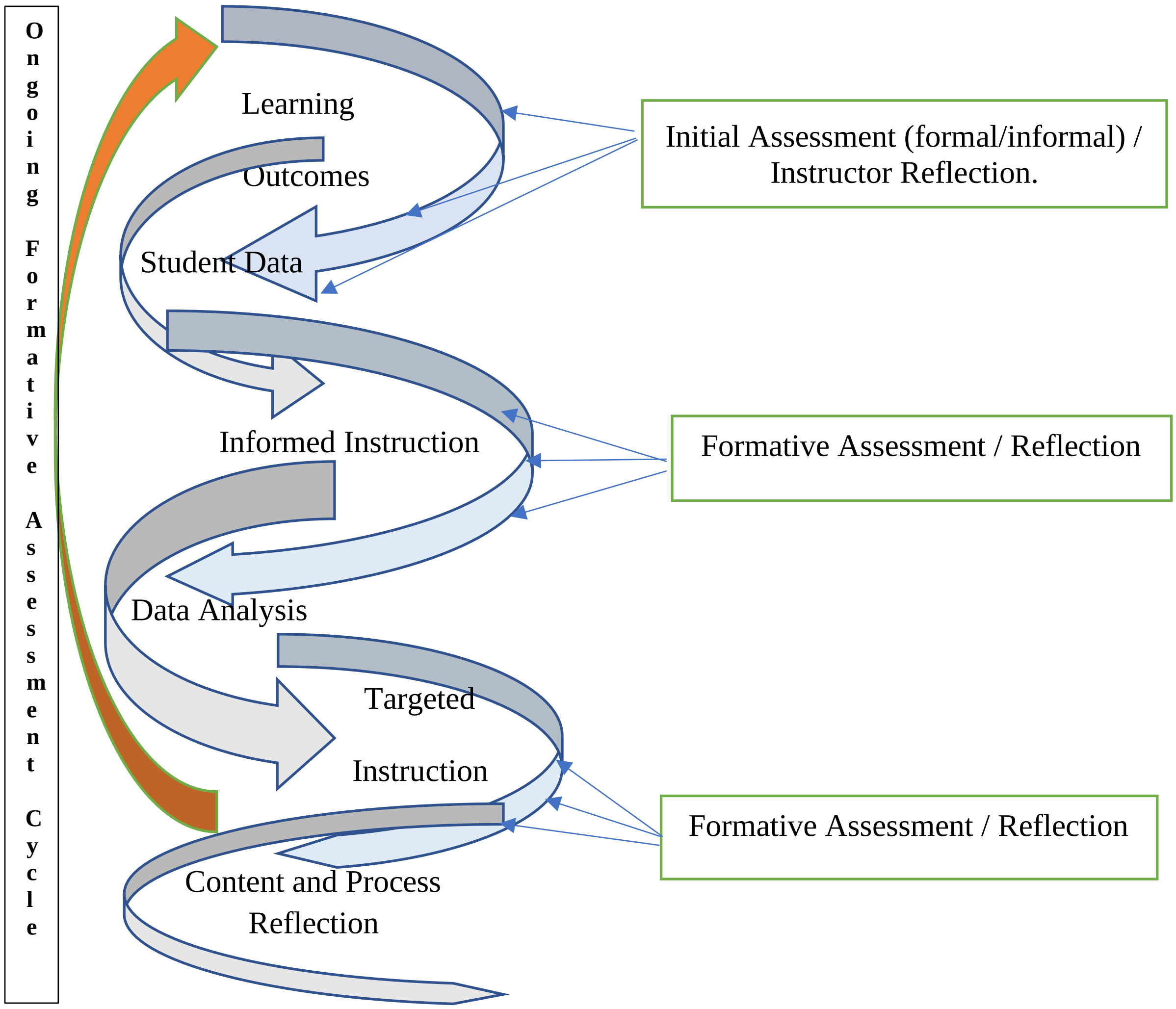
Triadic model in that the teachers' and students' reflections will lead the student to the three questions in the Triadic model.

The way students perceive assessment has a bearing on how they progress in their studies a positive perception of assessment results in them having clear learning targets and independence in the way they reason, whereas a negative perception brings fear of failure and over dependence on those viewed to be better placed to understand. This results in the learner losing confidence and failing to recognize where they are in terms of knowledge (Dodge, 2018). Establishing how students perceive assessment would ensure that educationists and other stakeholders create ways that ensure a positive approach towards assessment for all involved. While the State has come up with so many plans on how to implement formative assessment in schools there is a gap about how self-regulated learning could be encouraged among students.

The same model may also be used in investigating how teachers plan and implement formative assessment. This could be analyzed from the initial instructor reflections on learning outcomes and student data through targeted instruction and informed data. By using the model teachers may be able to differentiate instructions and allow students to construct new ideas and self-assess themselves as the reflect both the content and the learning process. This will encourage students' self-regulation, motivation and self-efficacy.

Figure 2.4

Model of formative assessment. Adapted from Branham and Johnson (2014).



Note: Spiral linkages of formative assessment both formally and informally with reflections.

2.3: Theoretical framework of the study

The aim of this study is rooted in the need to understand how teachers and students alike perceive formative assessment and how self-regulated learning could be encouraged. The theoretical framework of this study holds that 'knowledge is not mechanically acquired, but actively constructed within the constraints and offerings of the learning' (Liu and Matthews, 2005:387).

The genesis of constructivism in education may be linked to the various ways through which people acquire knowledge and may be traced to the works of Piaget (1971). Piaget's view on learning has supported the application of active involvement of children in their learning, with far-reaching implications for classroom practice. For example, activities that promote problem solving skills are in accordance with cognitive constructivism. Piaget advocated for student-driven education where teachers should provide a plethora of learning activities that allow students to utilize their interactions with their environment to enhance learning. For example, activities that promote problem solving skills are in accordance with cognitive constructivism. Since students interact with the environment independent of each other.

Piaget's studies also laid the foundations for differentiated learning where students' learning abilities are considered to be different. Piaget's work was also supported by Bruner (1961) who agreed with Piaget that children are curious learners and as such the purpose of education should not be about imparting knowledge, but instead to enable a child to think and solve problems, abilities which could then be transferred to a range of situations. This study will follow the constructivist approach in establishing how students and teachers' perception of assessment shapes the way knowledge is constructed.

Other scholars who advocated for constructivism in education include Dewey and Vygotsky. Dewey (1916) believed that students extend their personal knowledge structures through active engagement with others hence the need to acknowledge and utilize peer effects on students learning. Students can engage with those around them to construct new ideas through experiences they gain from those around them (Hacker et al., 1998).

The researcher would therefore take this approach to understand how students create knowledge through self-regulation, teacher and peer input. Bruner and Piaget's followers such as McInerney and Mclnerney (2002) argued that knowledge is not directly transmittable from person to person, but rather is individually and idiosyncratically constructed or discovered. The discovery of knowledge in a school set up may be a product of stakeholder interactions.

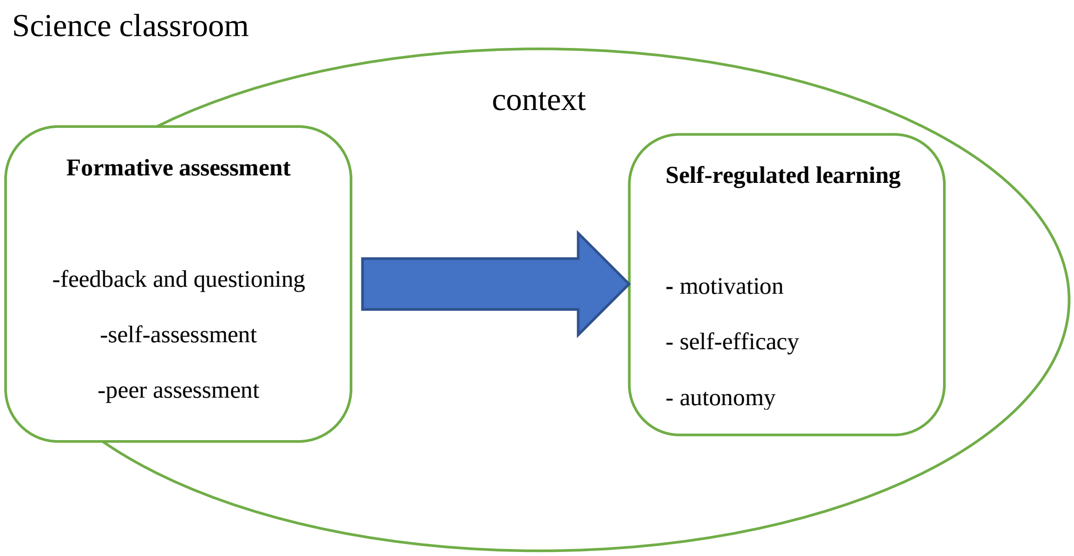
Hacker et al., (1998) posited that activating students as owners of their own learning brings in metacognition, motivation, interest, and self-assessment. As students become more engaged in their learning, they begin to perceive their learning and assessment differently. It is for this reason that I chose to use the constructivist theory since formative assessment encourages students to create their knowledge from their life experiences. Gaining more knowledge about how students construct knowledge through formative assessment could be used to better understand how they perceive formative assessment in particular, and assessment in general (McInerney and McInerney, 2002).

The theoretical grounding of formative assessment and self-regulated learning as discussed by Black and Wiliam (2009) posited that there are three key processes in learning and teaching which are establishing where students and teachers are in terms of their learning, establishing where they are going in their learning and establishing what needs to be done to get students where we intend to have them. Understanding these three important questions will enable the researcher to analyze how teachers and students construct knowledge.

After a careful look at what previous research found on formative assessment, I chose to investigate feedback and questioning, self-regulation, autonomy, self-assessment, and peer-assessment as basic aspects of formative assessment. It was pointed out that self-efficacy, student autonomy and motivation were also chosen as basic aspects of self-directed learning (Andrade, 2019; Huisman, 2019 and Logan, 2009). While these are interlinked in this study, I intend to establish how teachers' and students' perceptions of assessment impact on these phenomena. Perception in this case is behavioral and is a process that begins with receiving stimuli from the classroom environment through instructions, objectives, learning activities and ends with the interpretation of those stimuli (OECD, 2009). Figure 2.5 below shows the theoretical framework for this study. Formative assessment with self-assessment, peer assessment, feedback and questioning feeds into self-regulation. This would then promote motivation, self-efficacy and learner autonomy.

Figure 2.5

Theoretical framework of this study



Note: Theoretical framework of the study showing how formative assessment and self-regulated learning are linked to other phenomena in the classroom.

2.4: Constructivism

Matthews (2003) describes constructivism as a learning philosophy that centers on individuals constructing their own understanding of the world by reflecting on their experiences. When students construct their knowledge, they become motivated and more self-regulated since they would take control of when and what they learn.

Constructivism is an epistemological position that claims that people develop their intelligence and construct their knowledge through action in situation and by reflection on their actions and the results of those actions (Masciotra, 2020). People apprehend and comprehend new situations by means of what they already know and modify their previous knowledge in order to adapt to the new situation. Each adaptation to a situation progressively expands and enriches the network of previous knowledge at their disposal, which enables them to deal with increasingly complex situations.

In this study, learners will be expected to reflect on their past experiences as they construct new and related knowledge from various classroom interactions. Constructivism assumes that conceptual understanding is constructed from the interaction of new and old experiences within the mind of the individual (Piaget, 1967; Airasian and Walsh, 1997; Vrasidas, 2000). It is hoped that when students interact with their peers, their teachers and other stakeholders during their learning they should be able to tap from their experiences to academically develop themselves. Learners' past experiences therefore has a bearing on how children learn and how they progress. The educational philosophy of constructivism originated from Epistemology and was introduced to educational psychology by Jean Piaget (1896-1980) in his cognitive development theory (Adam, 1990). Educators rely on constructivism as a critical learning theory to facilitate their students' learning process. It is essential for instructors to comprehend constructivism as it influences the learning methods of students (Mangwaya, 2014).

Teachers who embrace constructivist learning theory understand that students bring their individual experiences to the classroom every day. By acknowledging this, educators can create meaningful learning opportunities that build upon students' existing knowledge, thus promoting active learning and personal growth. Their background and previous knowledge impacts how they can learn and adapt to science lessons. This would then help in how teachers plan and implement assessment for learning during classes. Without a clear understanding of where students are coming from there is a danger that assessment for learning may become meaningless. Constructivism may be used in enhancing learner self-regulation, self-efficacy and intrinsic motivation.

The basic principle of constructivism is that knowledge is built upon pre-existing knowledge and that students construct their knowledge in unique ways by putting together different pieces from experiences beliefs and insights (Piaget, 1971). Constructivists assume that when using techniques designed to provide experience for students, the students will show an elevated level of ownership for that understanding compared to alternative instruction methods (Alters and Nelson, 2002). WGU (2020) pointed out that in constructivism, people learn to learn as they learn and that the process of learning is an active process. It becomes meaningful and easier for students to construct knowledge through combining prior experiences and community of learning active participation. Learning is a process of constructing meaning through sensory input. It is an active rather than passive activity, requiring learners to engage with the world around them to promote their own learning and development.

Social interaction plays a vital role in learning, as it involves teachers, peers, parents, and the community. Progressive education acknowledges the significance of social interaction in learning and utilizes conversation, interaction, and group activities to promote knowledge retention among students (WGU, 2020; Carrol, 1996; Mangwaya, 2014).

Educators need to recognize that learners come from different backgrounds, possess distinct learning styles, and bring their own experiences to the classroom. By embracing social interaction as a cornerstone of learning, educators can create inclusive learning environments that cater to students' diverse needs. Through social interaction, learners can engage in collaborative learning, receive feedback, and gain insights into different perspectives, promoting deeper understanding and critical thinking. It should be noted that, the active participation of learners in social interaction facilitates the construction of meaning, leading to meaningful and lasting learning outcomes.

According to the constructivist learning model, students actively construct knowledge with the guidance of teachers, rather than passively receiving it (Mangwaya, 2014). This study employs the interpretation-construction design model and problem-based learning as a constructivist paradigm for learning. Honebein (1996) advanced a set of goals that aid the design of constructivism in learning settings. These goals are to:

> "Provide experience with the knowledge construction process. There is need to provide experience in and appreciation for multiple perspectives. Embed learning in realistic and relevant contexts. Another goal is to encourage ownership and voice in the learning process. Embed learning in social experience and encourage the use of multiple modes of representation; and finally, the need to encourage self-awareness in the knowledge construction process." (Honebein, 1996 p. 11)

Interpretation-construction design model emphasizes the importance of students' building interpretations from authentic observation, discussion of interpretations, reflection, analysis, and conclusion of interpretations. The principles of interpretation-construction model consist of observations in authentic activities, interpretation of construction, contextualization, cognitive apprenticeship, collaboration, multiple interpretations, and multiple manifestations (Zulkarnaen, 2019).

Problem-based learning is a student-centered instructional approach that enables learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution for a specific problem (Mangwaya, 2014). This approach differs significantly from conventional learning, where the teacher's role shifts from that of an information provider to a facilitator. The transition of this role may pose a challenge for many teachers (Zulkarnaen, 2019). Problem-Based Learning is characterized by several key principles that contribute to its effectiveness as an instructional approach. First, PBL emphasizes the use of authentic, real-world problems as the starting point for learning (Savery and Duffy, 1995). These problems are complex and ill-structured, requiring students to engage in higher-order thinking and problem-solving skills. Second, PBL promotes active learning by shifting the role of the instructor from a content provider to a facilitator (Hmelo-Silver, 2004). Students take ownership of their learning, actively seeking and constructing knowledge through collaborative discussions and research. Third, PBL encourages self-directed learning and the development of lifelong learning skills (Hmelo-Silver et al., 2007). Students learn how to identify their own learning needs, set goals, and seek resources independently.

Problem-Based Learning aligns closely with the principles of Constructivism. PBL emphasizes active learning and the construction of knowledge through the process of problem-solving. By working on authentic problems, students engage in meaningful tasks that require them to integrate new information with their prior knowledge, as suggested by Constructivism. Additionally, PBL fosters social interaction and collaboration, providing opportunities for students to engage in dialogue, negotiate meaning, and construct shared knowledge, in line with the constructivist perspective. The social nature of PBL promotes the development of communication and teamwork skills, which are crucial in constructivist learning environments.

Integrating Problem-Based Learning in constructivist learning environments offers several benefits to students. Firstly, PBL promotes active engagement and deeper understanding of the subject matter (Hmelo-Silver et al., 2007). By tackling authentic problems, students develop a more comprehensive understanding of the concepts and their applications. Secondly, PBL fosters critical thinking and problem-solving skills (Barrows and Tamblyn, 1980). The complex problems encountered in PBL require students to analyze, evaluate, and generate solutions, enhancing their higher-order thinking abilities. Thirdly, PBL enhances motivation and student ownership of learning (Hmelo-Silver, 2004). The authentic nature of PBL tasks and the opportunity for self-direction contribute to increased engagement and motivation among learners.

Problem-Based Learning and Constructivism share common principles and align closely in their approach to learning. PBL's emphasis on active learning, collaboration, and problem-solving makes it well-suited for constructivist learning environments. By integrating PBL into constructivist classrooms, educators can create engaging and meaningful learning experiences that promote deeper understanding, critical thinking, and student ownership of learning.

Constructivists agree on the facts that learning must involve the mind through hands-on experiences and physical activities are necessary for learning, and all these must motivate the learner. The success of constructive learning is impacted by motivation (Adams 1990). There are different types of constructivism that may be used by educators to motivate and enhance learning which include cognitive constructivism (Piaget), social constructivism (Vygotsky) and radical constructivism (Glasersfeld).

Cognitive constructivism focuses on the idea that learning should be related to the learners' stage of cognitive development (Piaget, 1971). When learners' learning material is mal aligned with their cognitive levels then they will struggle with the learning process (Mangwaya, 2014). Cognitive constructivism is characterized as a range of psychological perspectives, pertaining to cognitive processes and representations in learning that can be delineated to understand the individual and the society (Derry, 1996). Understanding how the individual constructs knowledge and how society provides an enabling environment for such growth is a major focus of cognitive constructivism (Anderson et al., 1996, Cobb and Yackel. 1994). Cognitive constructivists agree that knowledge construction is related to the students' stage of cognitive development hence the need to scaffold instruction according to learners' experiences (Derry, 1996). These methods work to help students in acquiring new knowledge by connecting ideas to things already known and enabling them to make modifications in their intelligence to accommodate new information (Mangwaya, 2014). This study aims to fill the gap on how cognitive constructivism may be used in enhancing self-regulation in students.

The surge in technology has resulted in our learners losing their abilities to be constructive learners as learning materials have now been commercialized. This shift has the potential to undermine the quality of materials presented and disrupt the educational process (Bull, 2013). One group of technologies that is increasingly of interest to instructors is social media. At present, social media platforms have piqued the interest of educators. Social media refers to web-based tools that encourage user-generated content, collaboration, and interaction (Surowiecki, 2005).

O'Reilly (2005) identifies these platforms as a subset of Web 2.0, characterized by a shift in perspective from perceiving the internet as an information retrieval system to a participatory platform. Facebook, Twitter, YouTube, FourSquare, and various wiki-style sites have firmly integrated themselves into the personal lives of most students (McLoughlin and Lee, 2008), which provides educators with the opportunity to customize course materials to facilitate and achieve learning objectives. Instructors can take advantage of social media sites' features to foster engagement, enhance communication, and create a personalized learning experience. For instance, Facebook groups can be established for discussions, Twitter hashtags can be utilized to share information, and YouTube videos can be embedded to illustrate concepts (Al-Rahmi et al., 2015). Therefore, using social media platforms in education could provide a more engaging and interactive learning experience that fosters better learning outcomes.

To ensure that students benefit from constructive cognitive learning, teachers need to involve student in the creation on digital materials at cognitive appropriate levels. The influence of Piaget’s cognitive constructivism is still being noticed in differentiated instructions in the classroom. However, the theory has not been spared from criticism as Matthews (2003) pointed out that the theory fails to acknowledge that the learners’ experience is not driven by the individual but by those around the individual, therefore there is no individual independence and creativity.

Social constructivism emphasizes the collaborative aspect of learning and holds that knowledge is constructed through social interaction. Anderson et al., (1996) posited that individuals rely on others to construct their building blocks of knowledge, and, in turn, help create others' knowledge. Furthermore, learning is influenced by one's culture and society. Social constructivist theory is based on the belief that knowledge is constructed through dialogue and interaction with others, as per Vygotsky, who is widely recognized as the father of social constructivism (Vygotsky, 1978). With the rise in the use of social media applications and platforms is unavoidable for science teachers to involve students in the generation of scientific knowledge using emerging technologies (Churcher et al., 2014).

Assessment practices greatly influence students' perception of their learning experiences. When assessment aligns with the principles of social constructivism, students are more likely to view assessment as a means for meaningful learning rather than a mere evaluation of performance. They perceive assessment as an opportunity to engage in collaborative problem-solving, receive feedback, and reflect on their understanding. Such assessments foster a positive learning environment that values students' active participation, encourages their autonomy and responsibility, and supports their development as lifelong learners.

Educators should consider the link between social constructivism and student perception of assessment when designing assessment strategies. Incorporating social constructivist principles into assessments can enhance students' engagement and perception of their learning experiences. Educators can implement group projects, peer assessments, and collaborative problem-solving tasks to promote social interaction, negotiation of meaning, and the construction of shared knowledge. Providing timely and constructive feedback that supports students' learning and growth further enhances the alignment between assessment and social constructivism.

The link between social constructivism and student perception of assessment highlights the importance of aligning assessment practices with the principles of social constructivism. When assessment promotes collaborative learning, meaningful tasks, and the construction of shared knowledge, students perceive assessment as a valuable part of their learning experiences. By incorporating social constructivist principles into assessment strategies, educators can create a positive learning environment that fosters active engagement, collaboration, and a deep understanding of the subject matter.

Another type of constructivism is radical constructivism which is very different from cognitive and social constructivism. Radical constructivism is a philosophical theory that posits that knowledge is not a reflection of objective reality, but rather a construction of the individual's subjective experience. The theory emphasizes the role of the individual in constructing their understanding of the world and suggests that there is no objective reality that exists independent of the knower. Radical constructivism has been applied in various fields, including education, psychology, and communication. The philosophy of radical constructivism focuses on the concept that students and the knowledge or ideas they construct tell us nothing real, only help us function in our environment. The overall idea is that knowledge is invented, not discovered (Glasersfeld, 2001). The study of science requires a revolutionary paradigm shift where learners become innovators and inventors of completely new knowledge and cease to recycle and re-invent on the old ideas. This study would, however, rely on very little from this type, except for the discovery component as it works well with innovation and autonomous learning.

Radical constructivism highlights the role of learners as active constructors of knowledge. Formative assessment practices that align with radical constructivist principles focus on providing timely and specific feedback that guides students' understanding and promotes reflection on their learning processes. These assessments recognize the individual nature of knowledge construction and emphasize the importance of student agency and self-regulation. Teachers who adopt radical constructivist principles in formative assessment value student perspectives, encourage metacognitive awareness, and provide opportunities for students to actively engage in self-assessment and goal setting.

Formative assessment practices significantly influence teachers' perceptions of their instructional practices and student learning. When formative assessment aligns with the principles of radical constructivism, teachers perceive assessment as a means for understanding and supporting student construction of knowledge. They view assessment as an ongoing process that helps them identify students' misconceptions, tailor instruction to individual needs, and foster student engagement and self-directed learning. Teachers who embrace radical constructivist principles in formative assessment develop a deeper understanding of student thinking and adjust their instructional strategies to meet students' diverse learning needs.

Educators should consider the link between radical constructivism and teachers' perceptions of formative assessment when designing assessment strategies. Incorporating radical constructivist principles into formative assessment practices can enhance teachers' understanding of student learning processes and promote student agency. Educators can provide opportunities for students to engage in self-assessment, reflection, and peer feedback. They can also use open-ended tasks that encourage students to construct and share their understanding. By adopting radical constructivist principles, educators can create a supportive learning environment that fosters student autonomy, metacognition, and deep understanding.

This study followed the constructivist learning theories in understanding how educators and their students view formative assessment and how their perception can be used in promoting self-directed learning among students. Constructivism is a theory about knowledge and learning that describes what knowing is and how the process of knowing is achieved (Fosnot, 2005). Constructivists regard knowledge not as truths to be transmitted or discovered but as emergent developmental explanations made by meaning making individuals. Liu and Matthews (2005) pointed out that constructivists consensually hold that knowledge is not mechanically acquired, but actively constructed within the constraints and offerings of the learning environment. Fosnot (2005) noted that when individuals learn by constructing new representations and models of reality, they will be involved in self-regulated learning. The author justified this by stating that constructivists regard the classroom as a mini society or community of learners engaged in activity, discourse, interpretation, justification, and reflection.

The constructivist perspective views the student’s involvement in the process of learning as essential, and therefore advocates the use of strategies such as self- assessment and self-regulated learning (Saddler, 1989). It is the empowerment of learners through active participation and reciprocity that Liu and Matthews (2005) argued that constructivism will alter how both teachers and students would perceive formative assessment. The authors contend that increased interaction between the teacher and the student that is brought about by the constructivist paradigm ensures that formative assessment and feedback are viewed as learning aids. The use of formative assessment to support learning is part of the shift from a testing culture toward constructivist ideals in education (Gipps,1994).

Constructive learning was described by Folashade and Akinbobola (2009) as a problem-based learning approach which is based on cognitive theory of learning which holds that learning takes place because of intuition that is, the individual intuitively brings a number of events together to serve a purpose in solving a particular problem at a particular time. It is a learning approach that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner' (Elliott et al., 2000). Accordingly, Fosnot (2005) added that it is a learner-centered instruction that allows students to use technology tools to connect new information to their prior knowledge.

Constructivism was defined as a theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas (Mishra and Kaur, 2018). The authors argued that the constructivist view of learning is based on the premise that learners construct their own personal meaning out of a given education experience. Constructivism is a learning theory which states that people learn best when they actively construct their knowledge. Duffy et al., (1993) posited that knowledge construction can be made possible by solving authentic problems, which usually requires collaboration with others. Accordingly, Piaget also pointed out that learning occurs by an active construction of meaning, rather than by passive resilience. He explained that when learners, encounters an experience or a situation that conflicts with their current way of thinking, a state of disequilibrium or imbalance is created. They must then alter their thinking to restore the equilibrium or balance. To do this, learners should make sense of the new information by associating it with what they already know, that is, by attempting to assimilate it into their existing knowledge (Mishra and Kaur, 2018).

Studies by Yildirim et al. (2001) revealed that students who are exposed to the constructivist way of learning were 60% more likely to retain learnt concepts about three months after an exam while those who were exposed to traditional learning methods were 15% likely to remember their learnt concepts after the same period. For this reason, Mishra, and Kaur (2018) pointed out that the constructivist approach allows learners to relate what they learn to reality making it an educational tool for life. Mishra and Kaur (2018) also posited that constructivist approaches towards learning improves the way students perceive learning as they feel that they have control over what they are learning.

According to Juniu (2006), constructivists assert that students construct their own understanding by actively engaging in the learning process and building their own representations of knowledge.

This approach is based on the idea that learning takes place through thinking and doing, and that reflection or thinking results from an activity (Jonassen et al., 1999). In a constructivist classroom, students interact with the learning environment and generate their own understanding of the world instead of passively receiving information from the teacher (Jonassen, 2000). Thus, the constructivist approach emphasizes the role of the student as an active participant in the learning process, rather than a passive recipient of information. It was also pointed out that formative assessment as offered by constructivists puts the teacher as a facilitator of learning whose purpose is to trigger students' curiosity to investigate and learn more on the topic (Juniu, 2006). Constructivist views offer students an opportunity for acquiring knowledge that will be applied to practical situations and for reflecting on the content learned (Bazilion and Braun, 1998; Jones, 1996). Constructivist's structure formative assessment and learning to promote collaborative learning and encourages both learners and educators to perceive formative assessment as a combination of doing and learning collaboratively (Moursound, 1999). The value of teamwork has the potential to elicit changes within the individual. The construction of meaning through collaboration with others and project-based learning is an approach that facilitates problem-solving activities among learners, and it is viewed as a process that is problem oriented and encourages collaboration (Juniu, 2006).

Junui (2006) recognized the impact of technology in learning and assessment as these can be used in exploration and reflection of learning. The constructivist theory posits that technology can be utilized to facilitate learning. Mindtools, a type of computer software, can aid in the creation of interactive, collaborative, and student-centered classrooms. As per Jonassen et al. (1999), inquiry-based software such as databases, spreadsheets, simulations, and multimedia can support thinking activities and enable students to articulate their knowledge by constructing their representations of the problem. Through the utilization of such technologies, students can engage in active learning and construct their understanding of the topic at hand. This was also supported by Junui (2006) who pointed out that when education embraces technology and the worldwide web and encourage learners to create and reflect on their ideas using the computer, they will become creators of data and not just consumers of computer-generated data. When technology is used in assessment that way, students develop a positive liking of assessment as they will be able to express themselves more than they would have done if they were only retracting data from the web, their teachers, or textbooks, hence they begin to construct new ideas from their experiences (Junui, 2006).

Jonassen (2000) proposed that software, such as Inspiration, can aid in the concept mapping and planning process. This type of software allows students to visualize their ideas and arrange their thoughts to initiate a project or activity. This constructive activity permits learners to assess the strategy required to solve a given problem. By creating a concept map, the students develop a visual diagram with a central node that represents the main concept. They connect the central node with multiple links to explain an outline of the plan of action. Technology provides an excellent motivational tool that allows learners to design and instruct others by creating a product and sharing their expertise with peers (Budin, 1999). In this way, learners can actively participate in the learning process, which can help to foster engagement and promote knowledge retention. Therefore, the use of technology in the classroom can enhance the learning experience by providing opportunities for active engagement and collaboration. This is another way of promoting self-regulated learning among learners. NCDPI (2019) also pointed out that when students are encouraged to use technology such as their smartphones to design and construct schoolwork for formative assessment, they become more engaged and use their gadgets constructively. School work becomes part of their playtime, and they begin to perceive formative assessment with greater zeal.

Furthermore, it should be noted that active participation by students in assessment design, choices, criteria and making judgments is a more sustainable preparation for subsequent working life (Boud and Falchikov, 2006). It was further suggested by Brew (1995) that when students construct their own ideas and tasks from what they would have been introduced to them, they do not just to solve the problems we already know the answer to, but to solve problems we cannot now even conceive. That way constructivists believe humanity will be better prepared for the unknown future. Boud and Falchikov (2006) also argued that formative assessment from a constructivist point of view takes students' perceptions onboard before embarking on the process of learning and developing learning targets with that in mind. This allows students to have a direct role in influencing their learning process hence students will perceive formative assessment from an informed viewpoint. To come up with a positive paradigm shift in the way students view formative assessment, educators need involve them in the formulation of what they would be learning (Spiller, 2012). The author defends this by claiming that when knowledge is developed from the known then the unknown will be revealed earlier than when the learning concepts are developed away from those who must learn. Studies by Tynjala (2006) revealed that students who took constructivist class were better placed than their counterparts who had not been involved in constructivist formative assessment.

According to the study, the group of students exposed to the constructivist approach prioritized the development of their thinking skills compared to the control group. They also displayed a greater understanding of the constructivist theory of learning. Although the examination answers of the control group were lengthier, the constructivist group produced answers that contained more classifications, evaluations, comparisons, and generalizations. Furthermore, the structure of the observed learning outcome level was more advanced in the constructivist group compared to the control group. From these findings, it is evident that a constructivist learning environment can produce higher-level learning outcomes more effectively than traditional teaching approaches. In other words, the constructivist approach can facilitate the development of students' critical thinking skills, resulting in a deeper understanding of the material. Reeves, Harrington, and Oliver (2002) supported the findings by pointing out that in constructivist learning and assessment, all learning concepts are as close to real life challenges as possible hence students will relate more to reality and tend to perceive assessment as solving real life experiences.

It has been stressed that project-based learning and assessment that may include the design of 3D models in science is another way of promoting students' involvement in their learning as they are able to describe and discuss why they came about with their models (Spiller, 2012). When students construct something, they become more confident when they explain to their peers and teachers about how they would have come up with ideas (NCDPI, 2019). Furthermore, Spiller (2012) argued that constructivism in formative assessment reduces the stress associated with summative assessment as students are more comfortable in receiving feedback from what they would have constructed. If constructivism in formative assessment reduces students stress, then this study would investigate if this would also translate to perception.

2.5: Formative assessment

The notion of formative assessment has been in existence since the early definitions by Bloom, Hastings and Madaus (1971), Ramaprasad (1983), and Sadler (1989). The term "formative assessment" has since been used interchangeably with "assessment for learning" (Assessment

Reform Group, 1999; Black, 2003; Earl, 2003), and the two are now deemed conceptually identical. Formative assessment involves gathering and using information on student learning in making decisions about teaching and learning in the classroom to better serve the needs of the students (Black and Wiliam, 2009). According to Tierney and Charland (2007), formative assessment is a collaborative act that requires interaction between teachers and students, making it inherently social and more consistent with social constructivist theory (Allal and Ducrey, 2000; Gipps, 2002; Shepard, 2000, 2005; Torrance and Pryor, 2001).

In the educational setting, formative assessment is an activity that collects feedback on the teaching and learning process to inform the actions of teachers and students. The terms "formative assessment" and "assessment for learning" are used interchangeably, with the purpose of assessment for learning being to promote students' learning (Black et al., 2003). It should be noted that formative assessment should not be confused with any form of assessment carried out by teachers, but rather the primary aim should be to promote students' learning.

Black and Wiliam (1998) highlighted three crises that arise from the lack of formative assessment in the classroom. Firstly, didactic teaching methods such as whole class lectures and initiate-response-evaluate often fail to address children's prior knowledge, potentially resulting in a lack of transfer in learning. Secondly, the overemphasis on mark-giving often leads to self-doubt among low achieving students, who believe they are incapable of learning due to traditional (summative) assessment feedback that lacks useful advice. The use of marks to compare student performance with others encourages competition and does not support collaborative learning. Finally, ability tracking, and grouping can have adverse effects on students' self-esteem and motivation, leading to reduced heterogeneous mix of students with different abilities.

Stiggins (2002) argued that raising standards through standardized testing does little to encourage students with low academic achievement and low self-efficacy to try harder. Although infrequent standardized testing provides information for policy makers and educators to make informed decisions, students are often ignored as active users of assessment information. Teachers should craft formative assessments that provide regular, if not daily, information for students to plan, monitor, and evaluate their own learning. In such classroom environments, students use assessments to understand what success looks like and how to do better, attributing academic success to individual effort.

The use of formative assessment can address the aforementioned crises in the practice of teaching and learning. Formative assessment, also known as assessment for learning, enables teachers to elicit and use information about student learning to make decisions about teaching and learning in the classroom. It is a collaborative act that requires interaction between teachers and students, making it more consistent with social constructivist theory. Students benefit from formative assessment as it enables them to visualize their ideas and organize their thoughts, which enhances their planning and problem-solving skills.

The benefits of formative assessment are not limited to academic achievement; they also promote positive learning experiences. Formative assessment enhances student motivation and self-efficacy, as it provides students with feedback on their progress and success, thereby increasing their confidence in their ability to learn. Furthermore, the use of formative assessment in the classroom enables students to take ownership of their learning, leading to a more student-centered learning environment.

It can be said that the use of formative assessment in the classroom addresses the crises that arise from the absence of formative assessment. Teachers should focus on crafting formative assessments that provide regular information for students to plan, monitor, and evaluate their learning. By doing so, students will become active users of assessment information, enhancing their motivation, self-efficacy, and planning and problem-solving skills.

Formative assessment is something done with pupils rather than to them. It is an assessment approach that is child centred and this study will expand on how it may be used to encourage self-regulation in learning science at middle school level.

In today's educational landscape, assessment is a crucial aspect of the teaching and learning process. Teachers are often required to administer both formative and summative assessments to evaluate student learning and understanding of taught concepts. The distinction between these two types of assessments lies in their purpose and how they are used.

Formative assessment is an ongoing process that involves the continuous evaluation of student learning and progress. It is an integral part of the teaching-learning process and should be used by both teachers and students to elicit evidence of learning and improve understanding of taught concepts. The purpose of formative assessment is to identify students' strengths and weaknesses and provide feedback that is actionable, so that students can work towards improving their understanding of the subject matter. This type of assessment should be implemented throughout the teaching-learning process to ensure that students are always aware of their progress and are given opportunities to improve.

In contrast, summative assessment is used to evaluate student learning at the end of a teaching-learning episode. The purpose of summative assessment is to provide an overall picture of a student's performance and understanding of the subject matter. Examples of summative assessments include final exams, standardized tests, and end-of-term projects. The results of summative assessments are usually used to determine a student's grade or level of achievement.

It is important to note that the same assessment tool can be used for both formative and summative assessment purposes. The difference lies in how the assessment results are used. For formative purposes, the assessment results are used to provide feedback to students and guide future instruction. For summative purposes, the assessment results are used to determine a student's overall performance and level of achievement.

Research has shown that formative assessment practices have a positive impact on student achievement (Black and Wiliam, 1998). However, for formative assessment to be effective, it must be planned and implemented appropriately. This requires teachers to integrate practices such as clarity of learning objectives and success criteria, the eliciting and analysis of evidence of student thinking, self-assessment, peer feedback, and actionable teacher feedback (Jobs for the Future, 2018).

Moreover, teachers must also be trained and supported in the use of formative assessment practices. In many cases, teachers may not fully understand the purpose and benefits of formative assessment or may not know how to effectively implement it in their teaching practice. Therefore, professional development opportunities should be provided to teachers to ensure that they are equipped with the necessary skills and knowledge to use formative assessment practices effectively.

It is also important to address the negative perceptions that students and teachers may have towards assessment. Taras (2008) argues that the fear associated with assessment has distorted perceptions of its necessity, centrality, and potential neutrality. The negative connotations associated with summative assessment have made it the least preferred type of assessment among students and teachers (Scriven, 1967).

To overcome these negative perceptions, it is important to promote the benefits of formative assessment and educate students and teachers on its purpose and importance. OECD (2016) defines formative assessment as the frequent, interactive checks of student progress and understanding to identify learning needs and adjust teaching appropriately. This definition emphasizes the importance of formative assessment as a tool for improving learning and understanding.

Therefore, formative assessment is a critical component of the teaching-learning process. It should be used by both teachers and students to elicit evidence of learning, provide feedback, and guide future instruction. While the negative perceptions associated with assessment may still exist, promoting the benefits of formative assessment and educating students and teachers on its purpose and importance can help to overcome these perceptions and ensure that students are equipped with the necessary skills and knowledge to succeed.

Saddler (2006) further pointed out that formative assessment reflects as closely as possible real teaching and learning situations rather than being experiments based on special interventions that test a narrow element of a learning theory. Studies by Wiliam and Leahy (2016) on how teachers spoke about formative assessment revealed that those who were engaged in formative spoke about how their practice has moved from a focus on what they are putting into the teaching and learning process to a focus on what their students are getting out of it. The authors pointed out that teachers involved in the study reported that formative assessment was a paradigm shift from teaching towards learning.

It was pointed out that formative assessment is effective in virtually all educational settings: ranging from content areas, knowledge, and skill types, and across all levels of education (Black and Wiliam, 1998). Additionally, Boston (2002) suggested that formative assessment allows teachers to know how students are progressing and where they are having trouble, they can use this information to make necessary instructional adjustments, such as re-teaching, trying alternative instructional approaches, or offering more opportunities for practice. This study aims address the missing link in formative assessment, what are students' perceptions, teachers' perceptions and how these may be harnessed toward improving students' self -regulation.

Administering formative assessment in schools remains elusive as society still views assessment only in terms of grades from summative assessment (NCDPI, 2019). Studies by Wiliam and Leahy (2016) also reported a similar trend when they pointed out that some teachers observed in their studies were using formative assessment to give grades to students and this resulted in students viewing formative assessment as not different from summative assessment. Hence this study seeks to understand how teachers implement assessment for learning and establish the effectiveness of such in the promotion of student self-regulation. Other authors such as Boston (2002) also argued that formative assessment ensures that teachers can build in many opportunities to assess how students are learning and then use this information to make beneficial changes in instruction. This was also supported by William and Black (1998) who suggested that grades and marks are at times counterproductive especially among slow learners as they do not deliver as much formative effectiveness due to limited and delayed feedback. Gipps (1994) contended that formative assessment is a necessary move away from a testing culture. It is therefore central to pedagogy, emphasizing the necessity of linking the information from assessment to context and can therefore be a dynamic, interactive, and evolving process where the teacher's role is facilitating the process of learning, (Rushton, 2005). Formative assessment encourages deed approaches to learning which are associated with students' intentions to understand and construct meaning of learnt content (Gijbels and Dochey, 2006). They went on to argue that summative assessment on the other hand assumes surface approaches to learning where children learn by memorization and reproduction of factual contents of study materials. Formative assessment can be used to adjust instruction to better meet students' needs, teachers can use evidence of students' understanding to make decisions about the next steps in teaching (Wiliam and Leahy, 2016). Formative assessment is an effective way of student centered and evidence-based learning, (Sadler, 2006).

Previous researchers such as Saljo,1976; Trigwell and Prosser,1991; Watkins, 2001; Struyven et al., 2003; Heikkila and Lonka, 2006 have revealed the positive relationship between formative assessment use and positive results. However, little has been written about how students and teachers perceive formative assessment. Gijbels and Dochey (2006) argued that if we wish to discover the truth about an educational system, we must first look to its assessment procedures. They contend that in their studies, most teachers revealed to them that they play the game of examinations while examiners also play the same game. Such an approach towards assessment results in both teachers and learners perceiving the process of assessment as testing. However, studies by the same authors have shown that formative assessment results in improved students' performance and when formative assessment is used both students and teachers begin to view assessment with a proactive lens. This was also supported by Crooks (1988) who suggested that formative assessment leads to such effects as:

reactivating or consolidating prerequisite skills or knowledge prior to introducing new material.

focusing attention on important aspects of the subject; encouraging active learning strategies.

giving students opportunities to practice skills and to consolidate learning.

providing knowledge of outcomes and corrective feedback.

helping students to monitor their own progress and to develop self-evaluation skills.

guiding the choice of further learning activities to increase performance and helping students to feel a sense of accomplishment.

This study will focus on how to link such findings with how students in middle school could be self-regulated in their learning. Studies by Black and Wiliam (1998) revealed that learners who preferred formative were found to be independent and self-driven individuals who performed at higher order thinking levels when they were compared to those who preferred summative assessment.

When learners are involved in their learning, they begin to be more assertive and confident in their learning content (Mangwaya, 2014). Formative assessment helps in guiding students toward the development of their own learning to learn skills (Beck, 2016). OECD (2016) argued that students who has an awareness of how they learn are better able to set goals, develop a variety of learning strategies, and control and evaluate their own learning process.

International research supports the idea that tracking a student's progress toward objective learning goals is more effective than in comparison with peers' progress (Cameron and Pierce, 1994). OECD (2016) reported that teachers have also moved away from traditional systems of marking which tend to rely on social comparison of student performance toward methods that allowed them to track an individual student's progress toward the learning goals, as judged through established criteria. Authors such as Black and Wiliam (1998) also pointed out that the establishing learning goals and tracking students' performance increases their motivation which in turn improves their perception of assessment.

Teachers can enhance the learning process by establishing clear learning goals and tracking student progress towards achieving those goals. By doing so, students no longer have to guess what is expected of them to perform well. Additionally, teachers can help students track their own progress, enabling them to build confidence and take ownership of their learning. This approach can lead to a more transparent and effective learning environment, ultimately benefiting both the students and the teachers. (OECD, 2016).

It was suggested by Moss and Brookhart (2019) that formative assessment promotes evidence-based self-assessment which demands individual teaching decisions as teachers can see the difference between intent and impact of their actions. This ensures that teachers take constructivist approaches in collecting and using strong data on what exactly works and what does not work with their students. NCDPI (2019) suggested that teachers should use a variety of assessment methods such as self-assessment, peer assessment, teacher-based assessment and group-based assessment. Through that constructive feedback on what went well with students' work and what could have been done differently and reasons thereof.

Varying formative assessment methods as pointed out by Mangwaya (2014) allows students with different abilities to express themselves differently without competition but with cooperative learning. When students are exposed to a variety of assessment methods, they begin to critically examine their own knowledge, practices and working assumptions with each assessment method (Moss and Brookhart, 2019). They further stated that students become inquiry minded and keenly aware of where they need to work on to improve their standards in line with set learning objectives and targets.

One of the main challenges of formative assessment that was identified by Wiliam and Black (1998) was lack of teacher preparedness and the use of defective formative assessment techniques which in-turn made students to adapt to incoherent or inconsistent methods. They argued that in some cases feedback enhancement in one subject area with a teacher may not be accompanied by complementary, mutually reinforcing teacher behaviors in other parts of the environment where other teachers follow a low feedback route. For formative assessment to be effective, they postulated that there is need for uniformity in the system. Ineffective formative assessment will cause students to learn and evolve some survival tactics to beat the system, (OECD, 2016).

The field of formative assessment still needs to be expanded and synchronized as there are a lot of types of formative assessments which in most cases do not seem to be compatible with each other. Stull (2013) identified online formative assessment as a unique, developing and effective type of formative assessment. Dixson and Worrell (2016) also came up with two other types of formative assessment which they termed spontaneous and planned formative assessment. Regier (2012) proposed more than sixty types of formative assessment, but for the purposes of this study only a handful will be discussed.

Formative assessments can be categorized into two main types: planned and spontaneous assessments (Cook, 2009). While planned assessments are scheduled and part of the curriculum, spontaneous assessments occur unexpectedly and can take place during a class session. Teachers can use spontaneous assessments to gather information about student learning in real time by observing student behavior and understanding during class. For example, a teacher may ask a student to provide an example of a concept just covered or engage in a question-and-answer session with students to assess their comprehension. Alternatively, a teacher may read misunderstanding in the body language of a student and ask them to clarify their understanding. These impromptu assessments can be valuable tools for teachers to assess student learning and adjust their teaching accordingly. However, such formative assessment lacks value in that there is no scientific data driven data and teachers do not plan for such other than using them to progress check and proceed (Mangwaya, 2014).

Planned formative assessment is widely varied and include strategies are all intended to improve student learning (Dwyer and Wiliam, n.d.) they help to answer the underlying questions of formative assessments: “What is working,” “What needs to be improved,” and “How can it be improved,” (Wiliam and Thompson, 2007, p. 64)?

Planned formative assessment has transformative effects on teachers' perceptions of assessment. It enhances their understanding of assessment as a tool for supporting student learning rather than solely evaluating performance (Heritage, 2010). Through ongoing data collection and analysis, teachers gain insights into students' strengths, challenges, and misconceptions, enabling them to make informed instructional decisions and tailor their teaching to address individual needs. Planned formative assessment also helps teachers recognize the value of timely feedback and the importance of involving students in the assessment process (Sadler, 1989). As a result, teachers develop a more positive and constructive view of assessment, viewing it as an integral part of effective teaching and learning.

Planned formative assessment positively influences students' perceptions of assessment. By providing students with frequent and specific feedback, it supports their understanding of learning goals and criteria for success (Hattie and Timperley, 2007). Students become more aware of their learning progress, areas for improvement, and the steps needed to reach their goals. This increased self-regulation and metacognitive awareness foster a sense of agency and ownership over their learning. Moreover, planned formative assessment promotes a growth mindset by emphasizing effort, improvement, and the belief that abilities can be developed (Dweck, 2006). Students view assessment as a valuable tool for learning, rather than a judgment of their abilities, which enhances their motivation, engagement, and perseverance.

Educators need to recognize the significant effects of planned formative assessment on both teachers' and students' perceptions of assessment. They should provide professional development opportunities for teachers to deepen their understanding of formative assessment and its impact on student learning. Educators should also promote a culture of feedback and reflection, encouraging teachers to collaborate and share best practices related to planned formative assessment. Additionally, educators should help students develop a growth mindset by emphasizing the role of assessment in their learning journey and teaching them how to use feedback to improve their understanding and skills.

Planned formative assessment can be effectively used when students are online. The use of online platforms for formative assessments is gaining popularity and traction in modern-day education (Gipps, 2005). One of the significant advantages of online assessments is the ability to provide immediate feedback, thereby reducing the time for feedback to students (Beatty et al., 2008). Online assessments also encourage peer-feedback and collaboration, leading to improved academic performance (Cassady et al., 2001; Chung et al., 2006; Henly, 2003; Peat and Franklin, 2002; Smith, 2007; Wang et al., 2006). Additionally, the use of online assessments has been shown to have a positive impact on student attitudes, student-instructor interaction, and improved student voices (Chung et al., 2006; Tierney and Charland, 2007). Nichol and Macfarlane-Dick (2006) further posited that online tools provide a conducive environment for students to initiate formative assessment, promoting virtual interaction with instructors. Therefore, the use of online platforms for formative assessment has proven to be a game-changer in modern education, providing numerous benefits for both students and instructors alike. Studies have also shown that more students tend to concentrate more when they are assessed formatively online as they can do it without worrying about how others would take their feedback (Stull et al., 2011). Some of the online formative assessment tools used by teachers include the following.

The exit ticket is a formative assessment technique that is planned by the teacher (Cornelius, 2013). It is implemented at the end of the lesson, where the teacher asks a question, which may vary in difficulty based on the day's lesson. The students then write down their responses to the question and submit them to the teacher as they leave the classroom. This written response is referred to as the exit ticket (Wylie, Lyon, and Goe, 2009). The teacher then reviews the exit tickets to evaluate the students' understanding and create small discussion groups the next day based on their responses. The teacher assigns students with a stronger grasp of the concepts to workstations with students who have a less firm understanding of the concepts.

After the students are in their workstations, the teacher reviews the concept that students were evaluated on the previous day, highlighting areas where students were unclear before allowing the students to discuss the topic. Additionally, the teacher identifies a student who demonstrated a strong grasp of the concept as the topic leader for each group based on their response to the exit ticket. The teacher monitors the progress of each group and provides feedback (Dixson and Worrell, 2016). The exit ticket technique allows teachers to identify areas where students may need additional clarification and provides students with the opportunity to self-reflect on their own understanding of the topic (Wylie et al., 2009).

Furthermore, the teacher's brief review and the small group discussion provide students who need remediation with an additional opportunity to learn the assessed concept. Students who already have a good understanding of the concept can also develop a deeper understanding of the concept by explaining it to their peers. The exit ticket technique allows teachers to evaluate the effectiveness of their lesson plan and adjust it if necessary to ensure that students fully comprehend the concept being taught.

Clickers are becoming an increasingly popular formative assessment technique due to their potential to promote deep or generative learning (Mayer et al., 2009). The theoretical underpinnings of clickers lie in their ability to support self-questioning and the "self-explanation effect." According to Mayer et al., (2009), the self-explanation effect is the phenomenon in which students perform better on summative assessments when they are encouraged to explain the material to themselves as they read a textbook, rather than simply reading the text without engaging in self-explanation. Stull et al., (2016) have conducted research on this effect, finding that it is an effective way to promote learning. Clickers, with their ability to prompt students to answer questions and reflect on their own learning, can provide an opportunity for students to engage in self-explanation and deepen their understanding of the material. As a result, clickers are a valuable tool for teachers looking to assess student learning while promoting deeper understanding and engagement with the material. Mangwaya (2014) added that the practice of encouraging pre-scholars to read aloud should not be discouraged to certain learners as some learners understand better, when they use clickers.

The use of graffiti wall resonates with the Ghetto and urban students as these are common phenomena in their environment. Students can summarize their lesson on sticky notes and paste them on a chart where all other students can post comments and questions. The graffiti wall is fun for students and allows them to walk around their classroom (Regier, 2012). In this study students and teachers' perceptions of such formative assessment techniques would also be investigated.

Concept maps and graphic organizers can be used to encourage students to be critical thinkers and organize their learnt concepts in ways that they understand. This gives students some control and independence in summarizing their lessons (Dixson and Worrell, 2016). Mangwaya added that student generated thinking and concept maps can complement other visual learning aids that map have been prepared by teachers for effective learning. The use of concept maps also assists students with remembering facts from previous experiences hence allowing them to draw knowledge from preexisting ideas.

According to Florez and Sammons (2020), the primary purpose of assessment for learning is to promote pupils' learning. This stands in contrast to assessments designed for accountability, ranking, or certifying competence. Assessment for learning emerged as a response to the need for more pedagogically consistent assessment practices that align with constructivist approaches to teaching and learning, as opposed to more traditional approaches. The constructivist approach prioritizes the learner's active engagement in constructing knowledge and understanding, rather than passively receiving information. Assessment for learning expands beyond psychometric and behavioristic assessment traditions, which focus on measuring individual student performance in specific domains against externally norm-referenced distributions of attainment. Instead, assessment for learning is designed to support the learner's ongoing development and to provide feedback that can help the student improve. It emphasizes self-assessment, peer-assessment, and collaborative learning, rather than just teacher-led assessments. Therefore, assessment for learning can help to create a learning environment where students can develop critical thinking skills, self-reflection, and metacognitive abilities. Ten principles can be used to summarize assessment for learning as shown in Table 2.1 below. When effectively planned for and implemented as shown in the Table, formative assessment can enhance student learning through motivation and self-regulation.

Table 2.1

Ten principles of formative assessment. Adapted from (Florez and Sammons, 2020:117).

1. Formative assessment is part of effective planning. 2. Assessment for learning is central to classroom practice. 3. Formative assessment promotes understanding of goals and criteria	The first three principles are interconnected, and they underscore the importance of considering assessment as an integral part of the teaching and learning process. To achieve this, assessment must be incorporated at every stage of the learning process, which requires careful planning. Thus, it is essential for teachers to set clear learning goals and criteria that can be easily comprehended by students. Additionally, students should be consistently reminded of these learning objectives throughout the learning process, their learning assessed, and feedback provided to evaluate their progress and make informed decisions. This approach will enable teachers to make better decisions based on evidence to improve students' learning outcomes. In summary, the principles emphasize the need for a comprehensive and continuous assessment strategy that informs teaching and learning, ensuring that learning objectives are being met.
4. Assessment for learning is sensitive and constructive. 5. Assessment for learning fosters motivation.	This second set of intertwined phenomena is related to the impact of assessment in shaping students' motivation, especially in terms of the nature of the feedback they receive. Teachers, ought to be careful in what they say to students and

6. Assessment for learning recognizes all educational achievement.	try to give descriptive feedback exclusively centered on the quality and content of each student's work rather than use generic and often outdated and ineffective value-laden terms such as 'good' or 'poor'. Teachers should also suggest alternative methods, ideas and ways for students to improve their work. In the context of formative assessment, there is not only an excellence level which all must achieve in order to have recognition; any learning progress made by the student in relation to his or her previous state deserves recognition and positive feedback.
7. Formative assessment focuses on how pupils learn. 8. Assessment for learning helps learners know how to improve. 9. Assessment for learning develops the capacity for peer and self-assessment	It is important for both teachers and students to focus on the learning process in the classroom. Students should develop an awareness of their own learning processes and gain autonomy through peer and self-assessment. This encourages responsibility for their own learning. Providing constructive feedback to students on how they can improve, rather than just pointing out mistakes, can also foster autonomous thinking and learning. By promoting autonomous learning, students are better equipped to take ownership of their education and continue to learn beyond the classroom setting.
10. Formative assessment is a key professional skill	This principle highlights the complexity involved in taking assessment for learning into practice, as it requires teachers

	to learn how to work from this perspective and to develop the necessary skills for doing so. There is reason to recognize the need for good quality professional development programs as a fundamental requirement for the successful implementation of assessment for learning in classroom practice.

Phases within formative assessment

Several theorists refer to formative assessment as a series of pupil- teacher and pupil- pupil interactions that involves several phases of activities (Russel et al., 2003). There is still lack of common vocabulary used in the phases of formative assessment (Bell and Cowie, 2001). The lack of common vocabulary may present challenges in imposing order on the different phases of formative assessment. Table 2.2 by Russel et al., (2003) gives ideas about kinds of, and phases within formative assessment. There is some commonality with the phases even though the verbs used maybe different. The lack of common vocabulary on the concept of assessment for learning has been one of the leading causes of different scholars using vocabulary that are common in their geographical regions. It may also be one of the reasons why teachers' planning and implementation of assessment for learning still lags behind the way they plan and implement assessment of learning. Coming up with uniform vocabulary for formative assessment may change the way educators perceive assessment for learning.

Table 2.2

Ideas about kinds of, and phases within formative assessment. Adopted from Russel et al., (2003)

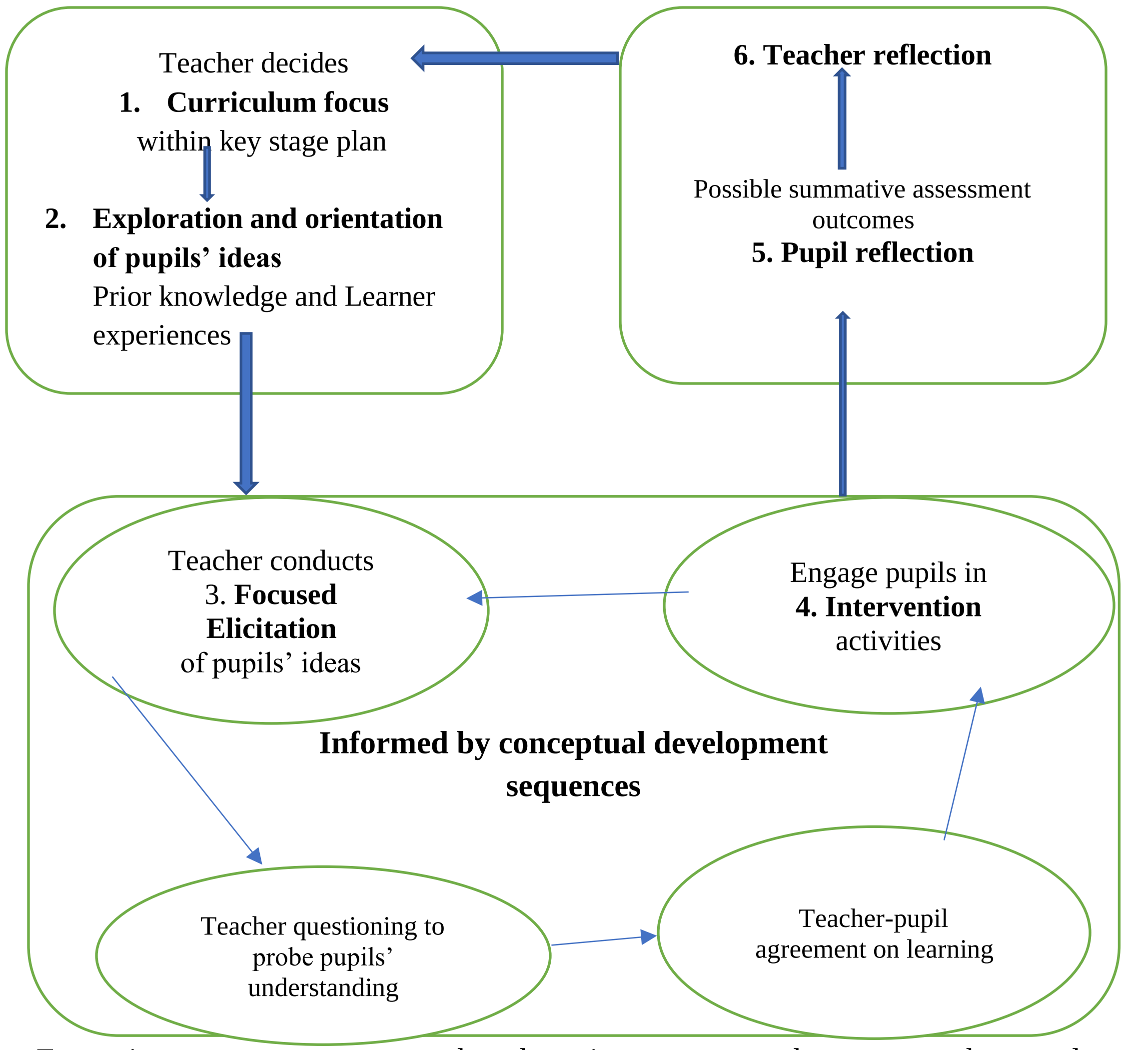
Published source	**Kind of assessment**	**Named Phases**		
Duschl and Gitomer, (1997); Duschl, 2003	Formative assessment	Receive	Recognize	Use
Bell and Cowie, (2001)	Planned formative assessment	Elicit	Interpret	Act
	Interactive formative assessment	Notice	Recognize	Respond
Ruiz-Primo and Furtack, (2004)	Formal formative assessment	Gather	Interpret	Act
	Informal formative assessment	Elicit	Recognize	Use

Model of formative assessment

Working from the phases of formative assessment Russell and McGuigan (2005) developed a model of formative assessment as shown in Figure 2.6. Their model requires the teaching and learning process to be interactive and responsive to pupils' emerging ideas and thoughts, therefore, teachers' plans would then be expected to have sufficient flexibility to allow details to be modified based on whatever evidence emerges (Duschl, 2003). That way formative assessment encourages learners to build from what they already know thus ensuring that students have some sort of reference point during their learning. Russell and McGuigan (2005) argued that while assessment for learning is a student-centered approach, the teacher is the one who sets the agenda with pupils being able to orientate their thinking vis-à-vis the teacher's agenda. The model is rooted in six general domains.

Figure 2.6

Domain-general model of formative assessment. (Russell and McGuigan)



Note: Formative assessment ensures that there is engagement between teachers and students allowing for exploration, focus questioning and feedback that generate intervention at appropriate times and reflection from all involved in the learning community.

The role of teachers in formative assessment

Formative assessment is a process that involves gathering and using evidence to improve students' learning. Teachers play a significant role in formative assessment, as they are responsible for designing and implementing assessment practices that can provide feedback to students and guide their learning (Black and Wiliam, 1998). According to Shepard (2005:3), "teachers are the key players in formative assessment, providing feedback to students, making adjustments to instruction, and using information from assessments to guide classroom decision making". Teachers play a crucial role in the success of formative assessment. According to Black and Wiliam (2009), "teachers are the key agents in the process of formative assessment, with their decisions determining how it is used and how effective it is in promoting learning" (p. 9). Teachers are responsible for designing and implementing formative assessment strategies, analyzing assessment data, and providing feedback to students.

Teachers need to design formative assessment strategies that align with the learning objectives and standards of the curriculum. They need to use a variety of techniques, such as questioning, observation, self-assessment, peer assessment, and quizzes, to gather information about student learning. Teachers also need to ensure that the assessment is valid, reliable, and fair. One of the critical roles of science teachers in formative assessment is to design assessment tasks that align with the learning objectives and standards of the science curriculum (Black and Wiliam, 1998). Teachers must develop assessment tasks that assess students' understanding of scientific concepts and skills and provide meaningful feedback to students. Teachers can use a variety of assessment methods, including observation, questioning, and student self-assessment (Harrison and Grayson, 2013).

Another crucial role of science teachers in formative assessment is to provide feedback to students that is timely, specific, and actionable. According to Black and Wiliam (1998), feedback should be "timely, specific, and should provide guidance on how to improve" (p. 19). Teachers must provide feedback that is focused on the learning objectives and standards of the science curriculum and is relevant to the students' level of understanding (Harrison and Grayson, 2013). This is one of the major advantages of formative assessment over summative assessment as with the later feedback tends to be generalized and is given after work has already been completed.

Teachers also play a critical role in using assessment information to adjust their instruction and improve student learning. Hattie and Timperley (2007:89), stated that "effective feedback must be used to adjust instruction to meet the learning needs of the students". Teachers must analyze the assessment data to identify areas where students are struggling and adjust their instruction to meet their learning needs. By using formative assessment data to adjust their instruction, teachers can provide targeted support to students and improve their learning outcomes (Harrison and Grayson, 2013).

Formative assessment has many benefits for both students and teachers. According to Black and Wiliam (2009), formative assessment can improve student learning outcomes, reduce achievement gaps, and enhance teacher effectiveness. Formative assessment can help students take ownership of their learning, develop critical thinking skills, and become more self-directed learners. It can also help teachers improve their instructional practices and become more responsive to the needs of their students.

In conclusion, formative assessment is an essential tool for improving student learning outcomes. Teachers play a critical role in the success of formative assessment by designing and implementing formative assessment strategies, analyzing assessment data, and providing feedback to students. Formative assessment has many benefits for both students and teachers, and it can improve student learning outcomes, reduce achievement gaps, and enhance teacher effectiveness. Teachers need to continue to use formative assessment as a tool to improve student learning outcomes and promote lifelong learning.

The role of students in formative assessment

Formative assessment is a process that involves gathering information about student learning and using that information to adjust teaching and learning strategies. In this process, students play an active role during the assessment process, which involves them in their learning process. According to Black and Wiliam (2009), students' involvement in the formative assessment process enhances their motivation, self-regulation, self-efficacy, and learning outcomes.

Involving students in formative assessment can take different forms, such as peer assessment, self-assessment, and teacher-student feedback. Peer assessment involves students evaluating and providing feedback to their peers' work, while self-assessment involves students reflecting on their work and assessing their own progress. Teacher-student feedback involves teachers providing feedback to students on their work, which can help students identify areas of strength and weakness and work on them (Hattie and Timperley, 2007).

Students' involvement in formative assessment has several benefits. Firstly, it helps students become more aware of their learning process and the learning outcomes they need to achieve. According to Nicol and Macfarlane-Dick (2006), involving students in formative assessment can help them develop metacognitive skills that enable them to take responsibility for their learning process.

Secondly, involving students in formative assessment helps them become more engaged in the learning process. Research shows that students who participate in formative assessment are more motivated to learn and take an active role in their learning (Black and Wiliam, 1998). This is because formative assessment provides students with feedback on their learning progress and identifies areas where they need to improve.

Finally, involving students in formative assessment helps teachers tailor their teaching strategies to meet the needs of individual students. According to Hattie and Timperley (2007), formative assessment helps teachers understand what students know and what they do not know and adjust their teaching to meet the needs of individual students.

Impact of students' participation in formative assessment

Students' participation in formative assessment has a significant impact on their learning outcomes. Research shows that involving students in formative assessment can lead to significant improvements in student learning outcomes (Black and Wiliam, 1998; Black and Wiliam, 2009). For example, in a study by Black and Wiliam (1998), involving students in formative assessment it was established that it led to significant improvements in students' learning outcomes in mathematics. The study found that students who received formative assessment improved their learning outcomes by two standard deviations compared to those who did not receive formative assessment. This suggests that involving students in formative assessment can have a significant impact on their learning outcomes.

Furthermore, students' participation in formative assessment can lead to improvements in their motivation to learn. According to Hattie and Timperley (2007), formative assessment can help students become more motivated to learn by providing them with feedback on their progress and identifying areas where they need to improve.

Finally, involving students in formative assessment could result in improvements in their self-regulation skills. According to Nicol and Macfarlane-Dick (2006), involving students in formative assessment can help them develop self-regulation skills, such as setting goals, monitoring progress, and evaluating their own learning. When students are equipped with these skills, they are better placed to take control of their learning.

Role of Parents in Students' Formative Assessment

Parents can support their child's learning by playing an active and supportive role in the formative assessment process. According to Epstein's (2011) model of parental involvement, parents can be involved in six different ways, including parenting, communicating, volunteering, learning at home, decision-making, and collaborating with the community. The following are some ways in which parents can support their child's formative assessment.

Parents can communicate with their child's teachers to understand the formative assessment strategies being used in the classroom. They can also discuss their child's learning progress and ask for feedback from teachers on how they can support their child's learning at home. Parents can also provide teachers with information about their child's strengths, weaknesses, interests, and learning styles to help teachers design more effective formative assessment strategies.

Parents can support their child's learning at home by creating a conducive learning environment and providing resources such as books, educational games, and technology to support their child's learning. They can also help their child with homework and provide opportunities for their child to practice their skills and knowledge outside of school.

Parents can encourage their child to reflect on their learning by asking them questions about what they have learned and how they can apply it in real-life situations. They can also encourage their child to set goals for their learning and monitor their progress towards these goals.

Parental involvement in students' formative assessment has many benefits. According to Henderson and Mapp (2002), parental involvement can improve student achievement, increase motivation and engagement, and reduce the likelihood of dropout. Parental involvement can also help teachers understand their students better and design more effective formative assessment strategies. When communication lines between parents and teachers are healthy it helps teachers reach out to parents early if a child faces challenges in learning thus ensuring that the child remains on track.

In conclusion, parental involvement in students' formative assessment is essential for improving student learning outcomes. Parents can support their child's learning by communicating with teachers, supporting learning at home, and encouraging self-reflection. Parental involvement has many benefits, including improved student achievement, increased motivation and engagement, and better understanding of students by teachers. Parents need to continue to play an active role in their child's formative assessment to promote lifelong learning and success. Parental involvement through formative assessment allows learners to easily construct knowledge by linking their home and school experiences to the learning activities.

2.5.1: Feedback and questioning

Over the years, numerous researchers and practitioners have dedicated their efforts to understanding what constitutes effective feedback (Nicol and Macfarlane-Dick, 2006; Dawson et al., 2019). They have also explored ways to engage with feedback and make it most beneficial to student learning (Price, Handley, and Millar, 2011; Carless and Boud, 2018). The evolution of feedback has progressed from being solely teacher-driven to a process where the student actively utilizes feedback to effect change (Dawson et al., 2019). The study of feedback has come a long way, and feedback is now considered a key component in student learning. Effective feedback should provide clear, specific, and actionable information that is relevant to the student's learning goals. Additionally, feedback should facilitate the development of the student's self-regulation skills, where they can use the information provided to improve their learning independently. Overall, feedback has transitioned from being solely teacher-focused to an interactive process that promotes student-centered learning. Such a transition allows students to construct new knowledge from reflecting on the feedback generated.

'Feedback refers to information about the gap between the actual level and reference level which is used to alter that gap' (Ramaprasad, 1983:4). While the definition given by Ramaprasad that feedback is about information, it is not clear about what information is, and if this information does not directly contribute to student learning, can it still be considered as feedback? (Chan and Luo, 2021). There is a lot misunderstanding and debate about what and how feedback should be effective. Over the years, various studies have proposed models and feature lists of effective feedback that highlight the importance of personalization and individualization (Ferguson, 2011; Li and De Luca, 2014), specificity and detail (Ferguson, 2011; Dawson et al., 2019), timeliness (Gibbs and Simpson, 2004; Poulos and Mahony, 2008), criteria referencing (O'Donovan, Price, and Rust, 2001; Poulos and Mahony, 2008), constructive criticism (Lizzio and Wilson, 2008; Dawson et al., 2019), and the facilitation of positive beliefs and self-assessment in learning (Nicol and Macfarlane-Dick, 2006). However, teachers are often faced with a multitude of questions concerning what constitutes effective feedback. For instance, if feedback lacks detail or personalization, can it still be considered feedback? Similarly, if feedback is detailed but lacks constructive criticism, can it still be considered feedback (Chan and Luo, 2021)?

Several studies have identified feedback's multiple purposes. Nelson and Schunn (2009) summarized three key meanings of feedback: motivational, reinforcement, and informational. Motivational feedback is intended to inspire learners to engage with their work, while reinforcement feedback recognizes their progress and provides encouragement. Informational feedback is designed to assist learners in understanding the requirements of their work and identifying areas where they need to improve. Effective feedback should incorporate all three of these purposes and meet the criteria outlined in the models and feature lists mentioned above.

Effective feedback should be personalized, specific, timely, criteria-referenced, constructive, and capable of fostering positive beliefs and self-assessment in learners. Additionally, feedback should serve the three primary purposes of motivational, reinforcement, and informational feedback. Teachers must recognize the significance of feedback as a tool for promoting student learning and ensure that their feedback meets the necessary criteria for effectiveness. The meanings assist teachers in knowing the type of feedback they have to offer to individual students as feedback is supposed to be specific (Mangwaya, 2014). In this study the role of feedback in the way students and teachers would perceive assessment will be investigated.

According to OECD (2016) feedback is beneficial to both the students and the teachers. However, feedback needs to be timely and specific, and include suggestions for ways to improve future performance. Black and Wiliam (1998) postulated that feedback should be structured for the task at hand and in accordance with the set success criteria and expected objectives. They argued teachers must avoid ego-involving feedback even in form of praise as this tends to have negative impacts on students' performance and motivation. NCDPI (2018) called for what is termed SMART feedback which specific, measurable, achievable reflection enabling and timely in terms of the task at hand.

Crooks (1988) called for a paradigm shift in the learning environment through modifications and transformations of the learning culture where feedback should be taken as an extension for learning opportunities and not as a pointer towards errors or mistakes. To support this Saddler (2006:5-6) suggested that 'students should also be trained in how to interpret feedback, how to make connections between the feedback and the characteristics of the work they produce, and how they can improve their work in the future. It cannot simply be assumed that when students are given feedback, they will know what to do with it.' Formative assessment relates well with the theories of Dewey, Piaget and Kuhn where they all advocated for child centered education. Rushton (2005) suggested that evidence shows that formative assessment provides feedback which is helpful in the provision of information about the existing gap between the actual and desired levels of performance. Hattie (1987) also postulated that feedback is the backbone of formative assessment as this is supported by a synthesis of meta-analyses that found feedback to produce the most powerful single effect on achievement. While a lot of research has been carried out on the benefits of formative assessment there is a need to explore how students and teachers perceive it. It is perception that determines the success of formative assessment.

Teacher experience is fundamental in formative assessment as experienced teachers tend to do well in formative assessment than newly qualified teachers (Rushton 2005). This could be attributed to the fact that experience brings in confidence and students tend to make more meaning from feedback when examples resonate with their environment. Student perception of formative assessment is fundamental. This was also supported by Biggs (1998) who argued that the effectiveness of assessment for learning is dependent upon the learners' accurate perception of the gap, as well as their motivation to address it. Rushton (2005) acknowledged that all teachers offer some feedback to their learners, but it is the quality of feedback offered that makes the difference. Teacher feedback, peer feedback, self-assessment feedback, and to certain extent parent feedback need to provide learners with information that will improve their learnt skills.

Work from research suggested that feedback must be used to close the gap between the actual learning and the desired level of performance (Ramaprasad, 1983). Feedback should be used for the benefit of both the student and the teacher as it affords both parties a time to listen to each other and adjust accordingly (Black and Wiliam, 2009). They pointed out that students and teachers can question each other and redirect the path that must be followed in line with set objectives and success criteria

Jimenez, Niles and Parks (2010) contended that formative assessment processes create a classroom climate that cultivates mindfulness, non-judgmental awareness, cognitive flexibility and self-regulation all of which can be made possible when the teacher varies the instructional methods to captivate students in their individual capacities. In addition to teachers scaffolding questions and varying their instructional methods they also need to scaffold these methods to ensure that every student's needs are taken onboard (Black and Wiliam, 2009). It was also argued that lack of high-quality formative assessment in schools has more to do with ineffective teacher instructional methods (Moss and Brookhart, 2019).

NCDPI (2019) argued that teachers should scaffold their questions to ensure that students of different learning abilities are taken onboard thus making sure that no child is left behind. Black and Wiliam (2009) further suggested that when planning for questions, teachers need to develop questions from simple to complex where all students must be able to answer the initial questions and then some students should be differentiated through the level of question and task difficulty. NCDPI (2019) pointed out that when questions are differentiated, they will allow students to reach the same goals through different routes as they are encouraged to construct new ideas from independent learning by making use of the shared learning goals.

Lastly teacher perception of feedback is paramount as to how effective their feedback can be. Teacher perceptions matter because they are significant contributors to the actions teachers take (Pajares 1992). 'Teacher feedback perceptions are reflective of their feedback literacy, such as teachers' knowledge, expertise and dispositions to design feedback processes in ways which enable student uptake of feedback and seed the development of student feedback literacy" (Carless and Winstone 2020:4). Carless and Winstone (2004) identified three dimensions of teacher feedback literacy, including 'designing for uptake', 'relational sensitivities' and 'managing practicalities'

Bell et al., (2013) postulated that questioning for formative assessments should be structured in such a way that they challenge the learners to be critical thinkers. They noticed some problems in the way in which teachers were formulating and using questions during class interaction. They concluded that the questions used by teachers were often insufficiently challenging for the students. The time given for students to elaborate on questions during assessment for learning should be adequate to allow learners time to critically think over their answers (Mangwaya, 2014). In the context of formative assessment, effective questioning strategies are essential in creating a non-threatening, and non-judgmental classroom environment that encourages dialogue and fosters student participation. Students must feel comfortable sharing their ideas and exposing their misconceptions without the fear of being wrong. This way every student is free to express what they have experienced and build their knowledge by combing their experiences with those of their peers. The primary objective of this approach is to promote learning opportunities for students through the discussion of mistakes or misconceptions that may arise during the learning process (Black et al., 2010).

Differentiated and well-structured questions can greatly enhance the quality of answers provided by learners, especially when scaffolded in an assessment for learning framework (Florez and Sammons, 2020). By asking clear and thought-provoking questions, teachers can challenge students to think critically and encourage active participation, which can ultimately lead to improved student learning outcomes. Overall, effective questioning is a crucial element of formative assessment and can significantly contribute to creating a positive classroom culture that promotes learning and development.

Feedback as formative assessment

Feedback that the teacher provides to students is also an essential resource so the students can take active steps to advance their own learning. The feedback to students can be understood as instructional action (NCDPI, 2011). Anyone involved in standardized testing knows two things: the results take entirely too long to get back and are completely impersonal, making that kind of feedback essentially irrelevant. In short, feedback needs to be personal, and it needs to be fast. According to Hatie (2018) students want feedback just for them, just in time, and just helping nudge forward. To that end, Hatie (2018) encourages teachers to worry more about how students are receiving teacher feedback than increasing feedback they give to their students. As a result, educators are beginning to refocus their attention on relevant, practical feedback for students during lessons or very soon after, rather than relying only on summative assessments (Hicks, 2014).

When teachers use feedback as corrections, criticism, comments, and clarifications, they encourage their learners to learn formatively. Feedback includes what students need to implement going forward. Students tend to not use to use information contained in the feedback to discover and increase their knowledge (Venezuela, 2022). Feedback is only effective when there is an action towards its intentions. Students, therefore, need feedback which they understand and can readily act upon along the continuum of the learning process. They also need to be involved and invested in the feedback. A good teacher uses formative assessment data to improve their teaching and address student learning needs (Marsh, 2022).

Feedback can be a two-way assessment tool as both students and teachers can use feedback generated either way to assess how information is conveyed either way (Hatie, 2018). Teachers can self-assess on how effective they are in facilitating learning through the feedback they get from students' responses to stimuli (Hicks, 2014). Typically, feedback is viewed as a tool to help students, yet it also informs the facilitator of learning about what went well and what could be done differently. The less discussed function of feedback is as a mechanism to help the educator (Molley and Boud, 2013). Yorke (2003:482) reported that ''the act of assessing has an effect on the assessor as well as the student. Assessors learn about the extent to which they [the students] have developed expertise and can tailor their teaching accordingly.''

The role of feedback in learning is widely acknowledged as a crucial process that provides information about actual performance in relation to the desired goal. While there is extensive research highlighting the significance of feedback, there is an increasing body of evidence that suggests that feedback is not always effective in practice. Surveys conducted among learners have identified feedback as one of the most problematic aspects of their academic experience (Carless et al., 2010). Interestingly, educators tend to overestimate the usefulness of their feedback compared to their students' perspectives, which further contributes to the feedback problem (Shute, 2008). This highlights a critical issue where educators require feedback on their feedback-giving skills to improve their practices (Molley and Boud, 2013). There is need to establish how teacher feedback should be structured to enhance student learning.

Effective feedback has a significant impact on student learning and the quality of formative assessment (Mangwaya, 2014). Hence, educators must prioritize enhancing their feedback-giving skills through professional development and seeking feedback on their performance. Additionally, educators must consider the type and timing of feedback provided to ensure that it is personalized, constructive, and relevant to the learning objectives. Additionally, educators play a vital role in providing effective feedback that fosters student learning and development. It is essential that they are receptive to feedback on their feedback-giving practices to improve the quality and effectiveness of their teaching practices.

Within the feedback discourse, it has been suggested that learners have difficulty understanding feedback, and therefore may not recognize when feedback is given (Hattie and Timperley, 2007; Shute, 2008). Conversely, some argue that learners are eager to receive performance information and may not be satisfied, regardless of the amount of attention they receive (Henderson et al., 2005). These arguments place blame on the learner, rather than considering factors such as the educator's skills, the appropriateness of the learning activity, or the learning environment. The tendency for deflection is common when there is a discrepancy between learners' self-evaluation and external teacher perceptions of feedback. Chin and Brewer (1993) proposed that in such cases, the receiver will re-interpret external feedback to align with their own beliefs, intentions, or interpretation of their practice. Educators may therefore argue that the issue with feedback lies with learners' inaccurate interpretation, rather than their own feedback practice.

To shift this perception of feedback, there must be a commitment to purposeful and supported opportunities for learners to engage in feedback and implement changes based on feedback, while reassessing their performance in relation to the target (Molly and Boud, 2013). A curricular redesign is necessary to provide these opportunities, and educators must be willing to improve their feedback skills to support learners in the process. By prioritizing the learners' understanding and use of feedback, educators can create a more effective and meaningful feedback process that will benefit both the learners and the overall quality of formative assessment.

Models of feedback

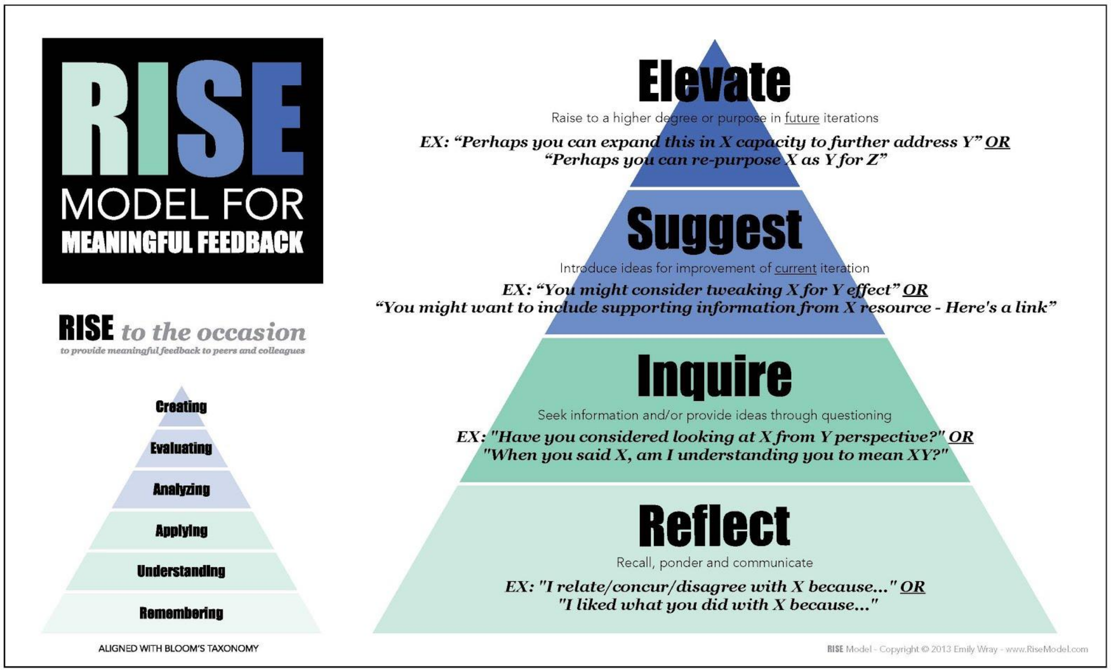
There are several explanatory models available to aid understanding about how feedback works in learning. Some are linear and behaviorist in sentiment, some are circular to imply an iterative process, some ignore the internal capacities of the learner, and others represent the interplay between internal and external performance information and how this affects response or output (Molloy and Boud, 2013). One of the widely used models is the feedback model by Hattie and Timperley (2007), which consists of three questions: Where am I going? How am I going? and Where to next? Another model is the Feedback Intervention Theory (FIT) proposed by Kluger and DeNisi (1996), which includes four components: goal setting, feedback provision, self-efficacy, and performance monitoring.

The RISE model of meaningful feedback

Coined by Emily Wray, the model borrowed from Maslow's hierarchy of needs to a greater extent. Aligned with Bloom's taxonomy, this model uses prompts to assist students "reflect, then build their constructive analysis through inquiry, and provide suggestions to help elevate each other's work" (Wray, 2013). By prompting, students critically engage with each other on four different levels; thus, transforming vague responses to meaningful feedback (Leusen, 2013). The RISE model encourages us to provide feedback that is not simply informative but moves students toward improvement (Molley and Boud, 2013). The model has the shape of a triangle with R at the base and E at the summit of the triangle as illustrated in Figure 2.7 below.

Figure 2.7

The R.I.S.E model of meaningful feedback. (Adapted from Wray, 2013)



Note: The R.I.S.E model of meaningful feedback showing the stages that one goes through for meaningful and effective feedback.

The model is designed to ensure a dialogue between the media producer and the media consumer in which parties can learn from each other and elevate skill levels and knowledge. The model has four levels which are Reflect, Inquire, Suggest and Elevate.

Reflect. The Reflect level involves participants being able to recall, ponder and communicate what would have been received. It is aligned to the Recall stage of the Blooms' taxonomy but goes beyond simple recall as students are able to ponder and communicate reasons for their answers through such statements as I agree/ relate/ concur / disagree with X because of reasons such as. This results in thought provoking feedback that also enable effective and meaningful communication between the parties involved (Leusen, 2013). This step ensures that there is meaningful discussion due to the elaboration given after the word because (Shuptrin, 2017). When linked to the constructivist approach of learning, this stage would involve students reflecting on their experiences to prepare to come up with new knowledge.

Inquire. This level seeks information and provide ideas through questioning. This step ensures that besides giving reasons for having agreed or disagreed one goes beyond that and provide alternatives as to why there was lack of agreement or how deep the agreement is. This step may include such statements as Have you considered looking at two or more variables such as Y and X? to ensure independence of reasoning or when you said X am I understanding that you meant YX? This probes and provokes deeper analysis and response in feedback (Liu, 2011). From the constructivist point of view, this stage ensures that students do not just take everything without constructing meaning from what they already know.

Suggest. This level creates another stratum for in-depth feedback as there is room for introducing ideas that may lead to improvements to what would have been initially presented and considered. This step challenges the recipient to reconsider certain aspect of their responses for tweaking Y for X effect or coming up with deeper supporting evidence for an answer give. It provokes critical thought skills (Shuptrin, 2017). The critical thought skills allows students to modify their new knowledge according to their own experience thus promoting self-regulation in learning.

Elevate. The allows the teacher to challenge students to raise to a higher degree or purpose in future iterations. It allows for continuity of learning after feedback has been given (Kagan and Kagan, 2013). This could include statements like perhaps you could repurpose X as Y for Z or perhaps you can expand on this in X fashion to further address Y… The stages ensures that students are challenged to think outside the box. This promotes innovation, critical reasoning and self-efficacy.

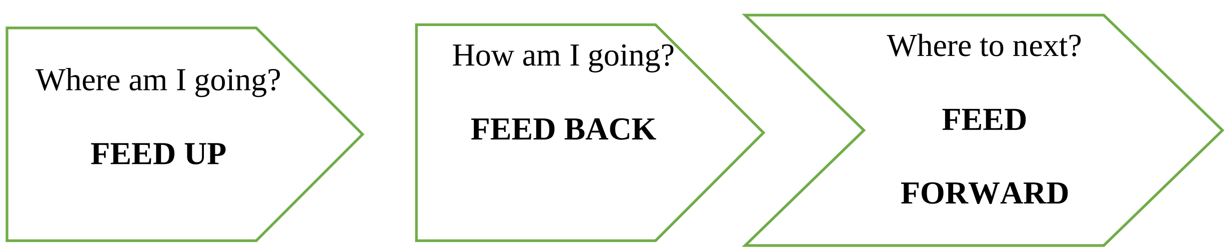
Three step feedback

The model shows that feedback is built from experiences from the past and postulates that effective feedback answers to three questions which are;

1. Where am I going? This stage encompasses the goals and is also referred to as the 'Feed Up' point. Feeding up would entail that there is some prior knowledge which need to be improved through new interactions.
2. How am I going? This stage gives the means of achieving the goals and is also known as the 'Feed Back'
3. Where to next? Which is also referred to as the 'Feed Forward as illustrated in Figure 2.8 below

Figure 2.8

Three step feedback. Modified from Hattie and Timperley model

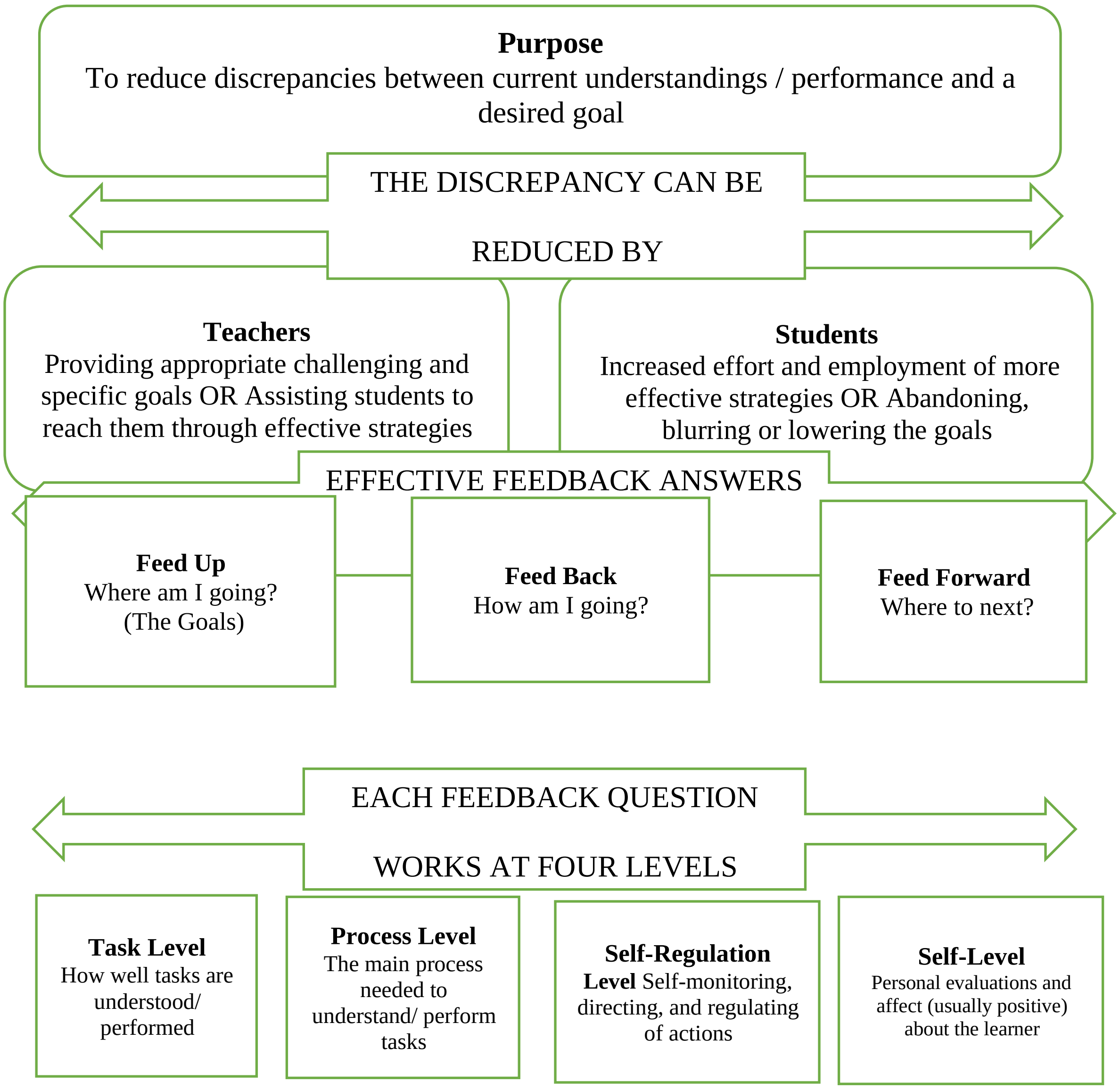


Note: The three stages of feedback showing the stages that one goes through using related and developmental questions.

The purpose of the model can be expanded using the Figure 2.9 below where the purpose of feedback is explained the roles of both the teacher and the students are given.

Figure 2.9

Power of feedback. Adapted from Hattie and Timperley.



Note: The power of feedback and how it relates to self-regulation and four levels generated from feedback questions thus ensuring continual communication.

The Butler and Winne model of feedback and self-regulation

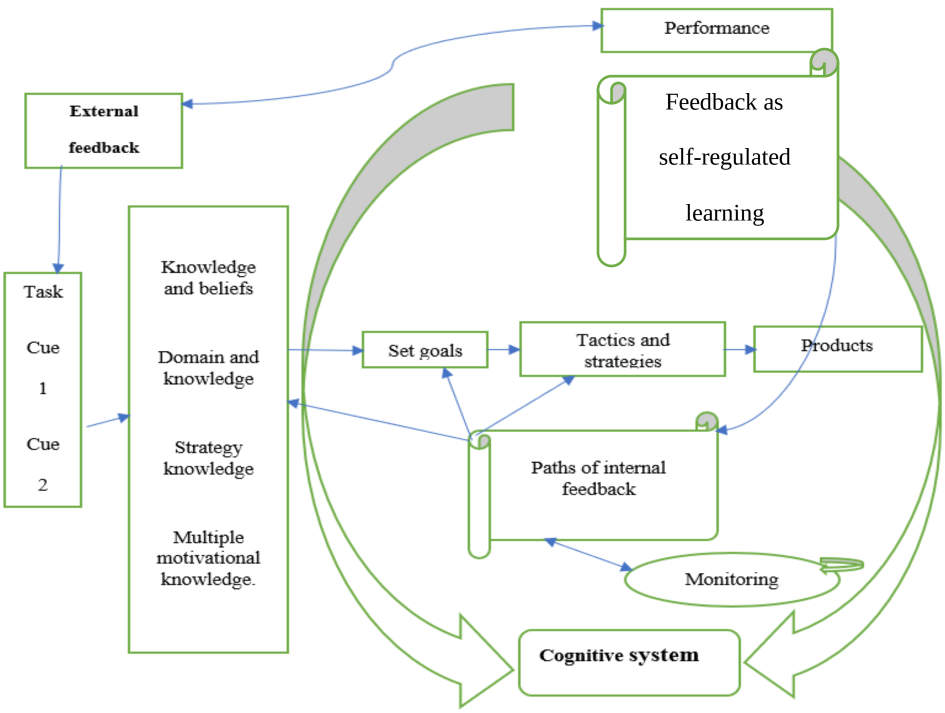
In the feedback process, the Butler and Winne model highlights the learner's central role, with emphasis placed on the active connections that learners make between their learning goals, strategies, approaches, and performance outcomes (Molloy and Boud, 2013). One of the most notable features of this model is that feedback is considered to be intrinsic to self-regulation. Butler and Winne (1995) identified six key maladaptive responses that learners may have towards external feedback, resulting in feedback becoming ineffective. These responses include ignoring external feedback, rejecting external feedback, considering the feedback irrelevant, perceiving that there is no connection between internal and external feedback, reinterpreting external feedback to align with internal judgement, and acting superficially on feedback to please the assessor rather than making genuine changes in knowledge or practice based on external feedback. In all these cases, external feedback's influence on behavior change is likely to be minimal (Molloy and Boud, 2013).

Kulhavy and Stock (1989) and Stock et al., (1992) examined how external feedback could confirm, complement, or contradict internal feedback or self-evaluation by learners. Figure 2.10 illustrates how learners cope with the discrepancy between self-evaluation and external feedback. Chin and Brewer (1993) and Butler and Winne (1995) also explored how learners collect and make sense of internal and external information related to performance. Notably, these researchers focused on the learner's role in seeking, interpreting, and acting on feedback, rather than on the mechanics of externally provided feedback's design or delivery.

Additionally, the Butler and Winne model acknowledges the critical role of learners in the feedback process, emphasizing their active connections between learning goals, strategies, approaches, and performance outcomes. The model conceptualizes feedback as intrinsic to self-regulation, and any maladaptive response to external feedback by learners renders feedback ineffective. Researchers have explored the complexities of external feedback's interactions with internal feedback and self-evaluation, with a focus on how learners collect and interpret performance-related information. These studies highlight the importance of considering the learner's role in feedback-seeking, interpreting, and acting, in designing feedback systems for optimal effectiveness.

Figure 2.10

Feedback as self-regulated learning model. Adapted and modified from Butler and Winne



Students' perception on feedback

Feedback is closely linked with student retention, achievement and progression (Murphy and Cornell, 2010) however, the missing link is how students even perceive this feedback. The way students perceive, and process feedback has a bearing on the effectiveness of the provided feedback. The value students attach to given feedback determines what they do with it (Simpsons and Gibbs, 2002). Students tend to positively perceive and give value to feedback when it is objective and touching on issues that reflect on their needs and challenges. Alien assessment methods do not resonate with students' experiences hence such types of assessment are likely to viewed negatively by learners. This is another example of why the researcher chose to use the constructivist approach.

In this study, the researcher will work toward understanding how feedback is effective in promoting students' self-regulation and autonomy in learning. How students receive and use data from feedback is important in this research. Feedback tends to be more effective when it addresses the learners' emotional and academic needs (Hinette, 2002). This would in turn affect the way student perceive both the source of feedback and the content of it (Murphy and Cornell, 2010). According to Nicol and Macfarlane-Dick (2006), positive student perceptions of feedback are essential for feedback to be interpreted and utilized to advance learning. Students make sense of the provided feedback especially when it touches on the experiences. Such feedback allows students to be active participants in their learning as they are able to self-reflect and link feedback to the experiences.

Rust et al., (2005), in a review of feedback from a social constructivist perspective, identified various issues with feedback practice, including student perceptions of feedback as being unhelpful, difficult to comprehend, irrelevant to the task, and arriving too late in the learning period. To address these issues, Rust et al., (2005) proposed a social constructivist approach to feedback that would enable learners to actively engage in the feedback process, rather than being passive recipients who wait for feedback that may never come or be unsuitable for their learning requirements. This approach would empower learners to take responsibility for their learning and use feedback to improve their performance. Feedback would be viewed as an interactive process, with learners actively seeking feedback and working collaboratively with their teachers and peers to interpret and utilize feedback in a way that supports their learning goals. This study aims to establish how feedback from formative assessment is perceived by learners. The way students perceive feedback is time-related and most of the feedback they receive is from summative assessment which often comes after the teacher has assessed the work, in most cases students do not pay attention to feedback as they only consider the scores attained thus defeating the purpose of feedback (Dweck, 2007).

2.5.2 Self-assessment

Brown and Harris (2013: 368) defined self-assessment in the K-16 context as a "descriptive and evaluative act carried out by the student concerning his or her own work and academic abilities." "Self-assessment is a wide variety of mechanisms and techniques through which students describe and possibly assign merit or worth to the qualities of their own learning processes and products" (Panadero et al., 2016: 804). Self-assessment is a critical component of learning and has become increasingly important in educational research. Self-assessment involves students reflecting on their learning and evaluating their own progress, allowing them to take ownership of their learning and identify areas for improvement. In this literature review, we will examine recent research on self-assessment in education.

Self-assessment has been shown to have a positive impact on student learning outcomes. In a study of 134 college students, researchers found that self-assessment improved students' academic achievement and their ability to set goals and monitor their progress (Kubiszyn and Borich, 2016). Similarly, in a study of 218 high school students, researchers found that self-assessment increased students' motivation and engagement in learning (Pekrun et al., 2017).

However, research has also identified some challenges to effective self-assessment. One challenge is that students may lack the necessary skills to evaluate their own work accurately. In a study of

103 undergraduate students, researchers found that students tended to overestimate their performance on self-assessments, highlighting the need for explicit instruction on how to self-assess accurately (Panadero and Jonsson, 2013). Another challenge is that students may be hesitant to evaluate their own work critically, particularly if they perceive that it will be evaluated by others. In a study of 313 high school students, researchers found that students were less likely to self-assess accurately when they believed their work would be evaluated by their peers (Van den Berghe et al., 2020).

To address these challenges, researchers have identified several strategies to promote effective self-assessment. One strategy is to provide explicit instruction on how to self-assess accurately. In a study of 123 college students, researchers found that providing students with explicit criteria for self-assessment improved their ability to evaluate their own work accurately (Wang and Chen, 2019). Another strategy is to provide feedback on self-assessments. In a study of 282 high school students, researchers found that providing feedback on self-assessments improved students' ability to evaluate their own work accurately (Andrade et al., 2018).

Technology has also been used to support self-assessment in education. In a study of 174 university students, researchers found that the use of an online self-assessment tool improved students' ability to evaluate their own work accurately (Cavanagh et al., 2016). Another study of 189 university students found that the use of a mobile app for self-assessment improved students' ability to set goals and monitor their progress (López-Pérez et al., 2019).

Self-assessment is a valuable tool for promoting student learning and engagement. While there are challenges to effective self-assessment, such as students' lack of skills and reluctance to evaluate their own work critically, there are strategies that can be used to support effective self-assessment, such as explicit instruction and feedback. Additionally, technology can be used to support self-assessment and enhance its effectiveness. Future research should continue to explore the use of self-assessment in education and identify additional strategies for promoting its effectiveness.

While research has focused how effective self-assessment is in formative assessment, there is a missing link on how students view self-assessment and how they can use this in their self-regulated learning.

Constructivism is a learning theory based on the work of Dewey (1916), Piaget (1972), Vygotsky (1978) and Bruner (1990). It emphasizes the active construction of new knowledge by learners based on their prior experiences. According to Woolfolk (1993), the essential idea behind constructivism is that students are actively involved in the process of creating their own knowledge, and their minds mediate the information they receive from the world to determine what they will learn. Learning is considered active mental work, not passive reception of teaching. The constructivist approach emphasizes the active-constructive processes that students engage in when building new knowledge. Student academic self-concept is negatively affected by teacher-centered learning (Zulkarnaen, 2019).

The constructivist approach encourages teachers to facilitate active learning, where students are engaged in the process of building their own knowledge and developing their own understanding of the subject matter. Self-assessment creates the atmosphere where students' involvement in work assessment and reflective critical thinking is encouraged and molded. This is unlike teacher-centered summative assessment because the learning process does not provide opportunities for students to be actively involved in the assessment process (Lee and Blanchard, 2018). Therefore, it is learning that involves self-reflection and the interaction of students and teachers and other students have an influence on the academic self-concept achievement (Jackson,2009). Self-assessment is an essential process that aims to generate feedback that informs adjustments to processes and products, thereby promoting learning and improving performance (Andrade, 2010). The primary purpose of self-assessment is to become aware of one's execution process and performance by comparing them with established criteria, which enables students to learn from their mistakes and improve their performance in the future (Lan, 1998). This process of formative assessment is characterized by self-reflection, where students evaluate the quality of their work, judge it based on explicit goals or criteria, and revise accordingly (Andrade and Valtcheva, 2009). By engaging in self-assessment, students become less reliant on their teachers' evaluative judgments and develop self-awareness of what they need to do to succeed in their learning process. Self-assessment is a critical component of self-regulated learning because it involves awareness of the goals of a task and monitoring one's progress toward them (Schunk, 2003).

The formative nature of self-assessment implies that there should be an opportunity for adjustment and correction to make it useful for learning. Without this opportunity, self-assessment becomes almost pointless, and the feedback generated may not promote learning or improve performance. Additionally, self-assessment is an active process that encourages students to take responsibility for their learning and engage in self-reflection to evaluate their performance against established criteria. The formative nature of self-assessment makes it an essential tool for promoting learning and improving performance, as it provides students with the opportunity to adjust and correct their work based on feedback. Therefore, self-assessment should be encouraged as a means of developing self-regulated learners who can take control of their learning and become successful in their academic endeavors.

It was observed that students who have awareness of how they learn are better able to set goals, develop a variety of learning strategies, and control and evaluate their own learning process (Beck, 2016). Similarly, Panadero et al., (2012) pointed out that the effectiveness of self-assessment is determined by how well rubrics and scripts are shared by the teacher with the students. When learning goals are clearly set and discussed with students, it becomes easier for the students to pursue these goals using rubrics (Efklides, 2011). It has been argued that rubrics and scripts on their own may not bring out the best out of the students' self-assessment unless if there is timely teacher intervention and feedback (Panadero et al., 2012). Andrade and Valtcheva (2009) revealed that teacher involvement in self-assessment may also involve models of self-assessment and cues on when to self-assess.

Self-assessment brings out the best out of the students when there is frequent teacher checks and positive feedback. Moss and Brookhart (2019) also suggested that when students self-assess by comparing their work to rubric and success criteria, they can self-regulate and redirect their energies towards their set and agreed learning goals. 'Students can compare their work against the criteria or standards in the rubric, and then self-grade their work accordingly' (Panadero et al., 2012:807).

Andrade and Valtcheva (2009) suggested that students who self-assess need support and practice to reap the full benefits of the process. Studies by Andrade and Du (2007) revealed that students' attitudes toward self-assessment tended to become more positive as they gained experience with practice. They pointed out that there is a positive relationship between self-assessment and student perception of their learning process.

Self-assessment activities help students to be realistic judges of their own performance and to improve their work (Panadero et al. 2016a). The use of self-assessment in students learning promotes the skills of reflective practice and self-monitoring as well as academic integrity through student self-reporting of learning progress (Center for Teaching Innovation, 2020). Incorporating self-assessment can motivate students to engage with the material more deeply and this develops self-directed learning which helps students develop a range of personal, transferrable skills (Andrade, 2018). The use of self-assessment draws attention to the inner dialogue that people engage in as they produce a piece of work and also provides an opportunity for students to take ownership of the assessment criteria and improve on autonomy (Brown and Harris, 2013).

According to Andrade (2010), self-assessment is a form of feedback that serves to inform adjustments to processes and products in order to deepen learning and enhance performance. The primary objective of self-assessment is to generate feedback that promotes learning and improvements in performance. When students engage in self-assessment, they generally take responsibility for their own learning, which can lead to increased critical and deep thinking (van Helvoort, 2012; Siow, 2015), as well as the application of newfound skills (Murakami et al., 2012). Additionally, self-assessment can foster self-regulated learning by guiding students to set goals, plan, self-monitor and reflect (Wang, 2017).

Some researchers (Ross et al., 1998) have suggested that children's attitudes toward self-assessment can become negative if it is summative, but positive perceptions of self-assessment are typically developed by students who actively engage in the formative type. For instance, students can develop their own criteria for an effective self-assessment response (Bourke, 2014) or use a rubric or checklist to guide their assessments and then revise their work (Huang and Gui, 2015; Wang, 2017). Self-assessment tends to be objective and more meaningful to students as it is non-judgmental yet full of corrective measures.

Self-assessment is considered an essential component of cognitive and constructivist theories of learning and motivation (McMillan and Hearn, 2008). Shepard (2001) noted that self-monitoring of learning and thinking is important in the knowledge construction that underlies these theories. Students construct meaning, in part, by self-assessing prior to and during learning. By organizing, evaluating, and internalizing what they learn, students connect new knowledge, understandings, and skills with what they have already stored and used. Self-assessment fosters students' ability to make these connections themselves. McMillan and Hearn (2008) further suggested that self-assessment provides a mechanism to enhance learning in a meaningful, rather than rote, manner, and results in greater student motivation and confidence.

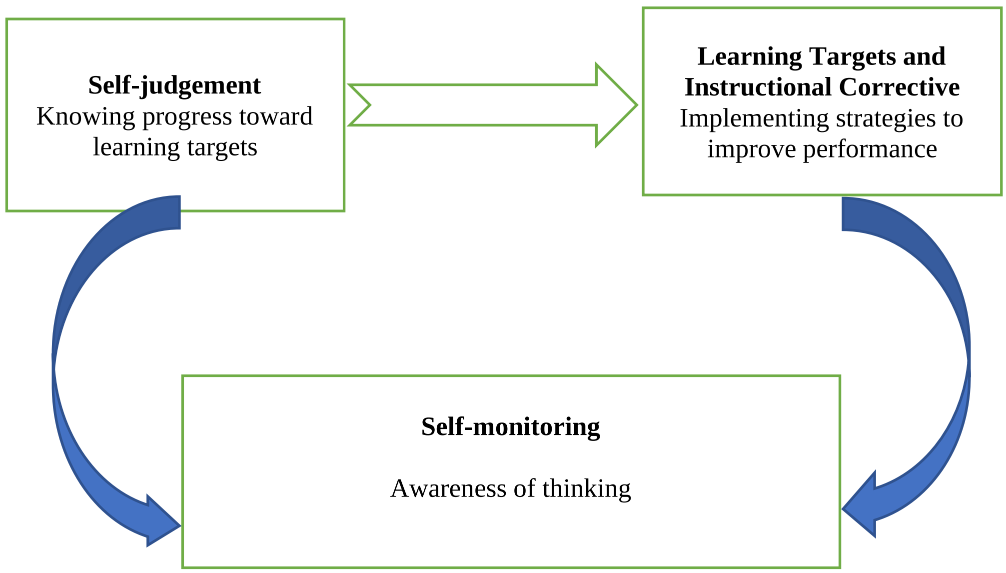
In addition to what has already been mentioned, self-assessment is an effective way for students to take responsibility for their own learning and deepen their understanding of concepts. It is essential for promoting critical and deep thinking, application of skills, self-regulated learning, and knowledge construction. Positive perceptions of self-assessment can be fostered through formative assessment practices, such as the use of rubrics and checklists. By encouraging self-assessment, educators can promote meaningful learning experiences that enhance student motivation and confidence.

Self-assessment encourages and enable students to identify their learning and performance strategies, provide feedback to themselves based on well-understood standards and criteria, and determine the next steps or plans to enhance their performance (McMillan and Hearn, 2008). Figure 2.11 below shows the three components of self-assessment which are all inter-twined.

Self-assessment plays a pivotal role in fostering student autonomy. By promoting reflection, metacognition, self-regulation, and decision-making abilities. Self-assessment empowers students to become active participants in their learning process. The link between self-assessment and student autonomy is evident in the development of independent learning skills and the creation of a supportive learning environment. Incorporating self-assessment practices in educational settings can contribute to the holistic development of students, equipping them with the necessary skills for innovation and creativity.

Figure 2.11

The self-assessment cycle. (Adapted from McMillan and Hearn, 2008:41)



A good relationship among students and teachers can affect students' self-assessment. Conversely, when the teacher is not responsive to the needs of students can cause students' self-assessment to be negative because students are considered incompetent or not academically feasible (Zulkarnaen, 2019). Students' beliefs and attitudes towards a subject are strongly influenced by their experiences in learning that subject. Students who have a positive attitude towards science tend to be more interested and try to study science seriously. This creates what psychologist would term intrinsic motivation. If students have a positive response to science teachers it will have an influence on students' sincerity in learning and mastering the subject (Cornelius-White, 2007). Students can assess and perceive themselves regarding ability in solving the questions posed, leaning styles, ways of learning with other students, communication with teachers or other students, and academic achievement. Self-assessment related to academic aspects is called academic self-concept (O'Mara et al., 2006). There is a strong relationship between self-assessment and self-esteem. Statman (2006) concluded that the improvement of self-assessment is a necessary condition for enhancing self-esteem. A positive self-esteem motivates students and promotes innovation and critical thinking (Jackson, 2009).

Some scholars have researched on students' perceptions on self-assessment and came up with the following results. According to research, children often have simplistic understandings of self-assessment and its purposes, which can lead to limited implementation of related processes (Harris and Brown, 2013; Bourke, 2016). On the other hand, studies conducted in higher education settings have shown that college and university students generally understand the function of self-assessment and find it useful for various purposes. For instance, Ratminingsih et al. (2018) found that college students perceived self-assessment as a valuable tool for guiding evaluation and revision. Additionally, research has shown that self-assessment can help students take responsibility for their own learning, prompting them to think more critically and deeply (van Helvoort, 2012; Siow, 2015), apply newfound skills (Murakami et al., 2012), and foster self-regulated learning by guiding them to set goals, plan, self-monitor, and reflect (Wang, 2017).

It is worth noting that positive perceptions of self-assessment are typically developed by students who engage actively with formative self-assessment processes. For example, Bourke (2014) found that students who developed their own criteria for effective self-assessment responses tended to have more positive attitudes towards the process. Similarly, using rubrics or checklists to guide self-assessment and then revising work accordingly has been shown to be an effective form of formative self-assessment (Huang and Gui, 2015; Wang, 2017). Previous research has suggested that children may develop negative attitudes towards self-assessment if it is used primarily for summative purposes (Ross et al., 1998). However, research with adult learners has shown that even summative self-assessment can be useful in helping students become more critical of their own and others' writing throughout a course and in subsequent courses (van Helvoort, 2012).

Overall, the evidence suggests that self-assessment can be a valuable tool for promoting learning and enhancing performance among college and university students. Engaging students in formative self-assessment processes and providing them with clear guidance and criteria can help to maximize the benefits of self-assessment. It is important for educators to recognize that children may need additional support in developing their understanding of self-assessment and its purposes.

Teacher or learner assessment is sometimes also considered as an exercise of power by the assessor, or the teacher over assesses or the students. On the other hand, student self-assessment is the process by which the students gather information about and reflect on their own learning and is a very important component of learning as it empowers students in the learning process (Sharma et al., 2016). Skilled self-assessment can be as reliable as other forms of assessment however, teachers must provide students with the right guidance and practice if they want results to closely align with the results from other assessors (NCDPI, 2016). In most cases it is beneficial to introduce students to the idea of self-assessment using formative assessment.

Student self-assessment occurs when learners assess their own performance and is primarily used to help students develop specific learning skills that they will need for professional competence. This process may assist in making students more aware of and more responsible for their own learning process (ACADEM, 2017). Combining student self and peer assessment with tutor assessment makes for a more reliable grade (Dancer and Kamvounias, 2005). Self-assessment has the potential of being highly effective when it is carefully designed to optimize students' engagement through clear directions on how the assessment would be carried out (ACADEM, 2017.

Students have been subjects of assessment, they have been recipients of the actions of others, not active agents in the assessment process. Such conceptions of assessment are inappropriate for long-term learning, and they also limit current learning (Rice University, 2019). This is contrary to the social constructivist theories of learning students where are at the center of the learning process as autonomous, engaged, responsible partners, they are largely excluded from assessment as active participants (Boud and Falchikov, 2006). Student centered learning is lost if learners are recipients of assessment instead of being active participants of the assessment processes (Liu, 2016).

According to Benson (2010), student-centered assessment is critical to ensure alignment between assessment and learning. To achieve this, self-assessment is a promising approach that allows students to reflect on quality standards within a discipline and establish criteria for evaluating their work (NCDPI, 2016). Through self-assessment, students learn to apply these criteria to their work and that of their peers, enabling them to judge the extent to which their work meets the standards (Boud and Falchikov, 2006). As a result, students become more engaged with the course content and develop their metacognitive abilities, as self-assessment activities often involve reflection, which encourages them to adjust their learning approaches (Rice University, 2019).

Numerous studies have shown that self-assessment has a positive impact on student learning. It enhances performance, motivation, and self-regulation while promoting feedback literacy, evaluative judgment, and lifelong learning (Rice University, 2019). Moreover, involving students in the assessment process can make it a more meaningful, transparent, and collaborative learning experience (Panadero et al., 2017). This is one of the missing links in assessment in schools as all assessment tends to be teacher-centered and mostly teacher-driven.

However, little research has been carried out to determine the effects of assessment on students' emotions and mental health. Boud and Falchikov (2006) found that assessment has significant negative emotional consequences for students. They surveyed a small group of adult education students about their experiences of assessment, and the findings were suggestive and distressing. The surveyed students reported feeling nervous, unsure, useless, and worthless when assessed. They also felt that exams made them feel like children, inadequate, and lacking self-belief, which led them to the verge of tears, and they had disdain and distrust towards exams (Rice University, 2019).

Thus, it is crucial to understand the impact of assessment on students' emotional well-being and mental health. Instructors should consider the emotional and mental impact of assessment on students and create a supportive learning environment that encourages student self-assessment, which could potentially reduce negative emotions during assessment. Furthermore, providing students with timely and constructive feedback can help alleviate negative emotions associated with assessment (Boud and Falchikov, 2006). Overall, self-assessment is a promising approach that can help align assessment and learning while providing an opportunity for students to improve their metacognitive abilities, but it is important to be mindful of the potential emotional impact of assessment on students. This was also mentioned by van Helvoot (2012) who argued that schools need to take self-assessment seriously as it helps in lessening students' stress associated with testing and summative assessment. Assessment is a nerve-wracking, perhaps even traumatizing, experience with long-lasting consequences for students' sense of self-worth and self-image (Mowl and Pain, 1995). Unfortunately, assessment appears to be intimately connected to one's identity (Boud and Falchikov, 2006).

Additionally, assessment is an inseparable part of educational settings and involving students in this process in meaningful ways can make a difference in how they experience it. Self-assessment has a significant positive impact on students' self-efficacy, meaning that it can increase their confidence in their ability to accomplish the assigned task, modulate negative emotions like anxiety, self-doubt, and fear of failure, and boost their sense of autonomy and ownership of learning (Panadero et al., 2017).

Self-assessment has the potential to mitigate against the negative emotional consequences associated with summative assessment as students would be better prepared (Andrade and Du, 2007). MacMillan and Hearn (2008) gave a guideline of how self-assessment could be implemented in stages to fit into different assessment and learning scenarios as shown in Table 2.3 below. In self-assessment, as in other kinds of assessment, a good rubric is essential to a good review process. It will include detailed criteria, to draw students' attention to important aspects of the work. The criteria should mention the goals and keywords of the assignment, so that students will focus on their goals in assessment as well as their writing (Gehringer, 2020). When assessment is linked to clear cleaning goals and clear success criteria it improves the way students perceive assessment and their overall performance in learning. Equipping students with assessment skills that are hierarchical allows them to easily construct meaning from the process.

Table 2.3

A framework for implementation of Self-assessment. Adapted from MacMillan and Hearn (2008).

	Stage 1	**Stage 2**	**Stage 3**	**Stage 4**
Level of implementation	Establishing criteria	Teaching students how to apply criteria	Providing feedback to students on the application of criteria	Setting learning goals and strategies
Beginning	Success criteria is given to students for their reaction	Examples of how to apply success criteria are given to students.	Teacher provides both class and individualized feedback.	Teacher engages students in justifying their feedback
Intermediate	Students select the most convenient success criteria from a menu of options	Teacher describes how to apply the success criteria to students while allowing students to make individual attempts	Feedback is provided from multiple sources from teacher to students and from students to teacher. Intra-students and inter-group feedback.	A menu of goals, objective and strategies is provided by the teacher.
Full	Students generate their own success criteria	Teacher models how to apply the success criteria	Teacher engages students in justifying their feedback thus creating more room for teacher-student and student-student communication.	Students construct goals, objectives and strategies becoming independent and autonomous learners.

Self-assessment is a powerful mechanism for enhancing learning. It encourages students to reflect on how their own work meets the goals set for learning concepts and skills (Sadler, 1998). Self-assessment promotes metacognition about what is being learned, and effective practices for learning. It encourages students to think about how a particular assignment or course fits into the context of their education. It imparts reflective skills that will be useful on the job or in academic research (Gehringer, 2020).

In middle school science, several factors can drive students to engage in self-assessment some of which are discussed in the next few paragraphs. One of the key drivers of self-assessment in middle school science is teacher feedback. In a study of 84 middle school students, researchers found that students' self-assessment accuracy was positively associated with the quality of feedback they received from their teachers (Liu et al., 2018). In another study of 202 middle school students, researchers found that teacher feedback that was specific and actionable improved students' self-assessment accuracy (Zhu et al., 2020). These studies suggest that effective feedback from teachers can promote accurate self-assessment in middle school science.

Another factor that can drive self-assessment is the use of rubrics. In a study of 140 middle school students, researchers found that the use of rubrics improved students' ability to self-assess accurately (Hwang et al., 2018). Similarly, in a study of 257 middle school students, researchers found that the use of rubrics that were aligned with learning goals improved students' motivation to engage in self-assessment (Lee and Yin, 2019). These studies suggest that rubrics can be a useful tool for promoting effective self-assessment in middle school science.

Self-efficacy, or students' belief in their ability to perform a task, is also a factor that can drive self-assessment. In a study of 277 middle school students, researchers found that students' self-efficacy was positively associated with their self-assessment accuracy (Cui et al., 2018). Similarly, in a study of 344 middle school students, researchers found that students' self-efficacy was positively associated with their motivation to engage in self-assessment (Wang and Hsieh, 2019). These studies suggest that promoting self-efficacy can be a useful strategy for driving effective self-assessment in middle school science.

Finally, the use of metacognitive strategies, such as goal setting and self-reflection, can also drive self-assessment in middle school science. In a study of 141 middle school students, researchers found that the use of metacognitive strategies improved students' ability to self-assess accurately (Lin and Chen, 2021). Similarly, in a study of 148 middle school students, researchers found that the use of a self-reflection tool improved students' motivation to engage in self-assessment (Liu et al., 2019). These studies suggest that promoting metacognitive strategies can be an effective way to drive effective self-assessment in middle school science.

In conclusion, several factors can drive self-assessment in middle school science, including teacher feedback, rubrics, self-efficacy, and metacognitive strategies. Teachers can use these factors to promote effective self-assessment in their middle school science classrooms, thereby improving students' learning outcomes. Future research should continue to explore these factors and identify additional strategies for promoting effective self-assessment in middle school science.

2.5.3 Peer assessment

According to van Zundert, Sluijsmans, and van Merriënboer (2010), peer assessment is a process whereby students evaluate, or are evaluated by, their peers. Peer assessment has been used for both formative and summative purposes. Summative purposes may be motivated by aims to save teacher workload. However, it may also be used as an assessment tool for teachers to discern the performance of individual students working in group projects. Peer assessment is sometimes used formatively to complement teacher feedback because it is argued that feedback from peers may be easier to understand than feedback received from a teacher. Another use of peer assessment is as a learning tool to develop students’ abilities to form judgments about what constitutes high-quality work.

Panadero (2016) argues that there are two potential outcomes of peer assessment: improving work from feedback and learning from assessing. The outcomes of both depend highly on the framed purpose of peer assessment and what guidance, for example, in the form of rubrics, are available to the students. Harris and Brown (2013) also agree that the purpose of the peer assessment should be clearly defined to ensure that it is used effectively.

Peer assessment can offer various benefits, including reducing the teacher workload, providing students with opportunities to develop their critical thinking and communication skills, and enhancing students' ability to give and receive constructive feedback. However, there are also potential drawbacks, such as the risk of students providing inaccurate or biased feedback, and the possibility of students feeling uncomfortable or anxious when evaluating their peers.

To address these concerns, it is crucial to provide clear guidelines and criteria for peer assessment, and to train students in providing constructive feedback. It is also essential to ensure that peer assessment is used in conjunction with other forms of assessment, such as teacher feedback, to ensure a comprehensive and balanced evaluation of student learning. Overall, when used appropriately, peer assessment can be a valuable tool for enhancing student learning and engagement.

Peer assessment in formative assessment, just like self-assessment is a communication process through which learners enter into dialogues related to performance and standards amongst themselves (Liu and Carless, 2006). It was further stated that formative peer assessment is primarily about rich detailed comments but without formal grades (Falchikov, 2001). OECD (2016) revealed that students feel more confident when they interact with their peers and teachers during learning. An interactive culture allows students to ask questions and seek for clarity thus improving their self-confidence (Mangwaya, 2014).

Peer assessment or peer review provides a structured learning process for students to critique and provide feedback to each other on their work. It helps students develop lifelong skills in assessing and providing feedback to others and equips them with skills to self-assess and improve their own work (Cornwell University Center for Teaching Innovation, 2019). Peer assessment is a process in which students provide feedback to other students. The purpose of this feedback is to help classmates improve their learning (Wray, 2013). Feedback provided by other students is a learning activity and student learning benefits when they provide feedback and take feedback from their peers (NCDPI, 2018). When students give feedback to their peers, they strengthen their understanding of the lesson goals and success criteria which in turn helps them assess their own learning (Oregon State University, 2020). According to Wiliam (2006) research has proved that the person providing feedback benefits just as much as the recipient because they are forced to internalize the learning intentions and success criteria in the context of someone else’s work.

Peer assessments empower students to take responsibility to manage their own learning while also enhancing students' learning through knowledge diffusion and exchange of ideas (Cornwell University Center for Teaching Innovation, 2019). The use of peer assessment motivates students to engage with course material more deeply and enables them to learn to assess and give others constructive feedback to develop lifelong assessment skills (Wray, 2013). The successful use of peer assessment requires a classroom culture characterized by supportive, collaborative relationships that lead to feelings of mutual trust among students (Lummis, 2001). A well laid out classroom culture will allow students to understand that they share responsibility for their own and their peers’ learning and that part of this joint responsibility is to provide respectful, constructive, and non-judgmental feedback (Slater, 2004). Teachers need to model the kind of peer assessment that should be followed by students, Wray (2013) argued that teacher modelling plays an important role in establishing a culture for peer assessment and collaboration.

Peer assessment has positive effects on self-regulation in learning science by promoting self-reflection, goal setting, self-monitoring, accountability, and feedback processes. By incorporating peer assessment practices in science education, educators can create an environment that supports students' development in self-regulated learning skills (Saddler, 2007). This in turn empowers students to become active learners, taking ownership of their scientific enquiries and attaining academic growth.

Studies by Hovardas et al. (2014) revealed that there are some challenges that are related to peer assessment as most science students do not fully utilize peer feedback to improve their work even if the feedback offered the appropriate suggestions for improvement. Students may not perceive peer feedback as relevant (Saddler, 2007). The process of receiving and giving feedback is influenced by social variables such as prior experiences with peer assessment, motivation for engagement and trust on oneself and the peer giving the feedback (Panadero, 2016). Students do not credit their peers with the same trust as they do with their teachers (Cheng and Tsai, 2012).

According to Wray (2013), peer assessment and feedback are grounded in three questions that frame the feedback loop as shown in Table 2.4 below. WestEd (2020) pointed out that in order to answer the three questions students need a clear understanding of learning goals and success criteria.

Table 2.4

The essentials questions of peer assessment (adapted from Wray, 2013:1)

Assumed self-status	**Assumed peer status**
Where am I going?	Where is my peer going?
Where am I now?	Where is my peer now?
Where to next?	Where is my peer going next?

Teachers could also use acronyms such as the R.I.S.E model to ensure that students provide engaging and meaningful feedback to their peers (Wray, 2013). The RISE model of assessment can be effectively used to encourage self-regulated learning in science by incorporating key principles and strategies that promote active engagement, metacognition, and reflection. According to Zimmerman's (2000) model of self-regulated learning, students can enhance their learning experiences by setting specific goals, monitoring their progress, and employing strategic planning and adaptive strategies. The RISE model aligns with these principles and provides a framework for implementing self-regulated learning in science education.

Firstly, the RISE model emphasizes the importance of Relevance in learning. Teachers can foster self-regulated learning by connecting scientific concepts to real-world applications and personal experiences. By demonstrating the relevance of science in everyday life, students are motivated to actively engage in the learning process (Linnenbrink-Garcia and Pekrun, 2011).

Secondly, the model promotes the use of Interactive assessment techniques. These techniques involve ongoing dialogues, peer discussions, and collaborative problem-solving activities. Through these interactive assessments, students can engage in metacognitive processes, such as reflecting on their own understanding and articulating their thoughts to others. This helps students develop a deeper understanding of scientific concepts and improves their self-monitoring skills (Black and Wiliam, 1998).

Thirdly, the model emphasizes the importance of Self-assessment. Students are encouraged to take ownership of their learning by regularly evaluating their progress and identifying areas for improvement. Self-assessment activities, such as self-reflection journals or rubrics, can enhance metacognitive awareness and promote self-regulation in science (Andrade, 2010).

Finally, the model advocates for Evaluation through feedback. Teachers should provide timely and constructive feedback to guide students' learning. Feedback should focus on specific learning goals, be actionable, and provide students with strategies for improvement. Effective feedback helps students develop self-efficacy and self-regulatory skills, enabling them to monitor and adjust their learning strategies accordingly (Hattie and Timperley, 2007). By implementing the RISE model of assessment, science educators can encourage self-regulated learning in students. By promoting relevance, interactivity, self-assessment, and evaluation through feedback, teachers can create an environment that fosters active engagement, metacognition, and reflection in science education. This approach empowers students to take control of their learning, leading to improved academic achievement and long-term retention of scientific knowledge.

This is shown in Table 2.5 below. Jackson (2008) pointed out that the RISE model when used with peer assessment scaffolds peer feedback as students consider the four prompts to provide structured feedback.

Table 2.5

The RISE model. Adapted from Wray (2013:3)

Reflect: Recall ponder and communicate	I concur/relate/disagree with X because …. I like what you did with X because …
Inquire: Seek information or provide ideas through questioning	Have you considered looking at X from Y perspective? How about …?
Suggest: Introduce ideas for improvement of current iteration	You may think about including some information from another resource for X…. Here is a suggested link …
Elevate: Raise a higher degree or purpose in future iterations	Perhaps you could expand this section on X to further to analyze this section Y …

Formative assessment, as pointed out by Black and Wiliam (1998) shifts focus towards students' attention on mastering tasks and developing emotional competencies rather than competition with peers. Emotional competencies, such as self-awareness, self-control, compassion, co-operation, flexibility, and the ability to make judgments on the value of information serve students well in school and throughout their lives (OECD, 2002:58). An interactive culture in the classroom opens avenues for greater understanding of concepts to be learnt. Liu and Carless (2006) argued that formative peer assessment has greater potential for learning as students are more likely to better self-assess themselves as some skills are common to both peer and self-assessment. They further stated that the link between peer assessment and self-assessment is salient. Research findings by Boud (1999) suggested that self-assessment can be enhanced by peer contributions which may take the form of questions, comments or challenges which prompt one to reflect on what has been done. Falchikov (2001) concluded that peers provide rich information which can then be used by individuals to make their own self-assessments and in the process of self-expression, students construct an evolving understanding of increasing complexity. In the same manner Lui and Carless (2006) concluded by stating that peer assessment provides learners with opportunities to explore and articulate criteria and standards in the context of working on specific assessment tasks.

Peer assessment can be improved upon to encourage critical thinking when teachers use strategies such as critical thinking acronyms and graphic organizers (Love and Stobaugh, 2018). They contended that when students work with clear learning objectives and success criteria, they are better place to peer assess their fellow students and, in the process, they will also benefit from the assessment as it helps them to become autonomous, critical thinkers. This was also mentioned by The Sheridan Center (2020) that the thoughtful integration of peer assessments into coursework can enhance students' learning in several ways: it helps build trust and intellectual community; it leads to more thoughtful and reflective discussions; and it can help students cultivate a greater capacity for critical and evaluative judgment.

Peer and self-assessment help students develop self-regulation. As they learn to become more self-regulatory and therefore independent in facilitating their own learning, they can monitor, direct and regulate their own actions towards their learning goals (Anker-Hasen, 2019). Peer assessment provides opportunities for students to reflect on their own work and that of peers, a process that builds higher-order thinking skills. They will also become more engaged in their learning and will build their confidence in discussing work with peers in a reflective, collaborative process (Double et al., 2020).

There are two crucial aspects that are associated with peer assessment, and these are anonymity and accuracy (Panadero et al., 2018). Several studies have come up with varying conclusions as to whether students prefer anonymity or to reveal the person who assess their work during peer assessment (Ballantyne et al., 2002). This interplay of interpersonal variables influences the assessment outcome, it has often been stated that decreasing negative social effects via anonymity is desirable (Vickerman, 2009) or should at least be explored (Howard et al., 2010). Topping (1998) indicated that privacy is an important structural feature of peer assessment, in that disclosing the identity of the assessors or assessees, seems to matter to students. Students have more positive attitudes towards peer assessment when anonymity for the assessor was assured, while the participating teacher suggested that identity revelation towards him might be desirable to control for undesirable social effects (Vanderhoven et al., 2015). Another perspective by Yu and Sung (2015) stated that anonymity might offer more psychological safety for students, but at the same it might lead to misbehavior, for example more positive marking towards friends. A survey by Panadero and Brown (2016) revealed that schoolteachers predominantly believed in the use of anonymous versions of peer assessment, although it was not found to be a significant determinant to peer assessment frequency of use, except for university teachers. The concept of anonymity needs further research especially students' conceptions towards the different anonymity modes that can be manipulated in a peer assessment setting such as anonymity towards the assessor, the assessee and the teacher (Panadero et al., 2018).

Perceived validity, accuracy, and reliability of peer assessment remains a concern (Topping, 2003). The problem for some is that students, as novices and learners, may not be sufficiently competent in a field to make an accurate estimation of another's' work quality (Panadero et al., 2018). Empirical research shows that students can be reliable sources under appropriate conditions

(Falchikov and Goldfinch, 2000) such as being accompanied using rubrics, involving students in the discussion about the criteria and/or considering the level of expertise of the students (Topping 2003).

There are six variables that may affect peer assessment (Panadero et al., 2018). These are friendship making, fear of disapproval, psychological safety, value congruency, trust in others and trust in the self an assessor.

Friendship making

Friendship bonds have been identified as a potential source of scoring bias as students are likely to award their friends higher scores than what they deserve (Double, 2020). However, Liu (2013) found that students were less likely to over score their peers. Research on the diminishing effect of rubrics on over- and underscoring by peers in PA shows that for low and medium friendship levels, a rubric does reduce the friendship bias, but for high-level friendship, the rubric even seems to amplify the potential friendship bias (Panadero et al., 2013). Cheng and Tsai (2012) found that anonymity was preferred for the reason of avoiding the pressure of friendships. When anonymous peer assessment is used the risk of friendship bias is eliminated and feedback is very constructive (Panadero et al., 2018).

Fear of disapproval

Fear of disapproval refers to the assessors' fear of negative comments from the assessee if they give them a low score or negative feedback /recrimination (Cartney, 2010). To decrease this type of fear, it has been argued that anonymity might play a role. Students in an anonymous face-to-face peer assessment setting experienced significantly less fear of disapproval compared to students in a non-anonymous setting (Vanderhoven et al., 2015). Some students may not give the actual feedback or score to some of their peers for fear of rejection and disapproval. This is especially so if a student with low self-esteem assess work from a peer, they perceive to be academically better than they are (Salih, 2013).

Psychological safety

Psychological safety refers to a situation in which students have a shared belief about taking interpersonal risks in a group (Panadero et al.,2018). People that feel psychologically safe tend to perceive differences in opinions as opportunities rather than conflicts (Nicol, 2010; Yu and Sung, 2015). This is important as several authors state that creating a safe environment is a precondition for accurate and thus valuable peer assessment activities (Harris and Brown, 2013; van Gennip, Segers, and Tillema, 2009).

Value of congruency

Value of congruency refers to the importance of unanimity on both the goals and criteria of the peer assessment activity (Cheng and Tsai, 2012). Rubrics hold the potential of augmenting the value congruency within a PA-activity as they provide the assessment criteria in a structured format and might thus enhance the perceived fairness and comfort with PA (Panadero et al., 2013).

Trust

Trust works in multiple ways and lack thereof may negatively impact self-assessment. Trust in the self as assessor refers to the assessors' beliefs about their skills when assessing a peer (van Gennip et al., 2010). Building upon self-trust is very important in enhancing self-confidence Trust in the other as assessor refers to the confidence in the reliability and validity of the assessment and feedback received from a peer. Students will only act based on trustworthy information such as if they believe that comments are capricious, they will not act on the basis of them (Carless, 2013). To ensure that this trust is not lost due to how students perceive themselves and their peers there is every need to make effective use of rubrics as they guide both the assessor and the one being assessed in establishing how the process of assessment would have taken place.

2.6: Self-regulated learning

Self-regulated learning is a vital aspect of achieving academic success. It is a process by which learners take control of their own learning and involves setting goals, monitoring progress, and adapting strategies to achieve those goals (Zimmerman, 2008). Self-regulated learning refers to one's ability to understand and control their learning environment. Learners who possess self-regulatory skills take responsibility for their own learning and proactively work towards achieving their goals.

Blair and Diamond (2008) define self-regulation as the volitional behavioral and cognitive processes through which people maintain levels of motivational, cognitive, and emotional arousal that facilitate positive adaptation and adjustment, as reflected in high levels of productivity and achievement as well as positive relationships and a positive sense of self. Self-regulation allows students to remain focused and persistent as they face daily challenges in a rigorous classroom (Keane and Shelton, 2003). Barkley (2012) defines self-regulation as self-directed action intended to alter subsequent behavior, guide future responses, and change the probability of a future event or consequence.

Denham (2006) suggests that the ability to self-regulate serves as an asset for students, allowing them to attend more fully to instruction in the classroom. McClelland et al., (2006) found that students with greater self-regulation from a young age are more skilled in reading, science, and math in later grades. All learners use regulatory processes to some degree, but self-regulated learners are distinguished by their awareness of strategic relations between regulatory processes or responses and learning outcomes and their use of these strategies to achieve their academic goals (Carver and Scheier, 1981).

Effective self-regulated learning requires the development of metacognitive skills, such as self-awareness, self-monitoring, and self-evaluation. These skills enable learners to identify their strengths and weaknesses and to develop strategies for addressing their areas of weakness. Self-regulated learning includes the cognitive, metacognitive, behavioral, motivational, and emotional/affective aspects of learning (Panadero, 2017).

Self-regulation is the self's capacity for altering its behaviors. It greatly increases the flexibility and adaptability of human behavior, enabling people to adjust their actions to a remarkably broad range of social and situational demands. It is an important basis for the popular conception of free will and for socially desirable behavior. It provides benefits to the individual and to society, and indeed good self-control seems to contribute to a great many desirable outcomes, including task performance, school and work success, popularity, mental health and adjustment, and good interpersonal relationships (Baumeister, Heatherton, and Tice, 1994; Duckworth and Seligman, 2005; Mischel, Shoda, and Peake, 1988; Shoda, Mischel, and Peake, 1990; Tangney, Baumeister, and Boone, 2004; Wolfe and Johnson, 1995).

Furthermore, self-regulated learning is crucial for academic success as it enables learners to take responsibility for their own learning and to be proactive in achieving their goals. Self-regulation involves setting goals, monitoring progress, and adapting strategies to achieve those goals. It is an essential process that involves cognitive, metacognitive, behavioral, motivational, and emotional/affective aspects of learning. Effective self-regulated learning requires the development of metacognitive skills, such as self-awareness, self-monitoring, and self-evaluation. Furthermore, self-regulation is the self's capacity for altering its behaviors and greatly increases the flexibility and adaptability of human behavior, leading to desirable outcomes for both the individual and society.

Self-regulation abilities include goal setting, self-monitoring, self-instruction, and self-reinforcement (Harris and Graham, 1999; Schraw, Crippen, and Hartley, 2006; Shunk, 1996). The process of self-regulation is a self-directive process and set of behaviors whereby learners transform their mental abilities into skills (Zimmerman, Bonnor, and Kovach, 2002) and habits through a developmental process (Butler, 1995, 1998, 2002) that emerges from guided practice and feedback (Paris and Paris, 2001). Zheng and Zhang (2020) added that self-regulated learning is an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and contextual features of the environment. Self-regulated learners are not merely reactive to their learning outcomes; rather, they proactively seek out opportunities to learn (Zimmerman, 1989a). They self-initiate activities designed to promote self-observation, self-evaluation, and self-improvement such as practice sessions, specialized training, and competitive events (Zimmerman and Martinez-Pons, 1986). This was summed up by McCombs (1989) who reasoned that self-regulated learning involves proactive efforts to seek out and profit from learning activities.

Black et al.'s (2004) study of formative assessment practices in math and science classes for 11-15year old students revealed a strong relationship between formative assessment, and self-regulated learning. According to Schunk and Zimmerman (2012) self-regulated learning refers to a process by which learners activate and sustain cognitions, affects and behaviors that are systemically oriented toward the attainment of learning goals. 'Self-regulated learning refers to self-generated, thoughts, feelings and actions towards attaining one's goals' (Zimmerman, 1998:73). Sun et al., (2018) declared that self-regulated learning offers opportunities to students to take control of their learning pace and be responsible for their learning process. However, Fulton (2012) noted that at the same time, self-regulated learning demands more from students. Self-regulated learning is an integrated learning process guided by a set of motivational beliefs, behaviors, and metacognitive activities that are planned and adapted to support the pursuit of personal goals (Zimmerman and Schunk, 2012). Liu and Matthews (2005) reported that self-regulated learning equips students with knowledge of how to regulate time, resources, and strategies to achieve learning goals is important.

Studies by Sun et al. (2018) pointed out that research shows that students with higher levels of self-regulation tend to learn effectively and achieve better than those with lower levels of self-regulation, hence they become more confident and perceive assessment with a proactive mindset. This was also noted by Zimmermann (2000) where the author added that self-regulated learners are characterized by their ability to initiate metacognitive, cognitive, motivational, and behavioral processes to act and persevere to pursue and achieve their set and shared learning goals. While self-regulated learning creates an innovative and independent student, there is need to provide supportive feedback and scaffolded intervention (Kizilcec et al., 2017). Research by DiBenedetto and Zimmerman (2013) listed three phases of self-regulated learning which are cyclic and feed into each other. The first phase was termed the fore-thought phase, where in Zimmerman's view the student will be engaged in goal setting and agreeing on the success criteria with the teacher. It is at this stage where interest in cultivated, strategic planning is invested in, and expectations are established.

The second phase according to the authors is termed the performance phase where the student engages in self-control, self-instruction from the set targets which in turn leads to self-imagery.

Bandura (1986) suggested that at this stage there is attention focusing and metacognitive monitoring through self-observation. Unlike their passive classmates, self-regulated students proactively seek out information when needed and take the necessary steps to master it. When they encounter obstacles such as poor study conditions, confusing teachers, or abstruse textbooks, they find a way to succeed. Self-regulated learners view acquisition as a systematic and controllable process, and they accept greater responsibility for their achievement outcomes (Zimmerman and Martinez-Pons, 1990)

The third phase involves self-reflection and self-judgement where students compare their work against standards and rubric provided and agreed upon. According to Zimmerman (2006) this leads to self-reaction and self-evaluation. Self-regulated learners can self-critic and initiate adaptive measures that will improve on the understanding of the subject matter, (DiBenedetto and Zimmerman, 2013). Bandura (1986) believed that the self-reflective stage can enable students to better plan for their new goals from prior experiences thus feeding into the forethought phase.

According to Zimmerman and Schunk (2006) It was revealed that students who better self-regulated in their learning processes tend to set better learning goals, implement more effective learning strategies, establish more productive learning environments than those who are ill-equipped in self-regulated learning.

Self-regulated learners are self-starters who seek assistance more often when it is needed while they can also adjust learning strategies from self-judgement and self-evaluation, they approach educational tasks with confidence, diligence, and resourcefulness (Zimmerman, 1990). In their behavioral processes, self-regulated learners select, structure, and create environments that optimize learning (Henderson, 1986; Wang and Peverly, 1986; Zimmerman and Martinez-Pons, 1986). They seek out advice, information, and places where they are most likely to learn, they self-instruct during acquisition and self-reinforce during performance enactments (Diaz and Neal, in press; Rohrkemper, 1989).

Self-regulated learning has become an extraordinary umbrella under which a considerable number of variables that influence learning such as self-efficacy, volition, cognitive strategies, are studied within a comprehensive and holistic approach (Panadero, 2017). Self-regulated learning (SRL) can make a significant contribution to assessment for learning (AfL). AfL is an approach to assessment that emphasizes the role of assessment in supporting and enhancing learning rather than just measuring learning outcomes. Self-regulated learning can be an effective means of achieving assessment for learning goals because it enables learners to take ownership of their learning and to become active participants in the assessment process.

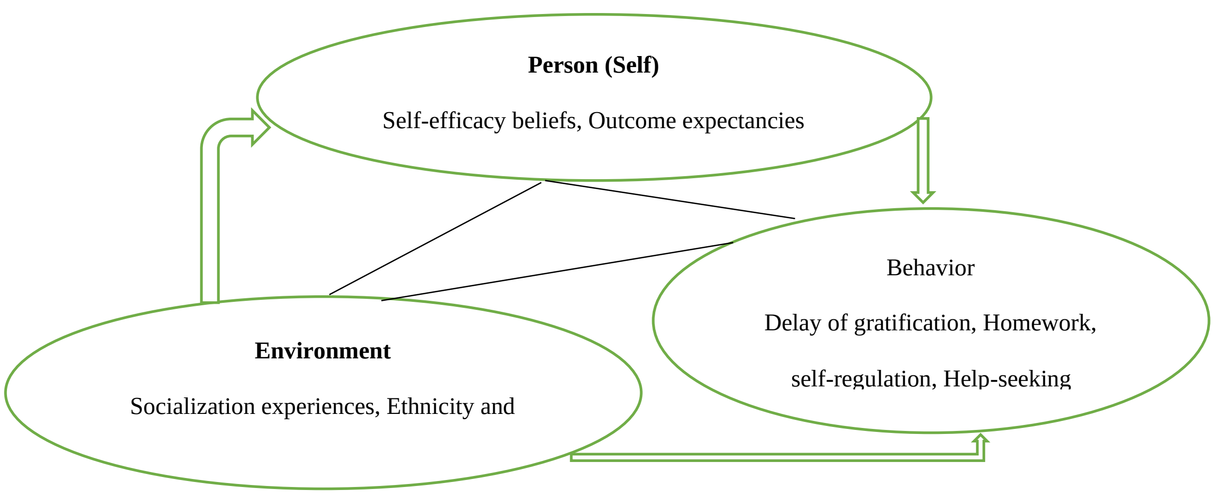
One way that SRL can contribute to AfL is by empowering learners to set their own goals and to monitor their progress towards those goals. By setting goals that align with the learning outcomes and assessment criteria, learners can ensure that they are focusing on the most important aspects of the material. Additionally, by monitoring their progress towards those goals, learners can identify areas where they need to improve and adjust their strategies accordingly. This study will focus on the contributions of different models of self-regulated learning such as those by Zimmerman, Boekaerts, Winne and Hadwin, Pintrich; Efklides, and Hadwin, Järvelä and Miller.

Zimmerman is credited as being the first author on self-regulated learning in detail (Panadero, 2017). Zimmerman’s socio-cognitive perspective assumes that individuals acquire knowledge by observing others and social interaction. The author developed three models of self-regulated learning which are, the triadic analysis model, the e cyclical phases model and the multi-Level model (Zimmerman and Schunk, 2011).

Developed in collaboration with Bandura, the triadic analysis model has three unidirectional dimensions which are shown in Figure 2.12. The model envisions how self-regulated learning is a product of the environment, the behavior and the person self. Personal dimensions affect one's behavior and one's behavior affects one's personal feelings and thoughts. Learning takes place through social modeling—observing patterns of behavior of another in the environment (DiBenedetto and Bembenutty, 2012). The model follows a constructivist approach in that through vicarious and direct observations provided during childhood, children learn about what is considered appropriate behavior for their gender. This ultimately affects their how individual self-regulate and get motivated as they learn (DiBenedetto and Bembenutty, 2012).

Figure 2.12

The triadic self-regulated learning. Adapted from Zimmerman (1989:330).



Note: Self-regulated learning is and result of the of one’s environment, expectations and behavior.

The cyclic phases model explains the individual level the interrelation of metacognitive and motivational processes (Greene and Alvezedo, 2007). This model describes how self-regulated learners can engage in forethought, volitional control and reflection as they do their work (Panadero, 2017). The model recognizes the essential role of the student in regulating the way the acquire knowledge (DiBenedetto and Bembenutty, 2012). The cyclic model of self-regulated learning, developed by Zimmerman and Moylan (2009), proposes that self-regulated learning is a cyclical process that involves three phases: forethought, performance, and self-reflection. The model emphasizes the importance of metacognitive processes, such as goal setting, self-monitoring, and self-evaluation, in guiding and regulating learning.

During the forethought phase, learners set goals, activate prior knowledge, and plan their learning strategies. This phase involves the use of metacognitive processes such as goal setting, task analysis, and self-motivation (Zimmerman and Moylan, 2009).

The performance phase involves the actual implementation of the learning strategies and the completion of the learning task. During this phase, learners engage in self-monitoring, where they observe their progress and adjust their learning strategies as needed. This phase also involves the use of self-instruction, where learners talk to themselves to regulate their thinking and behavior (Zimmerman and Moylan, 2009).

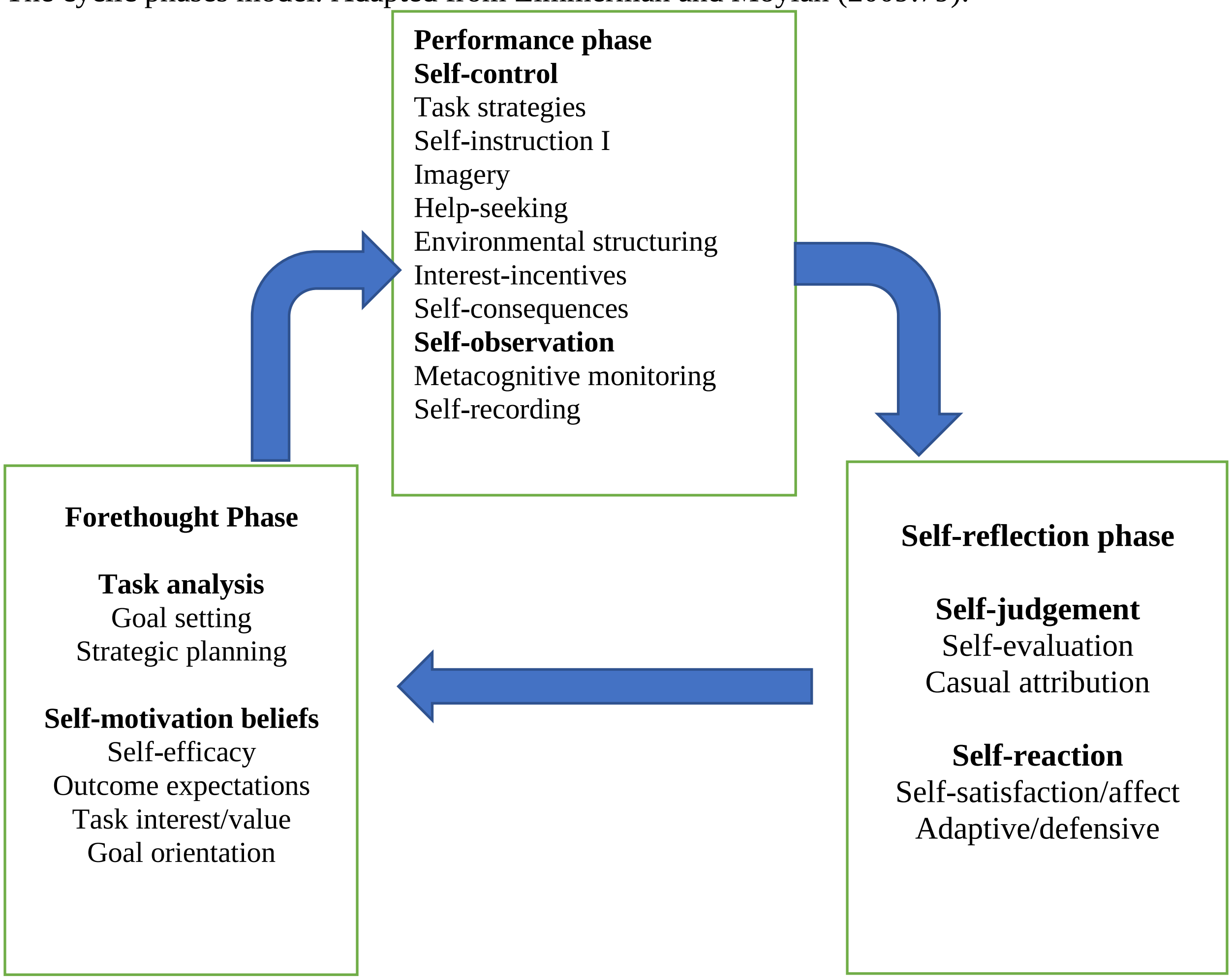
The self-reflection phase involves learners evaluating their performance and the effectiveness of their learning strategies. During this phase, learners engage in self-evaluation, where they compare their performance to their goals and standards. They also engage in self-reaction, where they evaluate their emotional reactions to their performance and the learning task (Zimmerman and Moylan, 2009).

The cyclic model of self-regulated learning provides a comprehensive framework for understanding the self-regulated learning process. It emphasizes the role of metacognitive processes in guiding and regulating learning and highlights the cyclical nature of self-regulated learning. By understanding and applying the cyclic model, learners can develop their metacognitive skills and become more effective self-regulated learners.

Figure 2.13 below shows the cyclic phases model.

Figure 2.13

The cyclic phases model. Adapted from Zimmerman and Moylan (2009:79).



The third model represents the four stages in which students acquire their self-regulatory competency (Zimmerman, 2000). It shows the four stages of self-regulated learning as presented in Figure 2.14 below.

Figure 2.14

Multi-level model. Adapted from Zimmerman (2000:422).

Level	Name	Description
1	Observation	Vicarious induction of a skill from a proficient model
2	Emulation	Imitative performance of the general pattern or style of a model's with social assistance
3	Self-control	Independent display of the model's skills under structures or modified environmental conditions.
4	Self-regulation	Adaptive use of skill across changing personal or environmental conditions.

In addition to Zimmerman's model other scholars who have presented work on self-regulated learning include Boekaerts who focused the role of goals and emotions.

Boekaerts focused her work on the role of goals and how students activate different types of goals in relation to self-regulated learning (Panadero, 2017). Boekaerts coined two self-regulatory learning models, namely the structural model and the adaptive learning model. There are three different purposes of self-regulation which are the top-down that is in pursuit of task goals is driven by the students' values, needs and personal goals. The second purpose is called bottom–up, as the strategies try to prevent the self from being damaged, and students may experience a mismatch between the task goals and their personal goals. The third purpose occurs when students try to redirect their strategies from the well-being to the mastery/growth pathway, which may happen via external sources, such as teacher or peer pressure or internal forces such as self-consequating thoughts (Boekaerts, 2011). In many cases curriculum specialists and teachers tend to give less attention to students' emotional needs and goals, a major reason why many students are afraid of assessment in general (Mangwaya, 2014). Using Boekaerts' two models one will understand the need to restructure the way students are assessed (Jackson, 2009).

Boekaerts' six-component self-regulated learning (SRL) model provides a valuable framework for understanding the perception of students and teachers towards assessment (Boekaerts, 1999). According to this model, SRL involves six interrelated components: task perception, goal setting and planning, learning strategies, environmental structuring, self-monitoring, and self-evaluation. Task perception is the first component and refers to how students interpret the assessment task and its requirements. It plays a crucial role in shaping their attitudes and motivation towards assessment. Students' perception of the task's difficulty, relevance, and personal importance can significantly impact their engagement and effort during assessment (Boekaerts, 1999).

Goal setting and planning, the second component, involves students setting clear objectives and developing strategies to accomplish them. In the context of assessment, this component influences students' perception of the assessment's purpose and the standards they need to meet (Boekaerts, 1999).

Learning strategies, the third component, are cognitive and metacognitive processes that students employ to acquire, organize, and recall information. Effective use of learning strategies helps students understand assessment requirements, select appropriate study techniques, and enhance their performance (Boekaerts, 1999).

Environmental structuring, the fourth component, refers to the arrangement of the learning environment to support self-regulated learning. In terms of assessment, teachers' provision of clear instructions, grading criteria, and feedback can shape students' perception of fairness and transparency, influencing their motivation and engagement (Boekaerts, 1999).

Self-monitoring, the fifth component, involves students' continuous assessment of their learning progress, identifying strengths and weaknesses, and making adjustments accordingly. In the context of assessment, students' perception of their own abilities and progress can impact their confidence and approach to the task (Boekaerts, 1999).

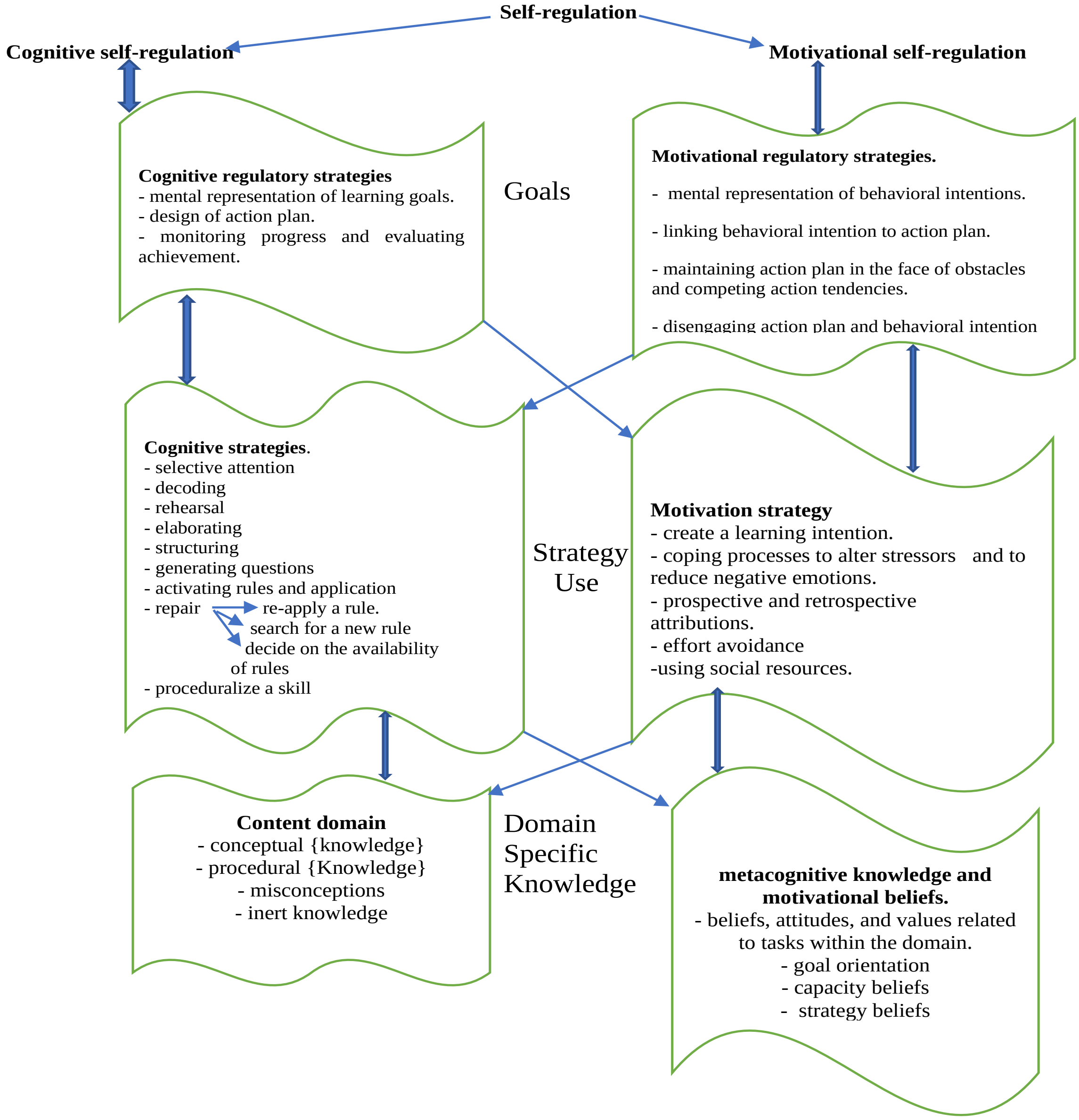
Finally, self-evaluation, the sixth component, refers to students' assessment of their performance and the outcomes of their learning efforts. Students' perception of assessment results, feedback, and grades can shape their self-concept, motivation, and future learning strategies (Boekaerts, 1999).

Understanding these six components of SRL can provide insights into students' and teachers' perceptions towards assessment. By recognizing the interconnected nature of these components, educators can design assessments that promote positive task perception, effective goal setting and planning, strategic use of learning strategies, supportive environmental structuring, accurate self-monitoring, and meaningful self-evaluation. This holistic approach to assessment can enhance students' motivation, engagement, and learning outcomes.

The structural model divides the self-regulation into six components which are shown in Figure 2.15 below.

Figure 2.15

Six component model of SRL. Adapted from Boekaerts (1996b:56)



Boekaerts' contributions to self-regulated learning are essential in understanding students' perceptions and behaviors with regards to assessment due to the use of the growth pathway and the wellbeing pathway (Panadero, 2016).

Other scholars who have also added their work to the same include Winnie and Hadwin who argued that self-regulated learning could be understood from from the metacognitive perspective

Winne and Hadwin's model is strongly influenced by the Information Processing Theory (Winne, 2001; Greene and Azevedo, 2007), it has a strong metacognitive perspective that recognizes self-regulated students as active and managing their own learning via monitoring and the use of, mainly, (meta)cognitive strategies (Winne, 1995, 1996, 1997; Winne and Hadwin, 1998) while asserting the goal driven nature of self-regulated learning and the effects of self-regulatory actions on motivation (Winne and Hadwin, 2008). The metacognitive perspective model recognizes the impact of technology in self-regulated learning and has four linked phases that are open and recursive and are comprehended in a feedback loop. These four phases are (a) task definition: the students generate an understanding of the task to be performed; (b) goal setting and planning: the students generate goals and a plan to achieve them; (c) enacting study tactics and strategies: the use of the actions needed to reach those goals; and (d) meta-cognitively adapting studying: occurs once the main processes are completed and the student decides to make long-term changes in her motivations, beliefs and strategies for the future (Panadero,2017).

The four phases operate with five facets which are identified the acronym COPES It stands for (a) Conditions: resources available to a person and the constrains inherent to a task or environment such as context, time; (b) Operations: the cognitive processes, tactics and strategies used by the student that are referred to as SMART -Searching, Monitoring, Assembling, Rehearsing and Translating- (Winne, 2001) such as planning how to perform a task; (c) Products: the information created by operations such as new knowledge; (d) Evaluations: feedback about the fit between products and standards that are either generated internally by the student or provided by external sources such as teacher or peer feedback; and (e) Standards: criteria against which products are monitored (Winne and Hadwin, 1998; Greene and Azevedo, 2007). The model also utilizes scaffolding of feedback by teachers to enhance self-regulated learning by learners in line with the levels of cognition (Panadero). When feedback is linked to the learners' level of cognitive development it requires teachers to be well versed with formative assessment lest more harm than good is done (Jackson, 2014).

Most of the other models of self-regulated learning tend to complement each other by adding other facets to what has already been discussed. Such models include Pintrich who made connections between motivation and cognition emphasized and clarified the differences between metacognition and self-regulation (Pintrich et al., 2000).

According to Pintrich (2000) model, self-regulated learning is compounded by four phases: (1) Forethought, planning and activation; (2) Monitoring; (3) Control; and (4) Reaction and reflection. Each of them has four different areas for regulation: cognition, motivation/affect, behavior and context (Panadero, 2017).

Efklides presented the Metacognitive and Affective Model of Self-Regulated Learning (MASRL), which dwelt on modifying other existing models, (Efklides, 2006, 2008). The model is grounded in classic socio-cognitive theory (Bandura, 1986), the author added the concept of ability to self-regulated learning which had not been discussed by other models. While the environment can be modified to enhance self-regulation, Efklides contended that the uniqueness of individuals can impact on individual abilities to self-regulate (Panadero, 2017). There is need for more research into the area of self-regulation.

2.6.1 Motivation

Motivation is a condition that activates and sustains behavior toward a goal. It is critical to learning and achievement across the lifespan in both informal settings and formal settings (Pintrich, 2003). The term motivation was defined by Zimmerman and Schunk (2006) as the interest, social cognition, volition, goal orientation and self-determination of students in achieving set educational goals. According to Bouffard-Bouchard and Larivee (1991) motivation is an important component of self-regulated learning. They pointed out that motivated students are more attentive in their learning processes and outcomes than poorly motivated students. Motivation is distinguishable from general cognitive functioning and may be used in helping to explain gains in achievement independent of scores on intelligence tests (Murayama et al., 2013). Motivation is also distinguishable from states related to it, such as interest, engagement, grit, tenacity, and goal orientation, all of which have different implications and varied antecedents for learning and achievement (Jarvela and Renninger, 2014)

Zimmerman and Schunk (2006) added that highly motivated students put forth greater effort in their learning and can even learn more challenging tasks as they enjoy what they will be learning. They added that motivated students display greater progress in learning than unmotivated students. Motivated students experience greater satisfaction in their learning and create an enabling learning environment where conflict of interest with other non-educational phenomena is minimized or even eliminated (Schuck, 1984). Goswami (2014) posited that intrinsically motivated students approach learning with a play-like attitude, which allows them to view learning from new perspectives. In contrast, unmotivated students may not have the same drive to explore concepts or find answers to their questions. Although motivated students are not necessarily more intelligent than their unmotivated peers, their desire to understand concepts and find answers pushes them to think more deeply about a topic (Filgona and Okoronka, 2020). These intrinsically motivated students are not driven by external factors like grades or teachers' approval, but rather by their own inherent curiosity.

Motivated students tend to think about questions beyond the scope of the classroom because their need for understanding is not limited to the classroom environment. Their intrinsic motivation allows them to ask thought-provoking and insightful questions, which leads them to a deeper understanding of the topic. As a result, motivated students are better equipped to apply learned content to new situations because they can reflect on the underlying frameworks and principles of the concepts they have learned (Filgona and Okoronka, 2020).

Moreover, intrinsically motivated students tend to experience a decrease in self-consciousness and stress levels during learning activities, as reported by Borah (2021). Because motivated students are not driven by the fear of failure or criticism, they are less likely to disengage in stressful situations such as receiving low grades or harsh criticisms from teachers or peers. They have a greater ability to emotionally "bounce back" from setbacks and continue to engage in the learning process (Eva et al., 2011).

In addition to the above, intrinsically motivated students view learning as a playful exploration of concepts, which enables them to think more deeply and ask more insightful questions. Their intrinsic motivation drives them to find answers and understand concepts beyond the classroom, making them better equipped to apply learned content to new situations. Additionally, motivated students tend to experience less stress and are better able to emotionally "bounce back" from setbacks, making them more likely to persist in the learning process.

Zimmerman and Schunk (2006) reported that there is evidence that students' self-regulated learning processes and motivational beliefs are reciprocally interactive and interdependent. Furthermore, Newman (1994) noted that while highly motivated students are more willing to seek help as they adapt to their learning, poorly motivated learners are reluctant to seek help. As a result of this Zimmerman and Schunk concluded that highly motivated learners increase their interaction with their teachers and have more formative assessment due to increased rapport with their teachers. Making learning more interesting for learners through the incorporation computer generated games can improve students' motivation (Budin, 1999). Once the students are motivated it is easier for them to ask questions and express themselves thus, improving their perception of learning (Mangwaya, 2014). Ainsworth (2010) postulated that clearly defined and scaffolded learning goals increase students' confidence and motivation.

Students who are highly motivated experience greater satisfaction and positive affect when given the opportunity to learn than poorly motivated students (Zimmerman and Kitsantas, 1999). For example, a student who is motivated to pursue a career in math is more likely to feel satisfied when receiving a good math test score than a student who does not expect to use math in his or her chosen career (Schunk and Pajares, 2005). Newman (1994) pointed out that it was also surprising that slow learners and poorly motivated learners are reluctant to seek help as they do not feel comfortable in exposing their weaknesses and shortcomings. Clearly, motivational processes play a vital role in initiating, guiding, and sustaining student efforts to self-regulate their learning (Zimmerman and Schunk, 2014). There is growing evidence that motivation and students' self-regulation are reciprocally interactive (Zimmerman and Schunk,2014).

Scholars have come up with different types of sources of motivation, that may be relevant to self-regulated learning. Banisaeidi and Huang (2015) listed a number of sources of motivation in students' self-regulated learning which are goal orientation, interest, self-efficacy, outcome expectancy, future time perspective, task values, volition, intrinsic motivation, causal attributions, goal setting and self-reactions, social motivation, gender identity, and cultural identity. Pintrich and Schunk (1996) also added an almost similar number of motivational models with three standing out above the rest. These are the self-efficacy beliefs model, the task value beliefs model, and the goal orientations model.

Goal orientation model of motivation

Goal orientation can be defined as the learner's awareness of the reasons why s/he takes part in a learning task. It means learner's general goals or orientations to the course (Beatty-Guenter, 2001). Goal orientation, an important touchstone of self-regulatory learning, is described as students' goals or orientation to a lesson (Pintrich et al., 1991). The goal orientation model of motivation received a fair amount of attention from scholars and while different scholars had different interpretations of goal orientation, they all agree on the existence of two groups. Elliot and Harackiewicz (1996) distinguished two types of goal orientation which were approach-performance and avoidance-performance. The approach-performance goal orientation motivation involves students wanting to demonstrate their mastery of a skill and wanting to outshine others through competency and superiority. On the other hand, the avoidance-performance goal orientation involves the avoidance of failure and not wanting to appear incompetent. Other authorities such as Elliot (1999) and Pintrich (2000a, 2000b) also theorized that a learning or mastery goal orientation also involves an approach and an avoidance type. An approach-learning goal orientation focuses on mastering tasks, learning, and enhancing understanding, whereas an avoidance-learning orientation focuses on evading learning or misunderstanding, perhaps by adopting a perfectionist self-evaluative standard. Mangwaya (2014) postulated that goal orientation motivation is based on intrinsic motivation and extrinsic motivation with students wanting to shine when they are intrinsically motivated while those who tend to adopt the phenomena of avoidance of failure are mostly extrinsically motivated. Intrinsic goal orientation defines the degree to which learners conceive of taking part in an activity and why, such as challenge, curiosity, or mastery. If the learners have an intrinsic goal orientation to an academic assignment, it means that taking part in the assignment is at an end. The emotional responses of students to a particular task are viewed as intrinsic values, which are the affective items of motivation (Pintrich and De Groot, 1990).

Interest model in motivation

Interest predicts traditional measures of educational success, including future course taking and performance (Harackiewicz et al., 2008). Historically, both teachers and students have attributed differences in academic motivation to the role of interest: Students who are interested in a task or skill are motivated to learn, but students who lack interest will remain disengaged (Zimmerman and Schunk, 2014). Interest plays a significant role in the process of motivation, which can fuel learning and guide academic and career aspirations. It is a psychological state of attention and affect towards a particular topic or object, which can lead to an enduring predisposition to re-engage with the topic over time. According to Harackiewicz, Smith, and Priniski (2016), interest is a critical component of academic success.

When students are interested in a subject, they are more likely to attend class, pay attention, become engaged, take more courses, and process information effectively. Hidi and Harackiewicz (2000) suggested that students who show interest in an academic topic tend to perform better than those who lack interest. This finding underscores the importance of interest in academic achievement.

Moreover, students who discover academic interests in high school and college are better equipped to pursue satisfying careers. Renninger and Hidi (2016) emphasized that interest is a powerful motivational process that can guide academic and career trajectories. Therefore, cultivating interest in a particular subject can lead to a more fulfilling career path.

Furthermore, interest is a crucial element that energizes learning, shapes academic and career aspirations, and leads to academic success. It is essential for educators and students to recognize the importance of interest in the learning process and foster an environment that encourages students to explore their interests. By doing so, students can unlock their full potential and achieve their academic and career goals.

Interest can either be individual interest or situational interest (Bandura, 1986). Individual interest tends to be intrinsic and is a stable, underlying disposition activated in particular situations. For example, students interested in geophysics might be especially likely to be in a state of interest during a lecture on tsunamis, whether the lecture is entertaining or not, because their interest is more developed and less dependent on situational factors (Hidi and Harackiewicz, 2000, Renninger and Hidi, 2016). When students experience situational interest, they are to increase attention and engagement as they will immense themselves into the learning process (Mangwaya, 2014).

Outcome expectancy motivation

The outcome expectancy theory of motivation stresses upon the expectations and perceptions of what is real and emphasizes on rewards and based on self-interest individuals who would want to achieve maximum satisfaction and minimize dissatisfaction (Juneja, 2015). Students are motivated by what they expect to get after learning which could be material or psychological (Mangwaya, 2014). Students' willingness to study diligently for a test or any form of assessment depends significantly on their beliefs about their self-regulated learning capabilities and the outcomes of those capabilities. Bandura (1997). Bandura added that the outcome expectancy among students is driven by their outcome expectations.

Task value and motivation

The perceived importance, usefulness, enjoyment or benefit to the individual of successful task completion (Cook and Artino, 2018). Science students are more likely to be motivated when they see value in the tasks they learn in class, hence the need to link science lessons with concepts that make students see the value of learning the subject (NCPDI, 2020).

Future time perspective and motivation

"Future time perspective is the degree to which and the way in which the chronological future is integrated into the present life-space of an individual through motivational goal-setting processes" (Husman and Lens 1999:74). From a motivational perspective, FTP may operate to encourage a person to be purposive and self-regulated and to flourish in the course of academic learning and schooling (Zimbardoand Boyd, 1999; Barber et al., 2009 and Janeiro et., 2017). Students tend to envision their future after having successfully mastered their science and what the future may offer and reward those who would have achieved success thus motivating them to work towards success (Lens et al., 2002). If the future does not appear to offer hope for those who are successful academically then there would be no motivation to learn. Mangwaya (2014) contended that in Zimbabwe many students are motivated to learn because from their experiences in society they have witnessed a lot of people who have moved up the social ladder through education. The author likened it the folk stories of moving from rags to riches. Existing research has provided empirical evidence to support the promotion and encouragement of a positive future time orientation (Phan et al., 2020).

Gender identity and motivation

Research illustrates that student motivations influence learning engagement, persistence, and achievement in powerful ways and that positive motivations are linked to deeper learning, critical thinking, pro-social behavior, and better performance (Stolk et al., 2021). Stereotyping has adversely affected female students' motivation to learn and excel in science in low income and other underprivileged communities (Mangwaya, 2014). Historically more males were encouraged to take up science subjects than females. However, the advent of the print, electronic and social media has now created an opportunity for females to break the barriers of the past as more females are now engaged and successful in STEM education (WCU, 2019).

Gendered patterns in learners' perceived competence and self-efficacy within gender-role stereotyped domains such as mathematics and engineering are widely reported (Schunk and Pajares 2002). Most investigations into gender identity and motivation show that girls or women express lower self-efficacy or perceived confidence in their technical abilities compared to boys or men, regardless of demonstrated ability or success in their programs (e.g., Besterfield-Sacre et al., 2001; Brainard and Carlin, 1998; DeBacker and Nelson, 2000; Gasco et al., 2014; Weisgram and Bigler, 2006). Weisgram and Bigler (2006) showed that girls report less interest in science and more strongly endorse altruistic values and egalitarian interests compared to boys; and Diekman and Steinberg (2013) found that women more strongly endorse communal goals than men. In most cases, interest in or perceived value of certain STEM topics was reportedly higher among boys and men compared to girls or women due to gender stereotype and gender identity (Weisgram and Bigler, 2006).

Cultural identity and motivation

Cultural identity is an important aspect to be considered since the methods of teaching might vary according to their cultural expectations (NCDPI,2014). Each different culture might require different activities and strategies to make learners be interested in lessons. Cultural relevance may prove to be a big issue in conservative societies. Teaching often involves working with students from diverse cultural backgrounds, which requires teachers to plan their lessons carefully to ensure that all students can learn effectively. To achieve this, teachers need to be aware of the cultural identity of each student and understand their individual learning strategies. By doing so, teachers can tailor their lessons to meet the needs of each student and create a more inclusive classroom environment.

To better understand the features and characteristics of each student, teachers should familiarize themselves with the factors that may affect their learning, including their nationality. This knowledge can help teachers identify the learning strategies that work best for each student and create a more effective learning environment for all.

Therefore, teachers must recognize the importance of cultural identity and individual learning strategies when teaching a diverse group of students. By doing so, teachers can plan their lessons, accordingly, create a more inclusive classroom environment, and help all students achieve academic success. When teachers understand and appreciate the cultural dynamics in their classes, they can use these to further formative assessment and instruction. Students who are in the encounter and immersion-emersion stages provide excellent examples of how exploration in the classroom can assist in the development of self (Ortiz, 2000). Allowing students to accept and value their cultural differences and consider this as an advantage will promote inter-student interactions harmony in their learning processes.

Researchers like Eleuterio (1997) and Hoelscher (1999) observed that classrooms filled with teachers and students who share their cultural identities build trust and foster stronger relationships, which leads to student engagement, higher motivation and excitement about learning together. The challenge with typical American classes is that students are from diverse cultural backgrounds and teachers need to be well prepared to deal with different cultures among students and ensure that every student feels welcome and encouraged to learn (NCDPI, 2011).

Cultural identity may also lead to underachievement especially among children from the Hispanic and migrant families. The NCDPI acknowledges that some cultural identities may be detrimental to students' motivation especially if it is engrained in communities that are resigned to education. Peirce (1995) posited that social identity is complex and contradictory. Cultural identity, which is a key aspect of social identity, cannot be separated from learning as learners are continually reliant on their cultural knowledge (Hinkel, 1999; Peirce, 1995; Tseng, 2002). Therefore, cultural identity is linked to learning as learners need to adjust their psychological perspective to focus on learning. Ellis (2002) contended that successful learning occurs when learners can construct an identity that enables them to assert their right to be heard. This suggests that learners need to establish a sense of confidence, intellectual curiosity, and an understanding of past successes and failures to enhance their motivation to learn.

Additionally, Tseng (2002) identified various aspects and dimensions of motivation that can impact learning, including awards, punishments, learning materials, and classroom atmosphere. Understanding the role of these factors in motivating learners is essential for teachers to create a conducive learning environment that fosters a positive attitude towards learning.

In conclusion, cultural identity is intertwined with the learning process, and learners need to establish a sense of confidence and motivation to succeed in their studies. Teachers need to create an inclusive classroom environment that promotes cultural diversity and fosters motivation to learn.

Motivation and academic work

Motivation is a crucial factor that influences academic work. It determines how much effort students put into their studies, how much time they spend on their assignments, and how much they enjoy learning. Motivation is the driving force behind academic success, and students who are motivated tend to perform better in their studies (NCDPI, 2016). Lack of motivation may derail any academic progress.

Motivation is broadly defined as the psychological processes that initiate, direct, and sustain behavior (Dweck, 1986). In the context of academic work, motivation refers to the factors that inspire and drive students to engage in their studies actively (Ryan and Deci, 2000). There are two primary types of motivation: intrinsic and extrinsic motivation.

Intrinsic motivation is the desire to engage in an activity for its own sake. It is the internal drive that comes from within the individual, and it is fueled by personal interest and enjoyment. Students who are intrinsically motivated tend to find their studies enjoyable and engaging, and they are more likely to put in extra effort to achieve their academic goals (NCDPI,2016).

Extrinsic motivation, on the other hand, is the desire to engage in an activity to gain a reward or avoid a punishment. It is the external drive that comes from outside the individual, and it is fueled by factors such as grades, parental expectations, and peer pressure. Students who are extrinsically motivated tend to focus on the rewards of academic success, such as good grades, and they may not find their studies as enjoyable or engaging as intrinsically motivated students (Black and Wiliam, 2009).

Research has shown that intrinsic motivation is more beneficial for academic success than extrinsic motivation. Students who are intrinsically motivated tend to have higher levels of academic achievement, greater creativity, and a more positive attitude towards learning (Deci and Ryan, 1985; Ryan and Deci, 2000). On the other hand, extrinsically motivated students tend to have lower levels of academic achievement, less creativity, and a more negative attitude towards learning (Deci, Koestner, and Ryan, 1999; Vansteenkiste et al., 2004).

Therefore, it is essential to foster intrinsic motivation in students to promote academic success. One way to do this is by providing students with autonomy in their learning. Autonomy refers to the freedom to choose what and how to learn. When students have a sense of control over their learning, they are more likely to be intrinsically motivated (Deci and Ryan, 1985). Teachers can promote autonomy by providing opportunities for choice in assignments, allowing students to set their own goals, and encouraging student-led discussions.

Another way to foster intrinsic motivation is by promoting a mastery orientation in students. A mastery orientation is the belief that success comes from effort and hard work rather than innate ability. When students adopt a mastery orientation, they are more likely to be intrinsically motivated because they see the value of learning for its own sake (Dweck, 1986). Teachers can promote a mastery orientation by providing feedback that focuses on effort and improvement rather than just grades and by creating a classroom culture that values effort and perseverance.

In conclusion, motivation is a crucial factor that influences academic work. Intrinsic motivation is more beneficial for academic success than extrinsic motivation, and teachers can foster intrinsic motivation by providing students with autonomy in their learning and promoting a mastery orientation in students. By promoting intrinsic motivation, teachers can help students achieve their academic goals and develop a love of learning that will last a lifetime.

2.6.2 Self-efficacy

Self-efficacy is an individual's judgment of his/her own capabilities to complete a task successfully (Bandura, 1986). Oscarson (1997) contended that self-efficacy is enhanced by the use of self-assessment which leads to more confidence and perceived self-mastery. Self-efficacy plays a major role in how students learn by fostering or impeding their progress, it is more powerful than knowledge, skill, and prior attainment (Bandura, 1986). Self-efficacy has its roots in the social-cognitive theory that states that humans can control their behaviors (Bandura, 1986). According to Bandura and Locke (2003) no mechanism of human agency is more central and pervasive than belief in personal efficacy. Self-efficacy plays a major part in determining our chances of success (Kaufman, 2019).

Self-efficacy for learning, which refers to students' beliefs in their capabilities to regulate their own learning, could determine students' motivation and academic achievement and, therefore, is significant in the learning process (Dorit,2015). Self-efficacy beliefs determine how people feel, think, motivate themselves and behave (Schunk, 1991). The self-efficacy theory postulates that people acquire information to appraise efficacy from their performance accomplishments, vicarious or observational experiences, forms of persuasion, and physiological indexes (Schunk, 1991). It is for this reason that Wiliam and Black (2010) contended that the theory of self-efficacy in learning has a close link with student centered formative assessment.

Bandura (1977) hypothesized that self-efficacy affects an individual's choice of activities, effort, and persistence. Bandura (2010) defined self-efficacy as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Hattie (1987) suggested that the way students perceive formative assessment reflects their self-efficacy.

A strong sense of efficacy enhances human accomplishment and personal well-being in many ways (Bandura, 2010). People with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided. It is for this reason that Mangwaya (2014) pointed out that students with higher self-efficacy tend to out-perform those with lower self-efficacy. The author however, postulated that when self-efficacy is fully utilized with formative assessment students begin to perceive assessment positively as they build on their self-efficacy, motivation and self-confidence from success criteria and shared learning targets which would be combine multi-thronged feedback from various sources.

The most effective way of creating a strong sense of efficacy is through mastery experiences (Bandura, 2010). Successes build a robust belief in one's personal efficacy. Failures undermine it, especially if failures occur before a sense of efficacy is firmly established. Such mastery experiences and success can be enhanced through formative assessment (Sadler, 2014). Bandura (2010) added that tasks given to students to harness self-efficacy should be differentiated. The author argued that the most effective way of creating a strong sense of efficacy is through mastery experiences.

On the other hand, Wiliam and Black (2010) pointed out that when students work on tasks from experiences, they are more likely to succeed as they build from the known towards the unknown. Successes build a robust belief in one's personal efficacy. Failures undermine it, especially if failures occur before a sense of efficacy is firmly established (Bandura, 2010). To improve students' self-efficacy, there is need to include their own experiences into learning.

Bandura (2010) also encouraged the use of cooperative learning and modelling to improve self-efficacy. This was also supported by other constructivist theorists such as Rushton (2005) and Biggs (1998) who advocated for self-paced, self-regulated and experience-based learning. They pointed out that when students see their peers succeed, they are more likely to emulate what their peers do and modify their own thinking to achieve their own set targets. It is the process of confidence building or self-efficacy that evolves the way students perceive any form of assessment (Saddler, 2014).

Bandura (2010) postulated that peers serve several important efficacy functions. Those who are most experienced and competent provide models of efficacious styles of thinking and behavior. A vast amount of social learning occurs among peers. In addition, age-mates provide highly informative comparisons for judging and verifying one's self-efficacy. In the educational system, there is a black box that needs to be opened and understood for successful teaching and learning. The black box metaphor was first used by Black and Wiliam (1998) to highlight the lack of knowledge on what was happening inside the classroom. It was evident that teachers, resources, standards, and requirements were inputs, while knowledgeable and competent students and acceptable levels of achievement were outputs. However, what was happening inside was largely unknown, and this led to a lot of research on formative assessment. Nevertheless, the cognitive and affective mechanisms of students engaged in the assessment process need to be understood to determine what works best and why (Lui, 2017).

The internal processes of feedback, and how students interpret them, have been discussed in theory, but more research is needed to test and understand how these theories work in practice. Crooks (1988) argued that students' interpretation of tasks and results influences the impact of assessment. On the other hand, Butler and Winne (1995) suggested that both cognitive and affective processes played a role in determining how feedback is internalized and used to improve students' self-efficacy and self-regulated learning. To better plan and facilitate learning, educators need to understand the internal mechanisms of students, particularly their self-efficacy (Bandura, 1998).

Several theoretical frameworks have been developed to understand the internal processes of feedback, such as Nicol and Macfarlane-Dick (2006), Draper (2009), Andrade (2013), and Lipnevich et al. (2016). However, there is a need for more research to test these frameworks and understand the extent to which they can explain the relationship between feedback, self-efficacy, and academic achievement. In conclusion, understanding the black box in education is essential for successful teaching and learning. Research on the cognitive and affective mechanisms of students engaged in assessment processes can help teachers to better understand how to facilitate learning and improve student success.Yet, Shute (2008:156) noted in her review of the literature on formative feedback that "despite the plethora of research on the topic, the specific mechanisms relating feedback to learning are still mostly murky, with very few (if any) general conclusions." The area of self-efficacy and how it is impacted by formative assessment and self-regulation in the 21st century is ripe for research (Andrade, 2019; NCDPI,2019).

The understanding of self-efficacy is important inasmuch as it appears to powerfully influence various behaviors such as attributions, choice of tasks, effort, emotions, cognition, goals, persistence, and achievement (Bandura, 1986). According to Bandura and Locke (2003), no mechanism of human agency is more central or pervasive than belief in personal efficacy. "Whatever other factors serve as guides and motivators are rooted in the core belief that one has the power to produce desired effects; otherwise, one has little incentive to act or to persevere in the face of difficulties" (p. 87). In this vein, Mills, Pajares, and Herron (2006) suggested that beliefs of personal efficacy are not dependent on one's abilities but on what one believes may be accomplished with one's personal skill set.

An individual's beliefs in their efficacy to complete a given task can be developed through four primary sources which are enactive mastery experiences, vicarious experiences, social persuasion, and physiological and emotional states (Bandura, 1986).

Inactive mastery experiences are the direct experiences with the task in question (Baleghizadeh and Masoun, 2013). They are considered the strongest source of self-efficacy (Schunk, 1991). Mastery Experiences provide the most authentic evidence that one can muster what it takes to succeed it fuels students' confidence (Kaufman, 2019). Enactive mastery experiences have been identified as the most influential source of self-efficacy beliefs. Yet little is known about enactive mastery experiences, including how such experiences manifest in naturally occurring situations (Jensen, 2012).

Vicarious experiences are driven by peers when peers succeed it makes individual have a strong self-efficacy to do the same (Saint Leger, 2009). In the case of social persuasion, learners have been convinced by an authoritative figure that they are capable of developing high self-efficacy. This is where teachers and other people who surround the student have a great impact in their self-efficacy (Mangwaya, 2014). Through physiological and emotional states, learners who tend to have low anxiety while performing a task are led into high self-efficacy. Bandura added five methods of increasing self-efficacy are presented in Table 2.6 below

Table 2.6

Methods to increase self-efficacy. (Source: Bandura)

Methods to increase self-efficacy	Description
1. Mastery experiences	Mastering an activity or concept provides the most authentic evidence of whether one can muster whatever it takes to succeed.
2. Vicarious experiences	By watching others, people can gain vicarious information that plays a role in their belief in their own abilities. The role of peers plays a pivotal role here.
3. Verbal persuasion	People can be convinced that they have the ability to succeed at a task through positive verbal encouragement and social pressure.
4. Physical and mental states	Stress levels, moods, emotions, and arousal levels all play a role in helping people determine if they are capable of tackling a challenge.
5. Visualizations (Imaginal experiences)	The ability to imagine future success to build belief that succeeding is possible.

Bandura's methods of increasing self-efficacy have been influential in the field of psychology, but they are not without criticism. One critique relates to the debate surrounding the concept of self-efficacy itself. According to Bandura (1977), self-efficacy refers to an individual's belief in their own ability to successfully execute behaviors that will lead to desired outcomes. However, some researchers argue that self-efficacy is not a separate construct but rather a manifestation of other cognitive processes, such as outcome expectations or perceived control (Luszczynska and Schwarzer, 2005). This debate challenges the uniqueness and distinctiveness of self-efficacy as a theoretical construct.

Another criticism concerns Bandura's emphasis on mastery experiences as the primary source of self-efficacy enhancement. Bandura (1997) posits that successful performance on tasks leads to increased self-efficacy beliefs. While mastery experiences undoubtedly contribute to self-efficacy, some researchers argue that other sources, such as vicarious experiences (observing others succeed), social persuasion (receiving positive feedback or encouragement), and physiological states (physical and emotional well-being), are equally important (Stajkovic and Luthans, 1998). This critique suggests that Bandura's focus on mastery experiences alone may overlook the potential influence of other sources of self-efficacy.

Furthermore, Bandura's methods of enhancing self-efficacy have been criticized for being overly reliant on individual-level interventions. While Bandura's research primarily focused on individual-level factors, self-efficacy is influenced by a broader range of contextual and social factors. For example, social support, cultural norms, and environmental cues can all shape self-efficacy beliefs (Schwarzer and Hallum, 2008). Neglecting these contextual factors may limit the effectiveness and applicability of Bandura's methods in diverse settings.

In conclusion, Bandura's methods for increasing self-efficacy have made significant contributions to understanding human motivation and behavior. However, they are not immune to criticism. Concerns regarding the conceptualization of self-efficacy, the exclusive focus on mastery experiences, and the limited consideration of contextual factors highlight important debates within the field. In this study, the role of formative assessment and self-regulation on self-efficacy will also be included.

2.6.3 Autonomy

Autonomy as involvement and choice in learning, self-direction, the capacity to learn in terms of self-awareness and willingness to be an active learner, acting independently, and making decisions about what and how to learn, setting goals, and measuring progress (Little, 1995). ‘Autonomous learning the ability to think and act critically and independently, to self-manage study and learning, and realistically to appraise one’s strengths and weaknesses as a learner. It is not simply one transferable skill among others; rather it is a disposition towards learning that is integral to the acquisition of all other skills and knowledge (Crome et al., 2009:112). Autonomy and self-regulated learning have both been defined as learners taking responsibility for their own learning (Andrade and Bunker, 2009). The authors further stated that autonomy allows the learner to determine study goals, how to accomplish these goals, and how much to learn. Lack of autonomy restricts the learner from all decision-making power related to the course resulting in lack of motivation and interest in learning (Anderson, 2007). According to Little (1995) autonomy does not imply complete independence or a lack of support but rather a state of interdependence between teachers and learners. This was also echoed by Lamb and Little (2016) who pointed out that autonomous learning is a construct of capacity for self-management through conscious reflection and informed decision making which requires both willingness and ability to assume responsibility in learning. Andrade (2010) suggested that autonomy is a sub-set of self-regulated learning where students exercise a greater degree of control of their learning processes. Autonomous learning involves both independence and interdependence and it develops and varies across time and circumstances (Lamb and Little, 2016).

According to Andrade and Bunker (2009) autonomy involves metacognition, strategic competence, and reflection as well as choice and decision-making. They further described autonomy as making decisions about what and how to learn, self-direction, involving the capacity to learn or what the learner brings to the task in terms of self-awareness and willingness to be an active learner, accepting responsibility, taking control, and acting independently with setting goals and time management as additional elements.

Autonomy is thus a self-regulated component of learning where students become effective without too much reliance on teacher structure (Andrade and Bunker, 2009). Accordingly, Sierens et al. (2009) pointed out that autonomy is innate psychological need that enhances self-regulated learning and is a necessary condition for students' optimal learning. Autonomy yields an energizing effect, which enables learners to get more fully immersed in the learning process which results in positive learning outcomes, including higher intrinsic motivation (Sierens et al., 2009).

Lamb and Little (2016) pointed out that there were some attempts to assess autonomy in learning using summative assessment approach resulting in some problematic relationships. This was mainly driven by the need for standardized testing which has become the prevailing discourse in assessment (Leung and Lewkowicz, 2016), thus turning the learning world into a testing environment. Some institutions have made attempts to assess autonomous learning summatively (Champagne et al., 2001, Ravindram, 2000 and O' Leary, 2009). This has resulted in in more questions being asked as to why people would need to use summative assessment to assess students' autonomy (Benson, 2010).

Lamb and Little (2006) argued that students' autonomy in learning should rather be assessed formatively. They pointed out that when institutions use the summative approach to assess autonomous learning there is a danger that students will act out to portray behaviors, they know teachers would be looking for. The same ideas were also raised by Benson (2010) who also disagreed with the use of summative assessment to gauge students' autonomy and coined reasons why autonomy is not compatible with summative assessment. The author pointed out that the multidimensionality of autonomy, makes it impossible to be reduced to any simple formula or to compare across different individuals or contexts; secondly, as a capacity, it is not observable, so observable behaviors do not necessarily indicate the presence or absence of autonomy, thirdly, autonomy is a developmental process, but development is not smooth or consistent across time or learning context and fourthly, students paradoxically can display autonomous behavior simply because this is what is expected by the teacher or because it is being tested, rather than because they are autonomous learners. These problematic aspects suggest that attempts to assess learners' autonomy summatively and comparatively are likely to be unreliable and misleading. They can be counterproductive as well, as they may simply label the learner without supporting him/her to become more autonomous (Benson, 2010).

Despite the problems of reliability of using summative assessments on autonomous learning it is clear that learners require support to become autonomous and bringing in summative assessments would strangle learner autonomy (Williams, et al., 2002). There is therefore need for institutions to evaluate learners' autonomy rather than test it in order to identify ways of developing it further (Dam and Legenhausen, 2010). Assessment of students' autonomy should take on a formative dimension rather than summative dimension (Lamb and Little, 2006). They went on to prescribe that the purpose of assessment for autonomy should not be to measure autonomy for its sake with the view of measuring ability or giving some stratified ranking of students but to increase learners' self-awareness of their own autonomy and teachers' awareness of what constitutes such awareness and the best possible ways of adapting teaching methods and approaches to enhance students' autonomy in learning (Lamb and Little, 2006).

There is a strong link between learner autonomy and intrinsic motivation (Deci and Ryan, 1987). Deci et al., (1991) suggested that humans have three innate psychological needs which are autonomy, competency and relatedness. They mentioned that autonomy involved having a sense of both control and agency while competency is the feeling of being competent with tasks and different activities. Relatedness is a sense of purpose or inclusion with others. If these three needs are met it would to a better psychological well-being, whereas conversely, the individual suffers if these needs are not met (Deci et al.,1991).

Support for autonomy can lead to several positive outcomes including more cognitive flexibility, greater interest, more creativity and intrinsic motivation (Ryan, 1987). Autonomy support actually enhances and increase learner curiosity and willingness to explore (Zhao et al., 2011).

Autonomy and self-determination

Self-determination theory (SDT) is a motivational theory that emphasizes the importance of autonomy, competence, and relatedness in driving individual behavior (Ryan and Deci, 2000). According to SDT, individuals who feel autonomous are more likely to be motivated to learn, which can lead to improved academic outcomes (Vansteenkiste et al., 2012). Autonomy is linked to students' sense of control over their learning and their ability to make choices about how to learn

(Reeve, 2012). This literature review examines the relationship between self-determination theory and autonomy in education and provides an overview of the relevant literature.

Self-determination theory proposes that individuals are inherently motivated to seek out new experiences and grow. However, this motivation can be undermined by external factors, such as rewards or punishments, that diminish individuals' sense of autonomy and control (Ryan and Deci, 2000). In contrast, when individuals feel autonomous, they are more likely to engage in behaviors that align with their values and interests. In education, autonomy can be fostered by providing students with opportunities to make choices about their learning and to engage in activities that align with their interests (Vansteenkiste et al., 2012).

Several classroom practices can foster autonomy in students. One such practice is student-centered instruction, which puts students at the center of the learning process and gives them more control over their learning outcomes (Ryan and Deci, 2000). Another practice is inquiry-based learning, in which students engage in the scientific process by asking questions, designing experiments, and analyzing data (National Research Council, 2000). Additionally, project-based learning can allow students to explore real-world problems and develop their solutions, providing a sense of autonomy and ownership over their learning (Thomas, 2000).

Assessment practices can also impact students' autonomy. Formative assessment practices that provide students with feedback and opportunities for reflection can help students take greater control of their learning (Black and Wiliam, 1998). Students who receive formative feedback are more likely to engage in self-reflection and goal setting, which can enhance their sense of autonomy and motivation (Hattie and Timperley, 2007).

Gender and cultural factors can impact students' sense of autonomy. For example, female students may experience lower levels of autonomy due to cultural biases and stereotypes that discourage women from pursuing certain academic fields, including STEM (Falk and Dierking, 2016). Teachers must recognize these biases and create a learning environment that supports all students' autonomy, regardless of their gender or cultural background.

2.7: Conclusion

Previous researchers have discussed the benefits of formative assessment and self-regulated learning. However, there is need for more research as to how teachers and students perceive formative assessment. Previous studies have left some gaps on how assessment for learning affects self-efficacy and autonomy. There is need for a paradigm shift into the study of teachers’ and students’ viewpoints in assessment for learning using a holistic approach where both stakeholders are taken onboard instead of looking at them separately. This study was undertaken to help in addressing the gaps on the ways teachers and students perceive formative assessment in the context of science at secondary school level. To better understand students’ and teachers’ perceptions towards formative assessment and self-regulated learning, related concepts such as feedback and questioning, self-assessment and peer-assessment were discussed. The links between self-regulated learning with motivation, self-efficacy, and autonomy were also presented. It is clear from previous research that assessment for learning is closely linked to other phenomena that work together in altering both the teachers’ and students’ perceptions towards assessment.

In conclusion, there are several research gaps regarding the perceptions of teachers and students towards formative assessment and the potential for improving student self-regulation. Firstly, there is a need for more research that examines the specific factors influencing teachers' perceptions of formative assessment, such as their beliefs, attitudes, and instructional practices (Hattie and Timperley, 2007). Understanding these factors can provide insights into how to effectively support and empower teachers in implementing formative assessment practices that promote student self-regulation.

Secondly, there is a gap in our understanding of students' perceptions of formative assessment and how these perceptions relate to their self-regulation strategies. Research should explore how students interpret and make meaning of formative assessment feedback, the impact of feedback on their self-efficacy and motivation, and the strategies they employ to self-regulate their learning in response to feedback (Black and Wiliam, 1998). This knowledge can inform the development of interventions and instructional practices that enhance students' self-regulation abilities in the context of formative assessment.

Additionally, there is a need for research that examines the role of contextual factors, such as classroom climate, teacher-student relationships, and cultural influences, in shaping both teachers' and students' perceptions of formative assessment and their self-regulation processes (Boekaerts and Cascallar, 2006; Zimmerman, 2000). Understanding these contextual factors can provide a more comprehensive understanding of the complex interactions that influence formative assessment practices and self-regulated learning in diverse educational settings.

To address these research gaps, this study employed a mixed-method approach, incorporating both quantitative and qualitative methods, to capture the multifaceted nature of perceptions and self-regulation processes. Additionally, longitudinal research designs can provide insights into the developmental trajectories of both teachers' and students' perceptions of formative assessment and self-regulation over time.

By addressing these research gaps, educators and policymakers may be able to gain a deeper understanding of the factors that influence perceptions of formative assessment and student self-regulation. This knowledge can inform the design of effective interventions, professional development programs, and educational policies aimed at enhancing formative assessment practices and promoting self-regulated learning in educational settings. The next Chapter presents the methodology of this study.

CHAPTER 3: RESEACRH METHODS AND DATA COLLECTION

3.1: Introduction

This Chapter describes the methodology employed during the study. The researcher used the mixed methods approach in probing and exploring the ways teachers and students perceive assessment for learning as well as how formative assessment can be used to promote motivation and self-regulated learning in science among junior secondary school students. Interviews, questionnaires, observations, and focus groups were used. The triangulation was meant to ensure the study would remain unbiased with the aim of producing reliable and valid data.

3.2: Research approach and design

Mixed methods research is an approach that combines both qualitative and quantitative methods in a single study to address research questions from different perspectives. The use of mixed methods in research offers several advantages. Mixed methods design is a dynamic research paradigm that combines a great deal of both qualitative and quantitative research designs; hence it is referred to as the third major research design that forms a bridge between the aforementioned research designs (Johnson et al., 2007).

Most scholars agree that mixed methods design is an evolving paradigm that uses a combination of different qualitative and quantitative methods of data collection and data analysis in one empirical research project. A mixed method design is a plan for a scientifically rigorous research process consisting of a qualitative or quantitative core component that directs the theoretical drive, with qualitative or quantitative supplementary components (Morse, 1991). Similarly, Miller and Gatta (2006) posited that mixed methods is a form of evolving methodological inquiry, primarily directed to the human sciences, which attempts to combine in some logical order the differing techniques and procedures of quantitative, qualitative, and historical approaches.

Mixed methods approach ensures that researchers collect multiple data using multiple methods that complement each other while avoiding overlapping weaknesses (Johnson and Turner 2003). The researcher used a mixed method approach with six teachers from three junior secondary schools. Creswell (2017) pointed out that mixed methods offset weaknesses of quantitative and qualitative methods and draw on the strengths of both through collaboration. The author was of the view that mixed methods improve the credibility of findings as both qualitative and quantitative approaches enhance integrity of findings and surprising results can be explained easily. Additionally, mixed methods research allows researchers to gain a more comprehensive understanding of the research problem by triangulating data from different sources and help to address limitations of individual methods. The use of both qualitative and quantitative data can lead to a deeper understanding of the research question than using only one approach.

The use of mixed methodology in research aligns well with the constructivist philosophy. Constructivism emphasizes the active role of individuals in constructing knowledge through their experiences, interactions, and interpretations of the world (Jonassen, 1991). Mixed methodology combines both qualitative and quantitative approaches, allowing researchers to capture the complexity and multiple perspectives inherent in constructivist views.

Mixed methodology supports constructivism by providing a comprehensive understanding of phenomena. Quantitative methods can help identify patterns, trends, and generalizability, while qualitative methods delve into the richness of individuals' experiences, meanings, and context (Creswell and Plano Clark, 2018). This combination allows researchers to explore both objective and subjective aspects of knowledge construction, aligning with constructivism's emphasis on multiple perspectives and situated understanding.

Moreover, mixed methodology supports the iterative nature of constructivist inquiry. Constructivism highlights the importance of reflection, revision, and co-construction of knowledge (Lincoln et al., 2011). By employing both qualitative and quantitative methods, researchers can engage in a cyclical process of data collection, analysis, and interpretation, allowing for ongoing reflection and refinement of their understanding. This iterative process helps researchers uncover deeper insights, challenge assumptions, and co-construct knowledge with participants.

Additionally, mixed methodology is well-suited to the constructivist philosophy as it embraces the complex, situated, and multifaceted nature of knowledge construction. By combining qualitative and quantitative approaches, researchers can capture both the objective and subjective aspects of phenomena, engage in an iterative process of inquiry, and embrace multiple perspectives, thus aligning with the principles of constructivism.

3.3: Population and sample of the research study

The study was carried out in a county with a total student population of 23343 (PCS, 2020-21) from K-12. There are 7 junior secondary schools in the county and three of these were selected for the study. Student statistics for the county revealed that there were 5524 junior secondary students out of these 7th graders were 1740. The average ages for 7th grades were between 12 and 15 years made about 31% of the junior secondary school population, close to 9% of the 7th grade students took part in the study. The demographic of the county is remarkably diverse with 62.08% White, 33.65% Black or African American, 0.27% Native American, 1.08% Asian, 0.04% Pacific

Islander, 1.80% from other races, and 1.09% from two or more races. 3.15% of the population are Hispanic (US census bureau, 2020). A purposive sampling approach was used in data collection. 7th grade was chosen as these are deemed to be a volatile group who are not under a lot of pressure as there are no end of grade transition tests to high school (NCDPI, 2018). Conducting interviews with this group is more convenient as they have already established themselves at junior secondary school. The fact that they are not an exam class puts less pressure on them and their parents as they may afford to engage in questionnaires, focus group discussions and interviews with less stress. The same can also be said about their teachers.

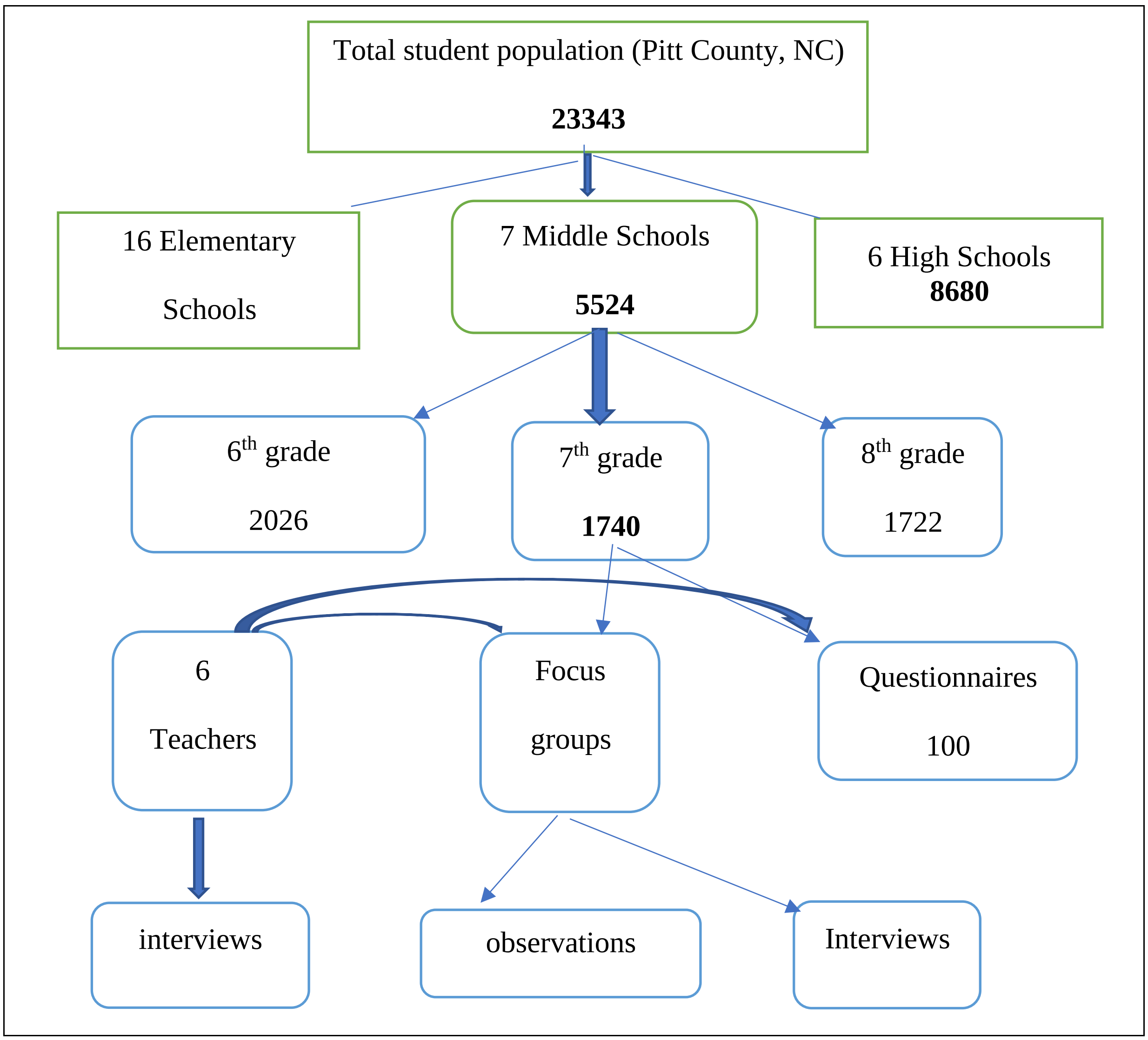
Collecting data about how students perceive formative assessment through their learning experiences makes use of narrative approach as this focuses on students' feelings rather than quantitative data (Creswell, 2013). Working with about 9% of the county's 7th grade population was both cost effective and would also provide credible data as these are drawn from different schools.

The six 7th grade science teachers out of a total of 33, 7th grade science teachers in the county who were part of the study also formed a representative population of the teachers who are involved in junior secondary school science teaching. They were composed of both males and females and cut across the local ethnic groups, three teachers were of Caucasian origin, two were African American descent and one was Hispanic. They formed 18.18% of the 7th grade science teachers and their responses would likely cover how most science teachers would interpret and implement formative assessment. Their responses would give a clear picture of how formative assessment can encourage students' self-regulated learning, autonomy, and self-efficacy. The teachers were instrumental in recruiting student participants as they knew the students they teach and how to convince them to take part in the study.

Figure 3.1 below shows the procedures that were followed in sampling the students for this study beginning with the entirety of the Pitt County student population at all three school levels which are elementary school, middle school and high school. Data shows student populations for each level and since the target population for this study is middle school, the other two groups were left out. Purposive sampling also left out the other two grade levels with focus being mainly for 7th grade students.

Figure 3.1

Sampling protocol.



3.4: Data collection tools

To accomplish the aims of this study, the researcher used interviews, questionnaires, observations, and focus groups in collecting data. These were chosen to ensure that all aspects of the research questions and aims were covered through triangulation.

3.4.1 Interviews

Semi-structured interviews with six teachers were conducted. One of the reasons for having semi-structured interviews with teachers was to ensure that interviews would remain focused on the research questions. Unstructured interviews could have the potential of rolling off the aims with interviewees leading how they would want discussions to go. Corbin and Morse (2003) pointed out that the key features of interviews are that interviews are cost effective often allowing the researcher to gather data in relatively short time frames. Interviews were considered due to some of the following advantages they offer toward research. They give the informants more power and control over what gets discussed and how it gets discussed (Johnson, 2002). This is done while allowing the research to have the opportunity to reflect on, and distance themselves from, their tacit knowledge of the topic under study (McCracken, 1998). I used interviews to, "gain insight into lived experiences, learn the perspectives of individuals participating in a study and discover the nuance in stories" (Jacob and Ferguson, 2012, p. 1). The student interviews were used as a way to attain the students' opinions on what was happening in their classroom throughout the study

Before conducting the actual interviews, the research had to practice the interview questions with some colleagues who had completed their thesis using qualitative research. This was to ensure that the interviews were not too long, and the questions were focused on getting answers to the research questions. Opdenakker (2006) justified the use of interviews in research as the method is characterized by synchronous communication in time and place. Due to this synchronous communication, interviews can take its advantage of social cues from phenomena such as voice, intonation, and body language of the interviewee. This gave the interviewer a lot of extra information that added to the verbal answer of the interviewee on a question. According to eValued (2006) interviews allow more detailed questions to be asked and ambiguities were easily clarified. Interviews are flexible, allowing the researcher to pursue emergent themes and follow the lead of the interviews to gain more insights into phenomena (Low, 2013). My interviews had open-ended questions to allow teachers to elaborate and reveal on certain data that could have been omitted in the interview questions. The structuring of questions also left out enough room for follow up and expanded questions in case the interviewee brought up something that would require further data.

Six teachers from three Junior secondary schools also known as Middle schools participated in the research and these were four females and two males and as per the State regulations all teachers hold a minimum of a first degree in addition to qualified teacher status. Each school had two classes participating in the study. Interviews were also carried out with purposively selected interviewees from the study population. Before the interviews were conducted the researcher had to agree with the teachers on the time of the interviews to ensure that the process did not disturb the normal running of their lessons. This research used a variety of interview techniques ranging from structured interviews where a set of questions were used and semi-structured interviews where some questions were avoided or added depending, especially on the interviewees. Saunders et al. (2009) referred to semi-structured interviews as non-standardized interviews. These were administered to interviewees on a face-to-face basis and through the telephone and internet platforms such as Zoom and WebEx applications when the covid19 pandemic began to take its toll. Creswell (2007) justified the use of interviews in qualitative research by pointing out that they are at the heart of qualitative research, because there is a natural storytelling urge and ability in all human beings which when harnessed can bring about a wealth of new knowledge. When properly executed, interviews can help the interviewer gain insight into lived experiences, learn the perspectives of individuals participating in a study, and discover the nuances in stories (Jacob and Ferguson, 2012).

In a constructivist research environment, interviews serve as a valuable method for data collection due to their alignment with the principles of constructivism. Several justifications support the use of interviews in this context.

Firstly, interviews enable the exploration of subjective and situated understanding, a central aspect of constructivism (Creswell and Poth, 2017). By engaging directly with participants, interviews allow researchers to delve into their unique perspectives and interpretations of the phenomena being studied. Through open-ended questions and probing, researchers can uncover participants' constructed meanings and knowledge. This was important in ensuring that students' perceptions were established.

Also, interviews facilitate the co-construction of knowledge, which is fundamental to constructivist philosophy (Guba and Lincoln, 1985). By engaging in a dialogue with participants, interviews create an interactive environment where both researchers and participants contribute to knowledge construction. This dynamic process allows for the exploration of multiple perspectives and encourages participants to actively shape the research outcomes.

Additionally, interviews provide rich and detailed data, enabling researchers to gain in-depth insights into participants' experiences, beliefs, and values (Seidman, 2013). Through follow-up questions and clarification prompts, researchers can elicit nuanced responses, capturing the complexities that underlie participants' viewpoints. This detailed data enhances the understanding of the phenomena under investigation.

Furthermore, interviews offer flexibility and adaptability, crucial in constructivist research (Charmaz, 2014). Researchers can tailor the interview process, questions, and prompts to suit the specific context and the individual participant's needs. This flexibility allows researchers to explore emergent themes, adjust the direction of inquiry, and accommodate participants' unique perspectives during the research process.

Lastly, interviews promote reflexivity and foster meaningful researcher-participant interactions (Charmaz, 2014). Researchers can engage in active listening, reflect on their own biases and assumptions, and critically examine their interpretations. The interview setting provides an opportunity for researchers to engage in reflexive practices, enhancing the validity and depth of the research findings.

3.4.2 Questionnaires

Questionnaires are a popular method of data collection in research, particularly in social sciences. The use of questionnaires in a mixed methods research design aligns with the constructivist philosophy and provides valuable insights into individuals' subjective experiences and interpretations. Questionnaires can capture quantitative data while also allowing for the exploration of participants' unique perspectives. They are an efficient way of gathering large amounts of data from a large sample of participants and can provide quantitative data that can be analyzed statistically. In this section, we will provide a brief justification for the use of questionnaires in research.

Firstly, questionnaires allow for standardized data collection. This means that all participants receive the same questions in the same format, ensuring consistency in data collection. This is particularly useful when researching sensitive or complex topics, as it can reduce potential interviewer bias or variability in data collection. By including open-ended questions, I could gather rich qualitative data that delves into participants' beliefs, values, and contextual influences. The constructivist perspective emphasizes the importance of understanding the social and cultural contexts in which individuals construct their realities, and questionnaires provide an opportunity to gather such contextual information.

Secondly, questionnaires allow for anonymity and confidentiality, which can encourage participants to be more honest and open in their responses. This is particularly relevant in studies where participants may be hesitant to share their views or experiences due to social desirability bias or fear of reprisal.

Questionnaires were randomly sent out to 7th grade science students through the Remind application platform which is used by the school district to communicate with students and parents. These questionnaires were sent out with students in form of both soft and hard copies to ensure that a large number would be returned. A total of 100 hard copies and 200 soft copies were sent out. Both sets of questionnaire sets were similar to ensure that responses would not be different. The Remind App proved to be discreet as respondents could only see their own response and had no access to any other responses. The questionnaires were designed with closed response questions and collected nominal, ordinal, and discrete data. Questionnaires ensured that a larger target population was reached. A large sample was chosen with the hope that the majority of students would respond and send back their questionnaires.

The use of questionnaires in research is well established and they are a low-cost data collection and processing tool that requires minimal training (Bowling, 2002). Questionnaires can reach a larger target of the population than would other data collection methods (Jones et al., 2008). It is for this reason that I decided to make use of questionnaires as reaching out to every potential target was going to be a challenge. Another reason for the use of questionnaires was that they have unique merits as regards validity of information (Jones, 2013). Since questionnaires allow for anonymity, they were suitable in creating high confidence levels for the respondents thus generating unbiased data about students' views and perceptions. Comparability of data using questionnaires becomes less ambiguous as one can compare and analyze data from different and independent respondents from similar questions. The uniformity of questions makes it manageable to standardize data, validate responses and for scalability. Since questionnaires were done away from school this may have allowed students to input their answers without pressure from either their peers or their teachers. A variety of questions were used to get to understand how students perceived assessment for learning from their prior experiences. Above all questionnaires are a practical data collection tool which does not create stress to the respondents.

Finally, questionnaires are a cost-effective way of gathering data, particularly in studies with large sample sizes. They can be administered online, through email, or in person, and can be completed at a time and location that is convenient for the participant.

Several studies have demonstrated the benefits of using questionnaires in research. For example, in a study examining the relationship between parental involvement and student academic achievement, researchers used a questionnaire to gather data from parents, which allowed for standardized data collection and ensured anonymity and confidentiality (Kim and Choi, 2018). In another study examining the use of technology in education, questionnaires were used to gather data from a large sample of students, which provided valuable quantitative data for analysis (Alnasser, Alwadaani, and Alshumaimeri, 2019).

In conclusion, questionnaires are a valuable method of data collection in research, particularly in studies with large sample sizes or sensitive topics. They allow for standardized data collection, anonymity and confidentiality, and cost-effective data gathering. The use of questionnaires in mixed methods research within a constructivist approach can be justified based on their ability to provide broad data collection, quantitative analysis, capture participant perspectives, facilitate participant reflection and self-expression, and enable data triangulation. By employing questionnaires alongside qualitative methods, researchers can enhance the comprehensiveness and depth of their investigations, aligning with the principles of constructivism.

3.4.3 Observations

Each of the six classes that took part during the study was observed three times making a total of eighteen observations. Each class was observed at the beginning of the study which coincided with the first nine weeks of the school year, then at the end of the first semester a second observation was carried out. The third and final round of observation for each was class was carried out towards the end of the school year. Each observed lesson was 50 minutes in duration for all schools. My intention was to ascertain whether the responses I was getting from other data collection tools was resonating with the observed phenomena. This also gave the researcher an opportunity to see if there were any significant changes in perceptions towards assessment during the year.

Observations helped in the triangulation and validating data that were being collected. Such a data gives us more information about the event under study than data gathered by any other sociological method (Becker and Geer, 1957). During each observation, the researcher would take note of the teachers' formative assessment types, frequencies, scaffolding and feedback. The researcher also took note of the time that was given to students to respond to questions, the learning atmosphere and weather students were interacting among themselves.

The advantages of observation methods include direct access to research phenomena, high levels of flexibility in terms of application, and generating a rich, permanent record of phenomena to be referred to later (Colosi, 2008). The most important reason that observational methods are used is to ascertain whether people actually do the things that they say they do. In observation the observer can directly check the accuracy from the observed. The researcher can apply various devices to test the reliability of their behavior. So very often the data collected through observation is more reliable than these collected through interview or questionnaire (Mangwaya, 2014). While interviews and Focus groups are strategies for eliciting the views of individuals and groups respectively, observation gives the researcher the benefit of collecting data in more natural conditions (Mulhull, 2003). Observations can deal with phenomena which are not capable of giving verbal information about their behavior, feeling and body language. I also used observation because it does not require the willingness of the people to provide various information about them. Observations gave the researcher a glimpse of how all students were responding to assessment for learning in a natural classroom set-up.

There was also some extensive observation of students during their lessons to gather data on their perception about formative assessment as they discussed issues with their peers. The researcher took note of students' reaction to feedback from various sources and how they reacted when there was formative assessment and other types of assessment. The researcher also observed students as they discussed their science tasks with their peers and their teachers. Besides observing students' reactions towards feedback, the researcher also made observations on self-efficacy, self-regulation and autonomy as students worked on their assigned tasks during classes. Observations provide researchers with ways to check for nonverbal expression of feelings, determine who interacts with whom, grasp how participants communicate with each other, and check for how much time is spent on various activities (Schmuck, 1997). The use of observation also increased the validity of the study as science classes were observed in their usual laboratories thus generating data which would be compared to the data that would come from the other data collection tools. Schensul, and LeCompte (1999) justified the use of observations by arguing that they help the researcher get the feel for how things are organized and prioritized, how people interrelate, and what are the parameters. They also stated that observations provide the researcher with a source of questions to be addressed with participants.

3.3.4 Focus groups

Focus groups allows for more non-formal conversations and students were more relaxed and made a lot of contributions in a more social atmosphere (Kitzinger, 1994). Focus groups are inexpensive, and individuals are likely to provide candid answers. Through facilitated discussion, participants build on each other's ideas through "piggybacking"; in this way, the Focus group is very useful for needs assessment and project evaluation purposes (Leung and Savithiri, 2009). This creates an enabling atmosphere for all students to air their views on assessment. Students' views were recorded and then latter analyzed. Focus group forums were sessions where ideas and issues were clarified among the participants, they allowed participants to discuss the topic in a relaxed environment with the researcher creating an enabling climate where all participants had a fair and equal chance of contributing. The use of Focus groups was done to triangulate data for comparative purposes with data from observations, questionnaires and interviews. This would assist in checking for uniformity of certain data and evaluate where there were similarities and variations and possibly come up with further research in an event that were contradictory. Kitzinger (1994) described focus groups as invaluable for constructivism theory development by way of generating rather than testing theories using participants' experiences. Focus groups are ideal for exploring ideas and perceptions are developed, cultivated, and sustained within communities. Rabiee (2004) argued that when exploring personal issues, the use of pre-existing groups has some advantages since there is a sense of trust amongst participants and the expression of views will be encouraged. The focus groups that took part in this study were representative of the 7th graders in the county in terms of the ages and demographic groupings.

Six Focus groups of students aged between 12 and 15 were involved, the focus group numbers ranged between seven and ten students throughout the study. Participation was voluntary and students could drop out of the group whenever they felt like leaving it. These groups were to meet once in every month in their different schools in their homerooms for 50 minutes. This was to ensure that the researcher would have more time with the focus group thus reducing chances of Focus group acting up. Spending more time with Focus groups also enables the students to be relaxed and carry on with their activities with little attention to the presence of the researcher. Focus groups allow researchers to look beyond the facts and numbers that might be obtained via survey methodology through Focus groups researchers can learn or confirm the meaning behind the facts. Since the study was set out to find out perceptions it was inevitable that more time would be spent with the Focus groups to recognize any changes in perception towards assessment as well as any accompanying behavioral modifications in self-regulation among students. Focus groups allowed the researcher increased time to listen to students' concerns, fears and joys about how they perceived assessment in general and assessment for learning in particular. Each Focus group had an almost similar number of males and females and represented the population diversity of the schools. Table 3.1 below shows the group compositions by gender and race. However, the number of girls who formed the Focus group was slightly higher than that for boys. Generally, more girls were willing to volunteer than boys and this may be because there were more female teachers than male teachers involved in the study or reasons behind it could form the basis of future studies. Another reason could also point towards the gender demographic demographics in Middle schools and in society at large where females tend to outnumber males.

Table 3.1

Data on focus group composition

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**Total**
Number of students	8	9	8	8	7	10	**50**
Gender	4F 4M	5F 4M	4F 4M	6F 2M	5F 2M	7F 3M	
Ethnicity							
Caucasian	4	1	1	3	1	2	
Hispanics	1	5	4	2	2	2	
Afric-Ameri	3	3	3	2	1	3	
Native	0	0	0	0	2	2	
Mixed	0	0	0	0	0	1	
Asia	0	0	0	2	1	0	
Duration	50’	50’	50’	50’	50’	50’	

For ethical and confidentiality reasons the student Focus groups were informed of how their participation was voluntary. The researcher ensured that students felt comfortable by confirming that whatever they said would be anonymous and making sure that they understood their right to withdraw from the research whenever they wanted. The researcher wanted the focus group members to have their own opinions and not be influenced by what someone else said. In order to encourage the expression of different opinions on various topics, focus group members were informed that they did not have to agree with each other (Hadjikou, 2016). The students were assured that they could express disagreement with each other and be critical on the topics presented in the discussions. The researcher made sure that focus groups were interactive allowing students the opportunity to enjoy because it could be the first time, they took part in an interview and create a positive experience. I tried to challenge students by asking 'why' or 'why not' which evoked the most interesting responses, but I was very careful in order not to make anyone feel judged by responding compassionately.

Confidentiality and anonymity were vital as participants expressed their honest views and talked about personal issues. Names of participants or their schools were not mentioned in the research. The data gathered were only used for the research and were not viewed by anyone other than the researcher.

Focus groups align with the constructivist theory by providing a platform for the active participation, social construction of knowledge, multiple perspectives, contextualized understanding, and reflexivity that are central to constructivist principles. Students were therefore able to help in the construction of new knowledge as they used their own experiences to help in the study.

3.5: Study procedure and ethical assurance

The process of data collection was carried out after approval had been granted by the UREC. As per procedure all data were collected with informed consent from participants and with consent from parents and guardians of children under the age of 18 who took part in the study. Permission to involve minors in the study was sought from Principals and parents in compliance with State and district laws. Participants were made aware of the fact that their participation was voluntary, and they had the right to withdraw from the study at any time and that all their responses would be anonymous and there was no mention of names during the data collection process. To ensure confidentiality participants did not indicate their names and they were issued with individualized codes which would allow them to check only on their input. Responses that were submitted online did not collect any email addresses and respondents could revisit their responses after a limited period but could not alter any of the questions as they were not granted editing rights.

The initial step in data collection after UREC approval was to get permission from the school district, which then cleared the researcher to approach the individual principals of the targeted schools. After getting permission from the principals, the next step was to recruit science teachers who in turn recruited students. When the students had expressed willingness to participate the teachers then compiled the names of these students and their parents or guardians were approached through the informed consent forms. It was only after getting the responses from parents that data were collected from students.

Lesson observations were carried out during normal lessons and the researcher would not interact with students as not all students had agreed to take part in the study. Participating teachers would have access to how the observation would have gone upon request and this had no impact on their lesson delivery and whatever was observed during the research would not be shared with anyone other than the teacher involved. Due to the impact of the pandemic some participants could not attend face to face classes, and these had to take some online interviews. The researcher is a science teacher who advocates for formative assessment more than summative assessment and there were chances that there could be a bias in the questionnaires, observations, and interviews, but this was dealt with through the supervisor as all questions were reviewed before they could be administered to ensure partiality. Triangulation was used in making sure that all collected data remained unbiased. Kennedy (2009) pointed out that the use of a variety of methods to collect data will overlap and complement data from various sources and has the effect of balancing each method out and giving a richer and hopefully truer account. The use of triangulation ensured that data remained unbiased as each method provided some checks and balances to the other.

3.6: Data collection and analysis.

This section describes how data were collected and analyzed. The section will describe how different data from interviews, questionnaires, focus groups and observations were collected and processed.

3.6.1 Analysis of the qualitative data

Qualitative data were analyzed with the use of thematic analysis (Braun and Clark, 2006). Thematic analysis was used because of its flexibility and propensity to be modified to suit the needs of the study, and it can produce trustworthy and insightful findings (Braun and Clark, 2006, King 2004). The researcher went through all the responses from participants and identified common themes from the participants (Starks and Trinidad, 2007). This allowed for the researcher to start the coding process through identifying common concepts, recurrent opinions and categories that were expressed by research participants (Hycne, 1985).

The researcher engaged in the transcription of data though listening to recorded interviews and revisiting the documentation done during the interviews and focus groups. The researcher listened to every interview without any disturbances and reviewed all data from focus groups to pick on the themes that were being generated. During the data analysis the researcher named teachers from T1 through T6, and students were identified from S1 to S150 for anonymity. The next step in the analysis of interviews and focus group data was done through the breaking down of data apart and delineating concepts to stand for blocks of raw data as argued by Corbin and Strauss (2008). The researcher reviewed all responses to identify any key issues in the participants' responses that could indicate some commonalities or variations in perceptions. Applying codes to raw data enabled the researcher to examine how the respondents' data supported or contradicted the theory that is guiding this research as well as enhances the current research literature, (Coffey and Atkinson 1996). The codes for this research were created from the data collected and in line with the research questions, aims and objectives. This meant that the codes were data-driven, they were generated from ideas that were repeated by respondents to create themes. Coding from interviews and observations followed Boyatzis (2010) framework of five steps; (1) reduce raw information, where data from different participants were analyzed for every paragraph with aim of understanding the responses and come up with themes; (2) identify subsample theme, where themes and sub-themes were identified; (3) compared themes across sub-samples; (4) created codes; and (5) determine reliability of codes in view of the research aims and objectives (DeCuir-Gunby, et, al. 2011). When these steps had been completed the researcher reviewed the list of themes and sub-themes of relevant meaning and eliminated those which are clearly redundant to others previously listed. This was meant to improve the validity and reliability of analyzed data.

A total of eighteen lesson observations were carried out with each class being observed three times and every lesson observation lasting for 50 minutes. Multiple observations were meant to improve credibility and reliability (Guba and Lincoln, 1989). Data collected during observations were both systemic and phenomenological. Of the eighteen observed lessons fourteen of them were hybrid as some students were attending classes synchronously online through Zoom meeting platform and others were attending face to face in the classroom. The researcher made recordings of the lessons with the aid of a Dictaphone and there was also a provision of having recordings retrieved from the permanently installed video cameras in each classroom. This gave the researcher more time to listen observe the same lesson from the recordings. Phenomena to be observed were drawn before the observations and the researcher also realized that these phenomena were dynamic as there were other things that were generated from the observations (Braun and Clarke, 2006). The expanded themes were then reviewed and the ones that were more relevant to the study were analyzed. The next step involved the contextualizing and connecting observations with the research question and aims (Braun and Clarke, 2006). This was followed by coding the events in the classroom and producing real-time semantic annotations. Observation notes were then compared with lesson reviews from recorded lessons to identify anything that could have been overlooked during observation.

3.6.2 Analysis of quantitative data

All quantitative data collected were input into Excel and SPSS (Muijs, 2010) to allow for a thorough analysis. The same was done for some qualitative data that were converted into quantitative data and then parametric tests were then done. Correlation command was used to examine the relationship among self-regulation, self-efficacy, feedback, autonomy, and motivation (Arkkelin, 2014). Descriptive data were compared using paired t-test, z-test, Chi-square test and Mann-Whitney U tests to compare findings from students in different schools. Analyzed data were in line with the research questions where focus was on students and teachers' experiences and perception of how formative assessment is administered during learning and how students' motivation and self-regulation may be improved. All questions were structured in a way that would probe all participants' perceptions about assessment, self-regulation, self-efficacy, motivation, and feedback. Preliminary analysis was conducted using excel before finally using SPSS. Data analysis is meant to ensure that raw data is converted into statistics that are easy and more convenient for the reader to go through and understand (Gath, 2008).

3.7: Summary

This topic collected all the data that was used to answer the research questions with a view of gaining a greater understanding of how teachers perceive assessment and how this impact on such phenomena as motivation, self-regulation, motivation, and self-efficacy. Data will be condensed from the collected raw material and analyzed in the next chapter. Accordingly, Kennedy (2009) summed it all by stating that lots of different views, lots of data! Each method is used in a way which is appropriate for it, and when combined they allow a degree of cross checking. A variety of data collection methods were used to ensure that the data will represent participants' perceptions without bias from the researcher. Analyzed data will be presented in the next Chapter.

CHAPTER 4: PRESENTATION OF RESEARCH FINDINGS

4.1: Introduction

This Chapter presents the findings from the research which explored teachers' and students' perceptions of formative assessment in science and how these impacted on self-regulated learning, feedback, self-efficacy, and motivation. The Chapter describes how data were collected and ensure that all data that were collected were trustworthy, credible, and reliable. Data were analyzed using embedded software in google forms and two other data analysis software, namely excel and SPSS. These packages are reliable and are widely used by scholars in analyzing data. At the end of this Chapter the findings of the study will be presented.

4.2: Reliability and validity of data

Questionnaire face validity was established with my supervisor and Critical Friends who are well versed with education research. They read through the questionnaires and offered feedback before the questionnaires were administered. A pilot survey was also carried out with students, and this was critical in ensuring validity. The researcher conducted three observations per each participating class to ensure reliability and validity of data. This also allowed the researcher to ensure that students' and teachers' behaviors were not in any way influenced by the researcher's presence.

Lincoln and Guba (1985) pointed out that there are five aspects for assessing the trustworthiness of qualitative research, that is, credibility, dependability, conformability, authenticity, and transferability. Credibility refers to the confidence that can be placed in the truth of the research findings (Korstjens and Moser, 2018). Strategies used to ensure credibility were prolonged engagement, persistent observation, and triangulation. Dependability and confirmability were achieved by inviting Critical friends who could point out various issues upon the methods and findings of the study. Sim and Sharp (1998) posits that transferability refers to the degree to which the results of qualitative research can be transferred to other contexts or settings with other respondents. Transferability was established through detailed description of data and reporting them with accuracy. Thick description leads to external validity thus conclusion from the study can be transferable to other settings (Teddlie and Tashkkori, 2009). The researcher used adequate engagement in data collection and member checks to avoid any bias or giving own opinions on emergent findings. The duration of the data collection phase was adequate to ensure that all respondents were not acting out during observation, this provided for research to be carried out in a real life and natural setting. Research instruments were scrutinized before data could be collected to make sure that right instruments were used to collect the intended data.

4.3: Demographics

Table 4.1 shows the demographics for the teachers who participated in the study. Data showed that the teachers' ages ranged from 27 years to 56 years, making an age range of 29 years. The number of years of teaching experience had a range of 32 years varying from between one year and 33 years. From the six teachers two had post graduate degrees while the other four held a first degree.

Table 4.1

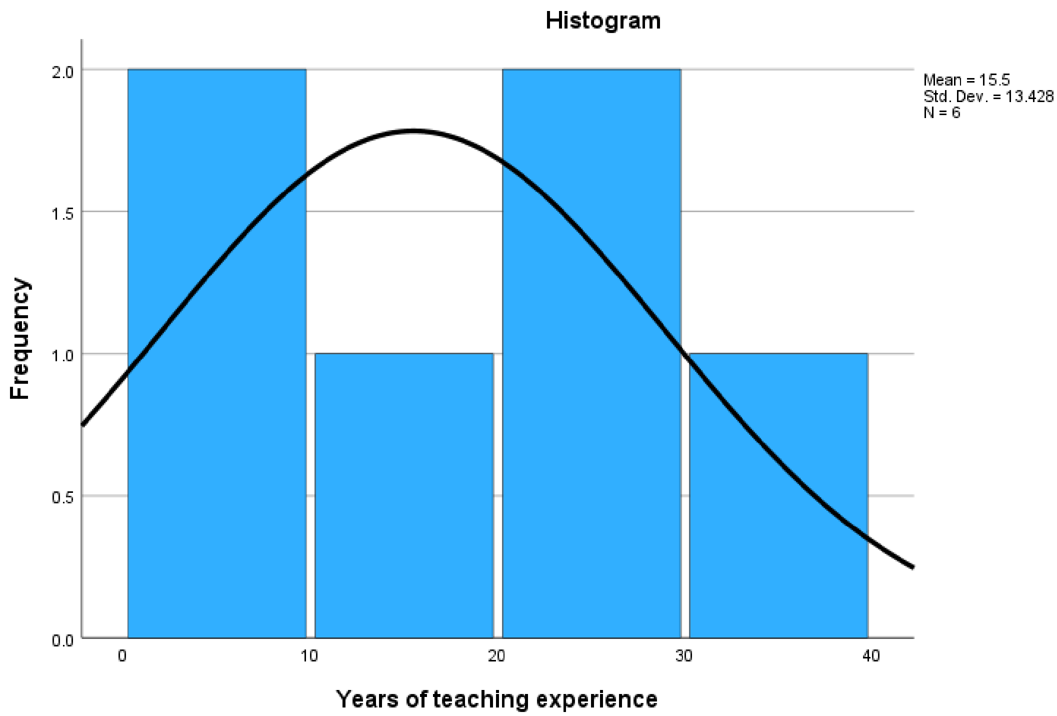
Demographics for teachers

Teacher code	**Gender**	**Age**	***Number of years of teaching experience***	***Highest qualification***
T1	Female	46	24	Post graduate degree
T2	Female	44	24	Post graduate degree
T3	Male	27	1	Undergraduate degree
T4	Male	44	1	Undergraduate degree
T5	Female	32	10	Undergraduate degree
T6	Female	56	33	Undergraduate degree

Teacher experience could have an impact on how teachers with less or more experience in their career could have perceived or implemented assessment of learning. There may be some possibilities that teachers' standard of question differentiation and feedback might be reflective of their number of years in teaching. Figure 4.1 shows data for the relationship between teachers' ranges of years of experience and the frequency. The mean years of experience for the six teachers was 15.5 years and a standard deviation of 13.428. Only two teachers were beginner teachers with the other four teachers being veteran teachers.

Figure 4.1

Teacher experience frequency



Students' demographics for questionnaires are shown in Table 4.2 below where each of the participating schools' data was divided into males and females. The Table also shows data on the total numbers of participants for each school. 100 students took part in the questionnaire. On average more females participated in the questionnaire than males for every school. Reasons for that may form the basis of future studies. This could also indicate the general demographic data for the county since there are more females than males.

Table 4.2

Demographics for students' questionnaires

Class code	**Males**	**Females**	**Total**
C1	6	14	20
C2	4	16	20
C3	3	11	14
C4	7	5	12
C5	6	11	17
C6	10	7	17
			100

Fifty students were also involved as the focus groups. There were three focus groups, one from each school. Focus groups were selected by their teachers to represent other student groups of the schools, teachers encouraged the participation of a selection of students whom they felt were going to be able to talk and discuss issues. Since teachers had knowledge of their students, they purposively enlisted students who had track records of dedication. All the participating schools had almost equal numbers of students for the focus group. The demographics for the focus group are shown in Table 4.3 below. Each school is represented by students whose ages ranged from 12 years to 15 years, each age group is summed up with a sub-total and then a cumulative total is then given for each school. As mentioned earlier on these focus groups were voluntary and students were made aware of the rights to withdrawal from the study whenever they needed to. Each focus group lasted for 50 minutes in their science laboratories.

Table 4.3

Demographics for focus group participants

Class	Age (years)	Females	Males	Total
C1	12	1	0	1
	13	2	1	3
	14	1	2	3
	15	0	1	1
C2	12	0	1	1
	13	2	2	4
	14	2	1	3
	15	1	0	1
C3	12	0	0	0
	13	2	1	3
	14	2	3	5
	15	0	0	0
C4	13	4	0	4
	14	2	2	4
	15	0	0	0
C5	12	1	0	1
	13	2	1	3
	14	1	1	2
	15	1	0	1
C6	13	3	2	5
	14	4	1	5
	15	0	0	2
				50

Further statistical data on the Focus groups are presented below on Figure 4.2a which gives data on population descriptive on Total number, Mean, Standard deviation and Variance of gender, age, ethnicity and class of the students. There were 50 students involved in the focus group with an average age of 13.5 years, standard deviation of 0.7 and variance of 0.49.

Figure 4.2a

Population descriptive

	N	Mean	Std. Deviation	Variance
Ethnicity	50	2.540	1.299	1.688
Age	50	13.500	.700	.490
Gender	50	1.620	.485	.236
Class	50	3.540	1.746	3.048
Valid N (listwise)	50			

Std. Deviation and Variance use N rather than N-1 in denominators.

Figure 4.2b also shows the gender-ethnicity cross tabulation where females formed 62% of the focus groups with males making the other 38%. Data for each of the divergent groups were presented students of Caucasian, Hispanic and African American origins forming the majority of the population. Focus groups were representative of the county's demographic patterns. Data on ethnicity by gender showed that for the Caucasian students there were 55% female and 45% male student participation with a residual of -8 and 8 respectively. An almost similar trend on female to male participation was shown with students of Hispanic origins with 69% females and 31% males and African Americans with 60% females and 40% males. Only students of Native origins and those mixed races had different statistical data on the numbers of males and females who participated. Reasons for such could be explained in a different study if such statistics were to be recorded in a different county.

Figure 4.2b

Ethnicity cross tabulation

Gender * Ethnicity Crosstabulation

		Ethnicity																									
		Caucasian				Hispanic				African American				Native				Mixed				Asiatic				Total	
		N	%	Residual	Standardized Residual	N	%	Residual	Standardized Residual	N	%	Residual	Standardized Residual	N	%	Residual	Standardized Residual	N	%	Residual	Standardized Residual	N	%	Residual	Standardized Residual	N	%
Gender	Male	5_a	45%	.8	.4	5_a	31%	-1.1	-.4	6_a	40%	.3	.1	2_a	50%	.5	.4	1_a	10...	.6	1.0	0_a	0%	-1.1	-1.1	19	38%
	Female	6_a	55%	-.8	-.3	11_a	69%	1.1	.3	9_a	60%	-.3	-.1	2_a	50%	-.5	-.3	0_a	0%	-.6	-.8	3_a	10...	1.1	.8	31	62%
Total		11	10...			16	10...			15	10...			4	10...			1	10...			3	10...			50	10...

Each subscript letter denotes a subset of Ethnicity categories whose column proportions do not differ significantly from each other at the .05 level.

4.4: Results from teachers' interviews.

All the six teachers who volunteered to take part in the study were interviewed in their three schools. Data from these are recorded in the following sections. These results addressed the research question about how teachers interpret and implement assessment for learning in Middle School science? Teachers' responses helped in answering the research question in multiple ways.

4.4.1: Types of formative assessment

All teachers responded that they were aware of formative assessment and could differentiate formative assessment from summative assessment. They all mentioned that they used a variety of assessment methods in the classroom to enhance students learning. While all teachers agreed on the value of formative assessment five of the respondents claimed that they used formative assessment as their primary assessment tool while the remaining one reported that she at times assess their students formatively. T6 felt that students' understanding of concepts cannot be assessed formatively. Teachers gave a variety of assessments that they use in the teaching learning process, the main forms of assessment were combined from both formative and summative types.

All teachers mentioned that they believed that formative assessment was helpful especially for their students who were attending their lessons virtually. These include discussions, exit tickets, quiz, projects and games. Teachers revealed that they used different types of formative assessment with some methods having been widely used than others. Teachers revealed that they were combining their formative assessment with computer based formative assessment. This is shown in Table 4.4 below which gives a summary of the various types of assessments that were used by the participating teachers in their science classes. Table 4.4 shows that there is more value attached to summative assessments as all teachers used tests and quizzes. There was some form of uniformity and consistency in the use of assessment of learning. Assessment for learning methods such as games and projects were not so popular while most teachers used discussions.

Table 4.4

Common types of assessment by teachers

Type of assessment used	Number of teachers using the assessment method
Tests	6
Projects	3
Games	3
Exit tickets	2
Quiz	5
Prompt worksheets	1
Discussion	5

Data from teacher interviews were analyzed using t-tests for two samples derived from teachers' experiences and the number of formative assessments used by each of the group members. There were 10 different types of formative assessment that were mentioned by different teachers. Each of these types was taken to be 10% for statistical purposes. Teachers with less than 20 years teaching experience had a mean formative assessment number of 5 which translated to 50% while teachers with over 20 years teaching experience utilized on average 9 out of the 10 mentioned formative assessment methods as shown in Figure 4.3a below. There was an equal distribution of teachers with under ten years of teaching experience and those with over 20 years of teaching experience. The standard deviation of 20 shows that there was a relatively large spread of values away from the mean for teachers with less than 20 years in the field, while the standard deviation of 10 for veteran teachers was also high though closer to the mean than for those with over 20 years' experience.

Figure 4.3a

T-test for teaching experience and types of assessment

Group Statistics

	groups	N	Mean	Std. Deviation	Std. Error Mean
Types	Below 20 years experience	3	50.0000	20.00000	11.54701
	Above 20 years experience	3	90.0000	10.00000	5.77350

The t-test revealed data of -3.098 and 4 degrees of freedom for equal assumed variances and less freedom (2.9) for unassumed equal variances. Data also revealed that teachers with lesser years of experience had implemented fewer assessment for learning tasks and in a slightly different way than those with more years of teaching experience and this could also point towards some variations in the way they perceive and value assessment for learning as shown in Figure 4.3b below.

Figure 4.3b

Independent t-test for experience and types of assessment for learning.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Types	Equal variances assumed	.800	.422	-3.098	4	.018	.036	-40.00000	12.90994	-75.84375	-4.15625
	Equal variances not assumed			-3.098	2.941	.027	.055	-40.00000	12.90994	-81.55400	1.55400

4.4.2: Teachers' perceptions the of benefits of formative assessment

This sub-section addresses the research question about how self-regulated learning could be encouraged through assessment for learning. It gives data on how teachers perceive formative assessment and how they could use their experiences to build on helping students develop self-regulation as they learn science. The results would combine the perceived benefits of assessment for learning with what would come from interviews and observations to close the gap on how assessment for learning may be used in improving student self-regulation.

Teachers were all in agreement that formative assessment was beneficial to students learning and pointed out that formative assessment improved students and teacher interaction. Other common responses from teachers were that giving feedback to students during formative assessment was more effective and less stressful on both the students and the teachers. Five teachers were of the view that formative assessment was informative and useful in shaping the direction of future lessons and differentiation. They also revealed that feedback generated during formative assessment helped in redirecting the lesson and comparing students' performance to set State standards which are expected grade level learning goals set by the State. However, one teacher stated that she rarely used formative assessment in her classroom. All teachers reported that the use of formative assessment encouraged and challenged students to perform at higher order think skills, they also mentioned that formative assessment boost student confidence and result in students being highly motivated to learn. Table 4.5 below presents the Themes, Respondents and Examples.

Table 4.5

Perceived benefits of formative assessment

Theme	Respondents	Example
Formative assessment informs you that students are on course and when to vary instruction	T1, T2, T3, T4, T5, T6	T1: Whenever I use formative assessment, I tend to work out more examples. Sometimes it informs me to pace up and move on to the next section or to slow down.
Formative assessment makes it easy to compare students' performance to standards.	T2, T3, T6, T4, T1, T5	T4: If learners are having difficulties in attaining State Standards it is easier to recognize and rectify it formatively.
Formative assessment gives the ability to offer immediate feedback and proceed with lesson	T1, T2, T3, T4, T5, T6	T2: Students can get feedback the teacher and redirect their focus towards the lesson goals.
Feedback given through formative assessment to students is valued	T1, T4, T5, T6, T2, T3	T6: Formative assessment feedback generates a lot of "Ahaa" moments from students and such moments create extended learning and teachable opportunities for in-depth interactions.

Formative assessment provides opportunities for peer assessment.	T1, T6, T3, T4, T5, T2	T1: Students can get feedback from their peers and are also able give feedback to others.
Formative assessment provides opportunities for self-assessment.	T4, T6, T5, T2	T6: When students are given the chance to assess their peers, they are also learning to self-assess.
Formative assessment allows students to self-evaluate and be actively involved in their assessment	T2, T4, T5, T6, T1, T3	T4: Giving students the opportunity to assess their work makes them more involved in assessment.
The use of formative assessment has positive impact on students' motivation.	T1, T4, T5, T3, T6, T2	T4: My students show more signs of being highly motivated when they are assessed formatively.
Formative assessment allows students to work from the known to the unknown	T2, T3, T5, T6, T4, T1	T3: I use formative assessment to allow students to learn from prior experiences. When students work form the known towards the unknown, they get highly motivated and are better prepared to self-regulate and work on their own to achieve higher learning skills.

Formative assessment encourages students' autonomy and creative learning skills.	T1, T2, T3, T5, T4, T6	T5: My students are more able to work on their own when work has been assessed formatively.
The use of formative assessment makes it easier to identify areas that require remediation and respond to individual needs.	T6, T4 T1, T2, T3, T5	T2: Involving other students and creating greater student engagement allows me to offer remediation and scaffold my instructions according to individual student needs.
Formative assessment sends a signal of care and hope to students	T3, T5, T6, T2, T4, T1	T4: Even when my students are struggling, I always let them know how proud I am of their responses.
Discussions in formative assessment helps students express themselves and develop higher order skills	T2, T3, T5	T3: Watching students engage in formative assessment makes me realize how they proactively express themselves and present higher order thinking skills.
Formative assessment informs teacher's instruction and future planning.	T1, T2, T3, T4, T5	T5: I can easily see where I need to change my lesson and plan accordingly for future lessons.
Formative assessment creates conditions for facilitation of learning which encourages student driven learning and research.	T2, T3, T4, T1, T5, T6	T3: The world is ever-changing and using formative assessment allows me to be a facilitator of learning instead of dishing out knowledge.

Formative assessment creates suitable conditions for cooperative learning.	T4, T6, T1, T3, T2, T5	T2: Formative assessment allows me to use station-based learning where students work on different tasks in different groups.
Formative assessment lets shy students participate in class activities	T5, T1, T3, T4, T6, T2	T5: I have implemented formative assessment through dance and arm-wrestling for my students. This made the assessment fun and more interactive with students combining their dance moves and arm-wrestling skills to explain the musculoskeletal system. Even some students who would otherwise shy away were eager to participate in everything.
Formative assessment challenges students to use high order thinking skills	T1, T2, T3, T4, T5, T6	T3: Since I started using formative assessment even my struggling students are coming up with well thought out answers and questions.
Formative assessment promotes students to develop a growth mindset	T2, T3, T4, T5, T6	T2: Students learn to explore and experiment on their own
Formative assessment encourages students to be problem solvers. Formative assessment encourages students to learn project management.	T2, T3, T4, T1, T5, T6 T2, T3, T4, T5, T6	T6: Students become systems thinkers. T4: Students develop iterative thinking skills

Formative assessment allows for improved and effective differentiated learning	T1, T2, T3, T5, T6	T6: Through formative assessment I am better able to address the individual needs of my students as it allows me to meet my students where they are.

Formative assessment informs you that students are on course and when to vary instruction

Teachers agreed that the use of formative assessment was barometric as it helped them in giving them indicators of how students were performing during lessons and when there were some challenges it was easy for them to vary instruction. Teachers also reported that formative assessment assists them in knowing when to pace up depending on how fast students demonstrate mastery of concepts that would be under discussion. Besides being helpful on students' learning, formative assessment also helped teachers in the way they pace and scaffold their work. Some of the points raised by teachers included the following.

> T5: The use of formative assessment helps both me and my students as it allows me to refocus on my lesson delivery. I can gauge how my lesson is going and how my students are progressing.

> T6: Formative assessment for me as a teacher is immediate feedback, lest I continue to teach yet there are some students not understanding. This allows me to know whether to proceed or to slow down. Sometimes it is not everyone understanding but at least the majority should. Sometimes students are not truthful when you assess formatively. Summative assessment for me is important because I can check individual overall understanding. However, I appreciate that students perceive formative assessment to be better as it gives them hope in continuing to learn the subject.

T4: Formative assessment for me is like a barometer which shows me how much of detail has been learnt from how much of detail my students had before the lesson. Assessment for learning is the way to go for me as it allows me to transition from hardworking to smart working. I and my students can cover a lot of content in depth with little or no stress at all.

T3: I am able to assess my students individually, formative assessment helps me to attend to a variety of individual needs in my classroom. That way I ensure that every child benefits from the lesson.

T2: Assessment for learning informs me as a teacher if my lesson is going in the required direction, whether my students are understating the concepts or not. Formative assessment provides check points for me that assist me in knowing if my students are growing academically, and if there is need for a change in the way things are done in my classroom. I would say assessment for learning is the best indicator that I have used to check if I and my students are on the right path.

Formative assessment makes it easy to compare students' performance to standards

Teachers believed the planned use of formative assessment in the classroom allowed them to continually check on State standards and compare how their students were performing against Common Core State Standards with ease and without having to wait for the mid-quarter summative tests.

Teachers also pointed out that when students are assessed formatively, they will demonstrate to you their areas of need and their areas of strength which made it easier for them to plan and compare students' performance to standards. This made it easier for them to assess their students in a way that would ensure that they would align performance and direction of students' self-directed learning with standards and areas of need.

> T1: Formative assessments are an enabling tool for me to link the Common Core State Standards for science as I am able to make the necessary interventions as the lesson progresses.

> T5: Assessment for learning removes fear that is associated with assessment of learning, my students have shown that they have become more confident with formative assessment and are better able to be more autonomous.

> T2: Assessment for learning informs me as a teacher if my students are performing above or below the expectations of the State's Common Core Standards and this allows me time to strategize accordingly.

> T6: When I compare my students' performance against State Standards through assessment for learning I am able create individualized student needs during the lesson and for the future.

> T3: Formative assessment allows me to see how students compare on each State standard and know what topics or concepts to reteach and address any grey areas before students take summative assessments.

Formative assessment gives the ability to offer immediate feedback and proceed with lesson

Teachers felt that formative assessment served as an early warning system to their teaching and its effective utilization in the classroom gave them the means and necessary tools to provide immediate and effective feedback while students still had fresh concepts in their memories.

When feedback is offered as soon as the students have made their presentations it is more effective as learners are able to make connections to their ideas and modify the line of thought. That way students benefit more from feedback.

> T3: The good thing about formative assessment is that I do not leave behind any students as remediation is offered to students while ideas are still fresh.
>
> T4: Students can get feedback their peers and the teacher. This allows me as a teacher to adjust in my lessons to fit individual student needs.
>
> T6: Formative assessment has enabled my students to work towards attaining the two critical components of both the State and the Federal goals as it ensures that all students race to the top with equity while no child is left behind during the process.
>
> T5: Assessment for learning is by far the most effective way for me to generate learning focused and student-centered feedback without having to wait for another time.
>
> T1: Assessment for learning makes it convenient for me to readjust and modify my lessons in response to how my students are performing.

Feedback given through formative assessment is valued

Teachers also reported that the feedback they gave to students during assessment for learning was more effective than written feedback that they provide for assessment of learning. Feedback given during formative assessment was more directed and afforded students the opportunity to respond and seek clarity on matters that would not be clear to them. They mentioned that when they offer feedback during formative assessment, they are also able to get counter feedback from students which makes a great improvement in classroom communication thus enabling conducive learning and participatory environments.

T4: When giving feedback formatively it creates trigger effects for individual students which allows them to have somewhere to begin from. I am always cognizant of individual differences and make sure that whenever feedback is given the learner should always feel uplifted and encouraged. When I realize that feedback is likely to be detrimental to students' ego I do it without allowing other students to hear it.

T1: Formative assessment allows me to give learning-focused feedback, this gives my students multiple options to come up with the correct or expected answers. Since feedback given during formative assessment is timely it is more effective on my students.

T3: My students value feedback that is generated through formative assessment more than feedback generated through summative assessment, as they always give reference to feedback given formatively even after a couple of months but occasionally refer to summative assessment feedback.

T2: Formative assessment feedback generates a lot of 'Ahaa' moments from students and such moments create extended learning and teachable opportunities for in-depth interactions Students can get feedback the teacher and redirect their focus towards the lesson goals.

T5: The value of formative assessment is both ways, I get to understand my students better which makes it easier for me to plan for them as individuals and not as a class. On the other hand, my students feel more comfortable with personalized feedback and are better positioned to reflect on my feedback and even create more interaction to derive better understanding of the concepts.

Formative assessment provides opportunities for peer assessment.

When teachers responded to how formative assessment is linked to peer feedback, they agreed that formative assessment provides a platform for increased peer interaction during the learning process. Formative assessment was seen as having provided students with the chance to look at other students' work from a different viewpoint. It gave students the chance to walk in other students' shoes.

> T6: When students are given the chance to assess their peers, they are also learning to self-assess. Formative assessment, therefore, gives student the opportunity to role-play as well as be able to look at their work from different viewpoints.

> T4: Assessment for learning permits my students to walk in the shoes of other students, it encourages them to think outside the box.

> T5: My students have been improving in self-reflection due to peer assessment, I have always encouraged them to use their experiences with peer assessment to improve on their presentations. Students now take their time to think about things before they rush to answer.

> T2: By using peer assessment I have come to realize that my students are now able to self-evaluate and considerate of their own learning needs as well different learning needs for their peers. Formative assessment has improved classroom communication and intra-student responses to divergent answers.

T3: Assessment for learning makes students become critical thinkers because in order for them to assess their peers' work, they should have prepared themselves more to be able to constructive peer assessment.

Formative assessment allows students to self-evaluate and be actively involved in their assessment

Teachers also pointed out that formative assessment allows students to self-evaluate and be actively involved in their assessment. Teachers agreed that self-evaluation is better enhanced through formative assessment as students have increased interaction time and are able to discuss and probe as to why some of their proposed answers will not be correct.

T2: Giving students the opportunity to assess their work allows them to be more focused on detail before submitting their work.

T6: When students self-assess they are able to identify errors and present work that is less flawless.

T3: The use of formative assessments makes sure that students no longer feel detached from the assessment processes, they now feel they are part of the process as they have an input into the assessment process without being subjected to the testing kind of assessment where they have little or nothing to say.

T1: Formative assessment has aided my students in being more autonomous and motivated as they no longer must wait for other students to learn on their behalf. My students enjoy evaluating their work and compare it to set success criteria and learning objectives.

T5: Self- evaluating students are more self-reflective in their reasoning and are more likely to be critical when analyzing their work which makes them better prepared to deal with scientific and general life challenges.

The use of formative assessment has positive impact on students' motivation

There was a consensus among all teachers that the use of formative assessment had a positive impact on students' motivation. Teachers reported that they ensure that their students are motivated through formative assessment by using strategies such as offering immediate feedback and focusing more on the positives, linking lessons to prior knowledge and scaffolding lessons from the known to the unknown. Five out of the six of the participating teachers mentioned that even when their students get some concepts wrong, they encouraged them to attain set target through follow-up questions.

A common response from teachers was that there was increased students' motivation to learn and to participate in assessment when they were assessed formatively. Teachers believed that students demonstrated that they were ready for assessment when they knew that the assessment was going to be formative and showed some signs of panic and stress when they were to be assessed through summative assessment.

Teachers also mentioned that students are motivated to contribute towards a discussion where they can use action and modelling, yet they get demoralized due to summative assessment. Formative assessment makes learning natural and makes students feel that it is ok to make mistakes and in most cases the students can self-correct. Students always show the zeal to learn, and one can see that when learners are assessed formatively, they become confident with each passing day. Students are better equipped to learn and are more motivated with each passing day. Maybe it is time that we realize that this is a better way to assess students as it leaves them more encouraged.

There was a consensus among teachers that formative assessment was effective in generating interest from students by building from what students already knew.

> T5: My students exhibit a lot of interest and determination when they are assessed formatively.

> T2: Formative assessment unearths the hidden talent in students. Most of my students appear to have come out their shells are showing a lot of self-confidence making them motivated to take up tasks that they would have previously shied away from taking up in the past.

> T3: Since I started planning for formative assessment in my classes, my students have been showing a lot of interest in science, it is like formative assessment has been the missing link between motivation and interest in going beyond expectations.

> T6: I have realized that when I use formative assessments my classes are very motivated and excited about their learning.

> T1: Even my slow learners show a lot of enthusiasm when I assess them formatively. They are always willing to come out of their shells unlike when I assess them using summative assessment where they retreat to their shells.

Formative assessment allows students to learn from the known to the unknown

All teachers stated that they linked formative assessment to prior knowledge, and this helps students' motivation since it becomes easier for them to work from what they already know. They also reported that formative assessment improves students' engagement, and this motivates them to be proactive and work towards attaining their set standards. Teachers agreed that when students learn new things, they found it easier to build up from what students already know before they introduce abstract learning materials.

> T6: When I use formative assessment it enables me to start from what I assume my students already know and then build up new concepts from there.

> T1: By using assessment for learning it becomes so easy for both me and my students to build up my lessons from what students already know towards new concepts as assessment for learning enables greater and effective communication.

> T2: I used formative assessment for pollination and using hibiscus flowers. This allowed students to be more engaged as most of them had similar flowers at home, students were more engaged motivated and there were cases where some students were even trying out cross pollination of some marigold flowers at school. They could link new knowledge to old knowledge.

> T5: Students love to learn when they realize that they have something they know about the topic. They become more engaged and are better able to accelerate in their learning when my lessons are structured from the known to the unknown. It is the use of assessment for learning that makes it manageable to have students' progress from the known to the unknown.

> T4: I have come realize that some students are failed by the system not that they don't know, but because we test them in a way they just do not understand. When such students are asked the same questions formatively, they produce excellent answers. Again, I noticed that when I scaffold my questions from what they know from experiences towards abstract my students are always up to the task.

Formative assessment encourages students' autonomy and creative learning skills

The use of formative assessment creates an enabling learning environment for students to work independently with minimal teacher support. Teachers pointed out that assessment for learning gave their students greater autonomy in the way they learn, thus enabling them to have more ownership of their learning. Most teachers responded that formative assessment gives students greater autonomy over their work especially when it comes to setting of the learning goals, their study times, and projects.

All the teachers agreed that students were more autonomous when assessment was conducted formatively as they would work on concepts at their own pace and interests. Teachers pointed out that formative assessment generates a lot of creativity and innovation among students.

> T1: I have used formative assessment in role play and debate on the topics of climate change, global warming and my students have come to like formative assessment. I have since realized that students are able to independently expedite over current scientific issues when they debate. I have even started awarding grades using that. My students are so hyped up when they know that grades will be awarded from such activities, they always look forward to that.

> T5: My students are better positioned and able to work on their own when work has been assessed formatively. I have used formative assessment for online games and my students are in the process of creating their own science online games.

> T4: With formative assessment I can see my students being proactive in their work, they tend to do most their work during their own time.

T2: The level of students' autonomy in learning is certainly enhanced when I assess my students formatively. They become more active and can bring in new ideas with ease. Students create their own expectations thus generating a firm foundation for innovation. When students are allowed to work autonomously, they become more innovative and whenever they are working on their tasks they rarely have anytime for behavioral issues.

T3: I feel like formative assessment was the missing link for me during my days as a high school student because I relied so much on my teachers' input. I am seeing that my students rarely need my input when I assess them using formative assessment as they can link their own experiences to come up with solutions to challenges presented.

The use of formative assessment makes it easier to identify areas that require remediation, respond to individual needs, and improve the quality of the lesson.

All teachers agreed that it was easier to identify and rectify students' areas of need when using formative assessments. Teachers mentioned that through formative assessment they are able to respond to students' individual needs and also identify the weak areas of their teaching. Teachers agreed that formative assessment was indeed a learning platform that ensured that students' needs, and shortcomings are identified and attended to as the lesson progresses making sure that none of the students are left behind the rest.

T2: Formative assessment allows me to involve other students through peer interaction and create greater student engagement. This allows me to identify individual student needs and offer remediation. I am also able to scaffold my instructions according to individual student needs therefore improve the quality of my lessons.

T4: I am better positioned to identify where the lesson is not going well and offer on-point remediation to my students when I use formative assessment. This has been improving the quality of both my lesson preparation and delivery as I can no longer take things for granted.

T5: The use of assessment for learning has been very effective among my students who have some language barrier challenges as it has freed up time for me to be able to attend to individual students when the others are engaged in either personal or group tasks. I am able to listen to my students and respond to their concerns in a language they understand and away from the spotlight of the whole class.

T3: Formative assessment has helped me as a teacher to be better able to respond to my student's needs when learning is taking place instead of waiting until the end of the topic. My students can interact with their peers and with me with greater intensity.

T1: Giving individualized or personalized remediation is made more effective when I assess my students formatively because I do not have to wait to respond to my students' needs after some time as I would be having the students with me. This is unlike when I assess my students using summative assessment where I have to write comments and then wait until I meet the students.

Formative assessment gives students a signal of caring teachers

The use of formative assessment was also seen to be a way of connecting with students as teachers pointed out that the feedback, they provide to students during formative assessment allows them to connect with them socially and emotionally. Teachers stated that formative assessment sends a message of care to the students, and this promotes positive student perceptions, challenges, and opportunities for them to demonstrate and showcase their competencies. Teachers also linked the use of formative to connecting with their students' emotional needs.

> T6: I use formative assessment to connect with my students emotionally and academically. My responses to students' contributions also address their emotional needs. That on its own allows my students to better relate with me during lessons. As long as students realize that you care about them as a teacher, they are always willing to go for an extra mile for you, they will complete their work and would never want to disappoint you.

> T1: Assessing students formatively allows me to respond to my learners' needs when it is very necessary and effective. My students are very comfortable with asking for help and unlike when they are assessed otherwise, I am there to offer assistance when it is needed, and this has helped in creating an environment of care, companionship and compassion.

> T2: Students want to do the right thing in class, and formative assessment allows them the chances to correct themselves and experience academic growth under the watch of their teachers. When students know that their teachers care about them and their work they tend to positively respond to learning.

> T3: Formative assessment helps in showing students that you care about their work as it brings in the human connection as you constantly check on students' progress instead of just moving on with the curriculum. This motivates students as they feel secure discuss their grey areas with their teachers.

> T5: My students are always engaged when I assess them using formative assessment because they know that I am always there to facilitate the way they should respond through follow up questions in case they stumble. Learning is not only about lesson delivery and

completion of tasks, empathy and human connection are also very important. Formative assessment has helped me to better understand my students, they yearn to be loved or for us as teachers to show them that we care and would go beyond just teaching. That way they open, and they begin to have positive experiences and perceptions with assessment.

Formative assessment creates conditions for facilitation of learning which encourages student driven learning and research

Teachers agreed that technology has been moving faster than innovation in schools hence if we are not careful our education may soon become obsolete and of no value to life. They mentioned that when students are assessed formatively it allows them to search for knowledge from different sources instead of waiting for their teachers to be the source of all knowledge.

T5: This world requires individuals who should be proactive and when students are assessed formatively, they tend to do most of the research on their own and become better than waiting for teachers to always direct them.

T1: The use of formative assessment has greatly improved my students' analytical skills and autonomous research; I have had several instances where students come to me with some research they will be carrying out on their own and just trying to have my input and feedback on what else they could do.

T6: As a school we are participating in the National Science Fair competitions and the use of formative assessment has greatly assisted my students as they have in many ways as they have demonstrated that they can carry out science fair research projects with or without much input from me as a teacher.

T4: My students are now promising young scientists as they are more independent than my previous students, they are intrinsically motivated to carry out science related research. You can see that they really enjoy working in their different stations to come up with learner-initiated and learner-driven research.

T2: Formative assessment gives me the chance to include technology in the classroom from the learners' perspectives. My students do most of the research online and I only ensure that I direct the way class interactions must take.

Formative assessment creates suitable conditions for cooperative learning

Another element that was agreed upon by teachers was that when students are engaged in assessment for learning they tend to cooperate more with their peers instead of competing. They mentioned that when students are assessed using formative assessment, the classroom becomes more energized and there is improved rapport. Teachers noted that when formative assessment is used in the classroom there is less tension and even fewer or no behavioral challenges as students are more engaged with everyone having a niche in the learning process.

T3: When I use formative assessment, I can place my students in evolving stations where individuals work on concepts in small groups and then split into different groups. This has improved students' cooperation for my classes.

T1: The use of formative assessment creates less conflicts in the classroom as more students are more engaged in their tasks and readily available to work cooperatively with their peers.

T4: The use of formative assessment in my classrooms has made me realize that it is possible to race to the top with every student with no child being left behind. Learners are more patient with each other and would go an extra length to ensure that they provide the necessary support systems for their struggling peers. Formative assessment makes everyone a winner as each student has an equal chance of making their input into their learning processes.

T5: The world would be a better place if formative assessment were to be the main form of assessment in our schools. It lessens the workload for teachers and increases the amount of work students do but with less effort. I would equate formative assessment to how machines work as students work together on a given task with each student making their small contributions that would eventually combine with their peers' small contributions resulting in a mega piece of work. In formative assessment there is cooperation rather than competition, team work rather than conflict, whole class achievement rather than partial achievement. It makes students want to be in school rather than finding ways of dodging school for fear of failure.

T6: I have seen more cooperation than competition when I assign assignments for students work in groups.

Formative assessment encourages students to remain focused on their work

All teachers expressed the view that formative assessment encourages students to work more independently and usually engage in learning activities as individuals and in groups on their own. Teachers also mentioned that formative assessments enable students to stretch their learning horizons beyond their expectations.

> T1: I have noticed that when I use formative assessment more regularly, my students are more independent and infrequently come to me for directions but rather to check on how much they would need to know from their own research.

> T4: With formative assessment I can see my students being proactive in their work, they tend to do most their work during their own time.

> T5: My students have become more focused and are able to go through the scientific methods steps as they work on their own projects. I could not have done this if I had not introduced assessment for learning in my science teaching. The last time I did this with students using summative assessment approach my students were more dependent on me than on themselves.

Formative assessment lets shy students participate in class activities

Teachers revealed that by using formative assessment they were able to improve the general participation of the shy and the withdrawn students. Most teachers felt that formative assessment encouraged such students to have a voice in their learning process thereby increasing their levels of engagement with both their teachers and their peers.

> T3: I equate formative assessment to the life cycle of a butterfly as formative assessment allows the reserved students to find time to come out of their shells like cocoons and blossom as they realize that they are part of the learning community and that their contributions are important.

> T4: It is very encouraging to see my usually withdrawn students being highly engaged in formative assessment. Formative assessment gives them a platform to be part of the class as they express their knowledge.

T2: Formative assessment has allowed me to as a teacher to experience my own ‘aha’ moments by witnessing my very withdrawn students coming out of their cocoons like butterflies. Such moments have always brought about some turning points for my students as they suddenly realize that their peers appreciate and value their contributions.

T1: Formative assessment offers the quiet students some real opportunities for personal growth. It, therefore, helps in organize students to interact.

T6: It is more fun for the kids when they are assessed formatively and allows them to frame their answers in a way more natural to them, that way their assessment ensures that they are no longer withdrawn but involved.

Formative assessment challenges students to use higher order thinking skills

There was consensus among all teacher that the use of formative assessment enables students make use of their higher order thinking skills. Teachers pointed out that when they assess students formatively, they notice that their learners are more engaged and can respond positively and more effectively to higher order thinking questions due to increased learning focused questioning.

T1: I can differentiate my tasks to ensure all students are operating at their level and beyond when I assess my students formatively as I am able to rephrase my questions according to the student’s level of concept mastery.

T5: Since I started using formative assessment even my struggling students are coming up with well thought out answers and questions. My students are more willing to share their thoughts than before.

T3: Since I started using formative assessment even my struggling students are coming up with well thought out answers and questions. There has been an improved rapport in class as every student has something to offer. This has even improved the quality of student discussions in their workstations and smaller groups.

T2: The working models I had from my students were far beyond what I previously had. It shows me that my students are now critical thinkers. They are certainly showing great signs of working outside the box by bringing in clear questions for discussions and engage in prolonged and sustainable discussion with the peers over scientific concepts.

T6: I have come to realize that when I assess my students using formative assessment, they provide well thought out answers and are able to reason more and challenge any answers that may not be very clear to them. Learners are now able to validate their answers by linking their ideas to previous knowledge. This is something that never happened in my previous years of teaching as learners were more passive than active.

Formative assessment encourages students to develop a positive-growth mindset

Teachers agreed that the use of formative assessments makes their students view mistakes as learning opportunities from which they will develop skills that enable them to become systems thinkers who can link past mistakes and learn from there.

T2: The use of formative assessment allows my students to always look back and see the progress they have made from day one. They now value their previous data from past assessments and are always working towards doing better.

T3: My students realize that with formative assessment there are no failures, but we all take away something from the assessment. They take formative assessment as a think win-win situation by combining it with the seven habits of successful teens. Formative assessment is taken as a learning curve where no one gets nothing.

T6: My students always look forward to formative assessment they have no fear or anxiety which comes with assessment as they know that formative assessment is not about finding out what they don't know but it is about expanding on what they already know thus making it a real learning experience.

T1: Formative assessment challenges my students to expand on their pre-existing knowledge hence my students always experience academic growth without dejection from formative assessment. They are more comfortable with it as they have several alternatives to tackle questions and respond to personalized feedback.

T4: When I use formative assessment my students no longer feel anxious and worried but are rather interested in what they will add on to their knowledge from the assessment.

Formative assessment encourages students to learn project management.

Some teachers felt that when they use formative assessments, their students are more likely to be self-directed and be ready for the global creative economy.

T5: The use of formative assessment has allowed my students to think outside the box and come up with real life solutions to their science challenges.

T3: I use formative assessment or assessment for learning to facilitate learning and provide students with the opportunities to judge their own work and learning progress based on feedback to various kinds of teacher-made tests and performance tasks such as student portfolios. This brings a shift in focus from rote learning and the memorization of the content of core subjects to the mastery of higher order thinking skills as well as self-direction skills such as learning how to learn is also driven by the need for 21st century skills, knowledge, and competencies.

T6: My students have developed skills of managing their work more efficiently as they can easily combine the skills, they have acquired to accomplish any project-based work using the scientific methods.

Formative assessment allows for improved and effective differentiated learning

T1: The use of formative assessment encourages me to differentiate instructions and questions to different students according to how exposed learners are and then build from what they know to create something more complex.

T2: I have noticed that each time when I plan and differentiate instruction it would be for a class, but through formative assessment I am able to effectively differentiate learning materials for my different learners to ensure that they all achieve success.

T3: Differentiated instructions and tasks during formative assessment has demonstrated to me that all learners will be able to achieve set objectives as assessment for learning creates an enabling environment where students feel comfortable to participate and air their views.

T5: Formative assessment removes the one size fits all assessment which tends to discourage slow learners. My students show a lot of proficiency from formative assessment as questions and discussions tend to be targeted and specific to individual student needs rather than focusing on the whole class.

4.5: Results from students' focus groups

Focus groups were meant to provide answers to two questions in this study which were about students' experiences and perceptions of formative assessment in their county and how the system could improve their self- regulation in learning science. Data collected from focus groups and other research tools would assist in addressing the questions.

Data were collected from students who formed the focus groups, and this is presented in the sections below. Table 4.6 present the themes that came out from the focus groups with students. For each theme, the coded references and an example is presented. Related responses were used in the creation of common themes for several students.

Most students mentioned that they were comfortable when teachers asked them to present the answers formally rather than when they were asked to write tests. Students reported that science had more to do with thinking and innovation than with taking tests.

Students felt that they benefitted more when they discussed through science challenges and used their skill to carry out experiments or make models of science phenomena. Though students did not know what formative assessment was, they were all able to mention different forms of formative assessment as being their preferred ways through which teachers assess their understanding. Results revealed a lot of student participation in their learning process with multiple interactions among all members of the learning community.

Table 4.6

Focus group views on assessment for learning.

Theme	Coded reference	Example
Games are fun, motivating, and helpful for students	S3, S4, S5, S6, S8, S9, S10, S14, S17, S19, S21, S23, S22, S26, S27, S28, S29, S30, S33, S34, S36, S37, S38, S39, S41, S47, S50	S47: Using games for assessment makes it fun to learn as games bring in joy and relief from pressure.
Short quizzes encourage students to focus on their work	S12, S3, S14, S17, S15, S24, S27, S29, S30, S33, S37 S36, S44, S46, S47, S48, S50, S19, S7, S11, S13	S12: Using the computer to take quiz ensures that I can focus more on my assessment while being able to provide comments and getting feedback from my classmates.
Simulation models are helpful for students	S1, S5, S6, S12, S13, S17, S23, S25, S15, S17, S18, S33, S41, S27, S29, S31, S26, S34, S43,	S31: Simulation models encourages us to be creative and be able to solve scientific challenges in a virtual setting therefore preparing us to be ready for anything that may be presented by the simulation models. It prepares us to be ready for the unexpected.

	S45, S47, S48, S50	
Discussions helps students express themselves and improve their understanding	S19, S37, S6, S9, S40, S30, S32, S35, S36, S37, S39, S20, S29, S18, S17, S24, S27, S11, S19	S4: Discussions allow us to be able to express ourselves verbally for some issues that may prove to be difficult to write. Discussions give us the opportunity to expand and ask teachers to clarify on their questions. Discussions help us to have more understanding just by listening to others discuss. S9: At times teachers will give us more hints on how to come up with solutions when we discuss. We can tell from our teachers' expressions if we are doing the right thing and if we make a mistake, we can easily discuss it and find a solution.
Presentations offer students opportunities to present in front of others and encourage peer learning	S14, S17, S19 S23, S24, S12, S13, S25, S26, S27, S28, S32, S36, S38, S44, S45, S46, S47, S48	S19: It feels good when presenting before the class, we are able to show what we know and share our experiences with others. Presenting findings and experiments allows us to self-assess and get feedback from others.
Projects are a powerful tool for learning	S1, S2, S4, S5, S6, S8, S9 S10, S11. S12, S13, S14, S15, S16,	S35: Projects allows us to implement our thoughts and ideas into reality. It feels good when we make something tangible from ideas and from what we see from books and the internet. It gives us a sense of achievement and

	S17, S19, S20, S21, S23, S24, S30, S31, S32, S33, S34 S35, S39, S42	ownership of our learning process when we are able research into something and find out if we can also prove facts.
Debates are helpful for students	S15, S21, S34, S39, S43, S48, S7, S9, S23, S5, S19, S11, S17, S18, S37, S25, S44, S45, S10	S48: Hearing other people's views that are different from ours creates an environment that challenges us to do a lot of research on our part. It allows us to better understand the topic from different viewpoints.
Station-based learning provides more room for student interaction	S22, S23, S45, S33, S37, S27, S34, S9, S11, S7, S6, S5, S2, S1, S19, S10, S14	S11: I can learn more from my peers when we work in small groups.
Role-plays create conducive environment for formative assessment	S1, S7, S25, S23, S31, S36, S11, S3, S5, S13, S31, S46, S47, S48, S49, S50	S1: When my teacher uses role-play to assess us it provides me with the means to think quickly just from observing and listening to my peers' lines of thought.

Lesson starters are important in motivating students	S2, S3, S5, S6, S7, S8, S9, S11, S18, S29, S22, S23, S37, S38, S39, S40, S45, S46, S49, S50	S11: The way my science teacher starts our lessons is just different from others. It makes me get excited and be ready for more.
Sitting arrangement in the science classroom is important	S49, S43, S39, S33, S28, S4, S9, S27, S26, S32, S16, S5, S3, S7, S22, S38, S45	S49: The position I sit in my science classroom is suitable for my learning progress.
Sharing learning objectives and success criteria is valued	S13, S23, S27, S42, S11, S14, S15, S17, S41, S44, S29, S30, S34, S47	S41: It is always good to know where we go, how we are going to the destination. When my teacher shares with us lesson objectives and come up with a criterion for success it makes me feel more comfortable to learn knowing that there are no surprises.
Linking prior knowledge with learning objectives is important for students	S3, S5, S7, S19, S36, S38, S44, S46, S47, S48, S49	S19: It always feels good when one realizes that the learning objectives are in line with what I already. At least I have somewhere to start from for my lessons.

Individual feedback is valued by students	S7, S8, S10, S13, S14, S21, S24, S25, S6, S39, S40, S41, S44	S21: When I get feedback that is directed towards my contributions it makes me be able to either readjust or probe my teacher to allow me to gain more knowledge.
Students enjoy working autonomously	S9, S12, S13, S15, S17, S18, S24, S38, S40, S44, S47, S42, S49	S24: I get to learn more and understand better when I work alone and self-correct.
The use of success criteria encourages students to be innovative	S1, S2, S9, S12, S24, S33, S39, S29, S27, S26, S23, S22, S14	S39: When my teacher shares success criteria I am able to see how others have accomplished something before and I can then be able to come up with my own ways.
Peer collaboration is valued	S17, S14, S31, S3, S19, S18, S47, S12, S13, S7, S5, S2, S47, S49, S30, S11, S22.	S19: I get to learn more from my peers when the teacher gives us time to collaborate during classes.
Success in individual work is effective	S3, S7, S9, S23, S24, S26, S27, S29, S36, S41	S41: I am so elated when I am successful in a task that I work on as an individual

The use of 3D models promotes innovation	S4, S7, S17, S1, S34, S10, S23, S29, S41, S44 S24, S35, S37, S39, S46, S33	S4: It is so fulfilling when I watch a model that I would have designed working as normal.
Students are sensitive to teachers' actions	S50, S13, S31, S46, S37, S11, S8, S49, S43, S37, S40, S39, S41, S33, S32	S37: I feel that my teacher does not really give me feedback like she does with other students.
Students are sensitive to grades	S1, S3, S4, S5, S7, S9, S12, S13, S14, S15, S18, S20, S22, S28, S29, S32, S36, S37, S40, S47	S1: Knowing that I will be assessed formatively greatly helps me to stay calm, I have no fear of being picked upon by my peers.

Games are fun, motivating and helpful for students

Students reported that they enjoyed being assessed through games as it brought in fun into their learning process. Students felt that when learning involves some play it becomes more appealing for them, and they would always look forward to it.

> S37: Using games for assessment makes it fun to learn as games brings joy and relief from pressure.

S38: Playing games a part of learning has changed my whole perception about science, I now love what I learn as learning has become so fun.

S5: My science teacher has brought in something that I was really missing; I love games and when assessment is made through games I become so involved.

S8: I always feel like time is not enough during science as games make learning so fun and fast paced. I enjoy using games to solve my challenges.

S9: Games have made it much easier to concentrate during my science classes as there is no more room for boredom.

S10: I find it easier to balance chemical equation when the teacher uses games as I relate easily with games, and it helps me to learn and enjoy at the same time.

S50: Some games require that I use critical thinking to continue to the next stage. Such games challenge me to think critically as failure to do so would mean that I remain at lower stages. I feel empowered when I have to search for certain concepts outside of the game and find them before I can resume my game.

S39: While I enjoy playing science-based games, I am elated to know that these games are not only for my learning, but they involve a lot of excitement especially when I complete the game in record time an earn virtual points.

S21: Games are a way of relaxing while remaining engaged to my learning. I enjoy playing experiment games against the computer and even against my peers. The feedback I get from the computer after failing to solve a chemical equation is also very good as it offers me another learning platform.

S17: I always wonder why the use of games was never tried when I was in lower grades maybe I could have progressed so well and so fast as games make learning easier and student friendly.

S14: I now believe my teacher when she says learning science is fun especially when we use games for assessment. Using games for assessment has made me realize that I am good in my science.

S19: Games help me to understand what I learn as the games brings in fun, learning should bring more fun as I tend to remember more when I have fun during my learning.

S22: Using games for assessment is awesome it makes me enjoy preparing for my assessment without stressing. At times I even sleep very late without feeling tired as I enjoy playing the science assessment games.

S26: I don't know if I could have understood how to analyze and synthesize balanced ecosystems had it not been for games. The concepts seemed very abstract for me but thanks to games and simulations I am now able to create my own online games on ecosystems.

S28: I thank my teacher for introducing games in assessment I never imagined that learning would be so relaxing. I no longer stress because of fear of failing.

S30: I used to get distracted so easily during my science lessons but, now I focus more as I don't want to struggle with otherwise interesting assessment games if I do not pay adequate attention to instructions.

S41: Games have a universal language I no longer struggle with understanding what I read and do in science when we use games. Games have been helpful in my language development.

S6: The use of games has really helped me to understand the topic of balancing chemical equations. Games have been helpful to me as this has brought some connection between what I enjoy and what I learn. For me the use of games has really transformed the way I understand science.

S3: I started liking science in 7th grade because my teacher makes us use some games to learn. The games are full of fun, and they make my learning so easy because they explain my errors with fun, and I always want to learn that way.

Short quizzes encourage students to focus on their work

The use of short quizzes by teachers to assess their students formatively was mentioned as another form of assessment that encouraged students to be more focused on their work. Students mentioned that short quizzes were less stressful and allowed them to be focus more on their tasks.

S3: Using the computer to take quiz ensures that I can focus more on my assessment while being able to provide comments and get feedback from my peers.

S7: Short quizzes are easier to handle for me as the questions are unambiguous. Short quizzes require short answers which makes it easier for me to expand from my own answers.

S11: I prefer short quizzes as they are relevant to our End of Grade (EOGs) tests. They help in preparing me for the tests because I can practice on how to come up with answers with the assistance of my peers.

S15: Short quizzes help me to be more focused and when I struggle to understand, some online short quizzes are structured differently but they convey the same concept which helps me to re-focus when I am lost.

S17: When I take quiz online, I feel that I learn more as I can see how I respond in relation to my classmates after posting my answers. I like the way my classmates' comment on the answers that we may have provided differently.

S27: When I take short quizzes on the computer, I find it easier to concentrate as I do not have to read long passages before answering. I struggle more when the quiz is too long.

S29: The use of short quizzes gives us more time to collaborate with our peers and discuss how some answers we would have come up with were different. Short quizzes help me to reconcile what I know with what my peers know.

S30: Online short quizzes are helpful, and I can even follow on what my peers will be doing in class even if I am on asynchronous learning. This is because we can choose to connect on the same quiz at the same time.

S33: I can explain with details how I solve my problems in short quizzes to my friends, but I do not seem to do the same for my written assessments. Short quizzes make me to be focused.

S13: The quiz I have on quizziz.com and Kahoot.com are always linked to a particular topic so this helps me prepare for specific topics that I may be struggling with little stress as most questions are short, keeping me focused.

S19: I like the way I get comments and solutions to my mistakes from taking quiz on ixl.com it becomes more like I am learning as I can interact with the computer.

S44: Timed short quizzes are very helpful when I must prepare for tests. They are quick and they teach me how to manage my time. Working on timed quiz while demanding has always been my way of practicing for time assessments.

S48: Questions on short quizzes are usually short and are structured in a language that is simple for me to understand. I also like the feedback that I get for my short quizzes especially from ixl.com.

Simulation models are helpful for students

There was an overwhelming response from students about how they positively felt with regards to simulation models. Students mentioned that they were more engaged when they worked on simulation models.

S43: I can solve most of my science challenges very easily when the teachers allow us to work on simulation models, it feels like it is easier for me to input all the points and facts into the computer and create the simulations. This is not that easy when I am told to write about it in a test. I just do not know what happens, I will know the answers but the same does not come out of my pen.

S26: When I make simulation models, I use my own understanding of the concepts and bring it to virtual reality. It encourages me when I change some variables and then see how other dependent variables are affected.

S5: Simulation models helps me to understand abstract concepts as I can use the models to bring in some realism into my science.

S6: When I use simulation models everything becomes so easy to grasp, I even feel that whenever I use simulation models my understanding of the concepts becomes enriched and deeper.

S12: Simulation models have helped me to understand virtual things as I cannot have access to all things in real life. Using simulation models has greatly helped me to understand cell mitosis and cell meiosis.

S17: Everything has gone digital and computerized therefore, when I use simulation models it makes me feel that science is preparing me for the present and the future. It makes me feel confident of myself as I can simulate events that are likely to take place in the real world and then create my own solutions to solve the foreseeable problems.

S23: Dealing with computer-based simulation models has been helpful for me as this creates certain situations that I may not envision on my own. It therefore challenges me to reason and think beyond the horizon, indeed simulation models are highly thought provocative on my part.

S25: I have enjoyed simulation models and find them very helpful for me. I worked on a simulation model on the preparation and mitigation measures for wildfires and it helped me understand why we need to respond to early warning systems as there is a very short window of escape once the fire has started.

S34: It is the reality-like situation that is brought about by simulation models which has taught about being critical with anything I have to say or do before I implement it. Simulation models have helped me in understanding the need to look at alternatives before I commit myself to any answer. The what if questions that are generated by simulation models have greatly affected my way of thinking. I can now plan before acting.

S41: Simulation models have been helpful for me as they create a virtual reality which makes learning more meaningful. With simulation models it is easier to recreate reality or to create likely situations that may result from our actions.

S29: I see the real meaning of learning science when we use simulation models, it helps me to be able to plan with greater precision.

S18: Learning science becomes a real joy when we use simulation models. Some things are better understood when you simulate them. I can manipulate variables and find out how independent and dependent variables interact. I would not have fully comprehended the scientific theory just by reading but when my teacher introduced us to simulation models everything seemed to have been revealed to me.

S15: Dealing with simulation models has helped me to confront my fears as I have come to realize that there are several ways of surviving under difficult conditions when there is a man-made natural disaster.

S47: The use of simulation models allows me to safely experiment with material that would otherwise be dangerous to use in real life situations therefore helping me to plan a safe experiment.

S50: Simulations help me to prepare for the digital world where most things are becoming virtual. Simulation models were so helpful during the lockdown period as I always felt somehow connected to my laboratory at school.

S48: I feel safe carrying out experiments with simulation models as I do not have to deal with the fear of accidents in the lab.

S1: Simulation models have helped me to appreciate why the world needs technology and satellites in particular, as data captured from space can be very useful in saving lives and property on the earth surface.

S17: I and my peers worked on simulation models to simulate the effects of pollution on ecosystems, and it greatly helped me understand some concepts such as loss of biodiversity, ecological niches, predators and prey as well as the importance of keystone species.

S45: The topic of climate change and global warming never made sense to me until after I began to use simulation models to see what would happen to some coastal areas with increased temperatures and greenhouse gases. Simulation modelling has made me understand some concepts which used to appear very difficult.

Discussions help students express themselves and improve their understanding.

Students also mentioned that whenever they had class discussions with their teachers controlling and giving every student a chance to air their views, they were better able to comprehend and master the concepts. Students reported that it was even more to their advantage when their discussions were linked to the learning objectives and success criteria as some students would explain some concepts in ways, they would better understand than when their teachers explained.

Some students believed that when they had discussions they were encouraged as they would contribute to the discussions thereby improving their own understanding of the concepts.

> S40: Discussions allow us to be able to express our views verbally for some issues that may prove to be difficult to write. Discussions give us the opportunity to expand and to ask teachers to clarify on their questions. Discussions helps me to have deeper understanding just by listening to others discuss.

> S37: I like discussions as they offer me an opportunity to take notes from my peers and to appreciate why we always see things from different perspectives, this helps me to have clearer and deeper understanding of concepts.

> S24: It is through discussions that I am able to seek more clarity from both my peers and my teacher on anything that I would be failing to understand. Above all, discussions remove the pressure associated with trying to do everything as an individual. I can always benefit from discussions as feedback comes from multiple sources.

> S17: While some students tend to be very dominating during discussions, I feel like my teacher always ensure that before someone speaks multiple times everyone else has been given the chance to air their views. Discussions have been helpful for they have taught me to value other people’s views.

S35: Discussion during our science classes have taught me to be a good listener, previously I cared less about my listening skills, and it has been costing me valuable points and ideas from my classmates.

S29: I can explore a topic further during a discussion than I would on my own. I also hardly forget what I learn from a discussion.

S20: Discussions make it easier for me to understand when I revise through my work individually away from the classroom. I kind of start hearing my peers' points and easily relate with these imbedded voices as I revise through my work. It allows me to reflect on previous discussions and even come up with new ideas. Ideas I get through discussions rarely fade away.

S19: At times teachers give us more hints on how to come up with solutions when we discuss. We can tell from our teacher's expressions if we are doing the right thing and if we are making mistakes, we can easily discuss it and find a solution.

S11: I am more likely to learn and gain from discussions as I am not only receiving information from one side, but I also can process the information and respond.

S27: Discussion help me in gaining some interest in the topic and thereafter I become more engaged resulting in getting more information than without discussions.

S30: I can follow up with any grey areas when we discuss than when I am just listening. Discussions are essential for me as they make me feel that I am involved in my learning.

S39: Discussions helps me to learn how to listen to others, to challenge others' thinking as they explain and defend their reasoning. Through discussions I learn to respect others' opinions, wait their turn, and remain open-minded in the face of new evidence.

S18: I feel like discussions in the classroom removes the abstract from my lessons and merge this with reality. I can easily follow discussions and make my contributions, sometimes I make mistakes and my classmates also make mistakes, then comes a time that someone brings in something new and different which make us realize and correct our own misconceptions.

S6: Discussions makes learning to become a familiar thing as we will learn the way we do things in real life. You are not faced with a set of questions from nowhere. It makes learning science become real because if I do not understand a question, I ask other students and my teacher so that I understand better.

Presentations offer students opportunities to present in front of others and encourage peer learning

Getting people to stand in front of others is not always an easy thing to do. However, when students present their work to their peers, they are more relaxed and ready to showcase their findings. Presentation skills are necessary in life as they prepare learners to be articulate and confident before other people. Students mentioned that they are more comfortable with presentations of their findings from experiments and benefit from their peer presentations.

S17: It feels good to when presenting before the class, as we can show what we know and share our experiences with others. Presenting finding from experiments allows us to self-assess ourselves and get feedback from others.

S24: I have always had a phobia of standing in front of others and have all eyes on me. I would rather not stand up and present in the past, but formative assessment has given me the courage to be able to stand up and confidently present my work without fear of being ridiculed by others as my classmates appreciate everyone's contribution.

S27: I have come to realize that I gain more by making my presentations before my station and my class as the feedback I get always assist me in improving on my work.

S28: Presentations have helped me a lot because when I feel like I am stuck on a point my peers' body language and contributions have always come in handy for me as they give me hints on how to proceed.

S32: Presentations have made me realize the leader in me. I never knew that I could do a presentation before for I always self-pitted myself, little did I know was doing myself a disservice. Through presentations I have become confident and can articulate issues without any stage fright before my class or in front of the whole school.

S47: Watching teachers present lessons and doing nothing but listen has been a boring school experience. Now that we have a chance to make our own presentations to the class, I make sure that I stay alert and do extra research on any presentations that other students will be presenting. That way I now feel that I belong to my class.

S48: Class presentations have increased my lesson preparedness as I make sure that I am well versed with the topics to be presented by other students lest I have no contributions to make.

S36: Presentations help me in taking control of my learning from preparation delivery and self-reflection. It helps a lot in building myself confidence.

S26: I used to struggle with my communication skills but presentations before the class and my peers helped me a lot with my communication skills. I can now stand up and present yet in the past I would rather find an excuse so that I would not do it.

S38: Presentations in class helps me with being ready to meet and discuss with some people with whom I rarely talk to. I start by being uneasy but by the time I finish I would be settled.

S46: Presentations have been a powerful learning tool for me as they require me to be a critical thinker who must be very fast in identifying gaps in my own understanding or where some information could have been presented differently. I can use presentations to self-assess myself and peer assess as others present.

S37: Presentations offer me a rare opportunity of being able to stand in front of others and confront my stage fear. It creates a leader in me and whenever I must present, I prepare myself intensively through research that way I am more enriched. I also feel good when others ask questions about my presentations, and I can answer them.

Projects are a powerful tool for learning

When assessment for learning is done using projects students are more engaged and there is greater self-regulation and autonomy. Students reported that working on projects allows them to work independently and with minimal teacher input. They also mentioned that when teachers provide rubrics it becomes more convenient for them to come up with original ideas for their projects.

S39: Projects allows us to implement our thoughts and ideas into reality. It feels good when you make something tangible from ideas and from what we read from books and from internet. It gives us a sense of achievement and ownership of our learning process when we can research into something and find out if we can also prove facts.

S10: I can easily relate to projects than I would do from just reading, listening and from experiments. Projects enable me to have the hands-on experience with my learning.

S19: Using projects for assessment has helped me to appreciate the use of success criteria. In the past I would try out projects with very little success because I did not use the template properly, now I can work on my projects with ease and enjoy every step of it due to the use of success criteria.

S12: The use of projects in my science has helped me to ask questions as to why certain things happen instead of focusing on what things are. I think projects are making me see things differently.

S11: I find pride in myself when I complete a project as working on projects always encourages me to apply creative thinking skills to innovate new product designs which are mostly imaginative.

S13: I have used the projects I work on to deepen my knowledge about the topic and I always remember the details of my projects more than I remember the things I do in class.

S20: I used to think that projects were a waste of time as it appeared to me that the projects that were shown or displayed for 7th grade were always the same. However, I now understand that project allow me to learn ahead and revise what I have already learnt while completing my projects. I can now test my hypotheses from projects.

S2: When I successfully complete my project, I usually ask my peers to give me feedback on what I could have missed or if they have any ideas about how my project could have been done differently. I use they input to reflect on my work and celebrate when I eventually finish the project as this becomes my source of motivation and inspiration.

S33: I am now able to work independently when I do projects as my teacher allows us to choose from any science topic in the curriculum to develop a project topic and then follow through all the stages.

S24: Working with projects is fun it teaches me how to manage obstacles more effectively, often learning from failure and adjusting until I am satisfied with my work.

S32: Projects offer me a safe way of carrying out experiments as I do a lot of reading about what I need to work on before I can engage in experiments.

S31: I can now understand my curriculum pathways through projects as we must choose our topics from the North Carolina 7th grade essential standards. That way I am now able to know which topics we cover during the year.

S16: Projects are more realistic, they remove the abstract from my science, hence I can understand complex scientific concepts from my own reasoning. I am better positioned to discuss with my peers and my teacher when I work through projects.

Debates are helpful for students

Students expressed their opinions about how helpful debates were in comprehending and understanding concepts as well as how they could be able to look at a topic from more than one perspective. Data from watching teachers and students conducting assessment for learning using class debate on whether global warming and climate change were scientific facts of science fiction. Students were working in two groups which had culminated from workstations where each station had studied through the topics on different days. Whenever the rapporteurs were debating other team members were noting down facts and researching on facts given as they prepared to defend and refute points from the opposing group. There was total engagement of all students during the debate. After the debate both teachers and students felt that they had benefitted more from the assessment as it challenged them to research on new data and allowed them to work cooperatively with other team members.

Students demonstrated a lot of critical thinking from the way they would analyze data from their peers. Students' reactions to how they felt when debate was used as a way of assessment showed that they were able to be critical of scientific data.

> S34: I like the way I learn when learning involves debates because in most scientific innovations there is always the alternative. I tend to do better when I can look at science questions from more than one side.
>
> S39: Listening to my peers, debate has always offered me an extra learning opportunity as some of the points they bring would be new to me. Debates have always challenged me to read widely which has greatly helped me in the way I prepare myself for science
>
> S37: Hearing other people's views that are different from ours creates an environment that challenges us to do a lot of research on our part. It allows us to better understand the topic from different viewpoints.

S15: Debates always bring the best of me for when I prepare for a debate, I make sure that I always think outside the box. Debates challenge me to look for answers from a wide range of sources, those in support, those against and from the fence sitters' point of views.

S21: I benefit from debates because I can assess the points that are presented by my peers, and I can then make an informed decision.

S7: When we debate, I feel that the teacher really meets us at where we are and I can explain concepts such as global warming from reality, from my daily experiences and not from the computer.

S9: Debates have assisted me to be able to listen to one than one opinion before I can make my own decision. In a similar way I no longer rush through my multiple tests as I use the skills, I have learnt from debates to find the most suitable link between the question and the choice of answers.

S43: Taking part in my science class debates has shown me that although many aspects of life are about competition, they are also about compromise and cooperation. I have learnt to see things from different angles and to compromise when things do not go my way with my friends.

S11: My science class debates have helped me to realize that I can say more with a few words. This has really assisted me with sharpening my communication skills.

S44: I like debates because they teach me to listen to others, give them a chance to speak without interrupting them and then respectfully agree or disagree with the way they articulate things.

S17: Through debates I learnt to be a more critical thinker, I always research on a topic and put myself in the shoes of the opposing side then imagine what the other side would say. That way I am able to do a lot more research about a topic.

S25: Debates have always made me know more about a topic from different views and even what other people overseas feel and do about such topics as climate change. Debates are also helpful in conflict resolution as they allow us to delay judgement.

S23: For a change, being assessed through debates, brings in the real link between our lives and what we are learning if all assessment were like this, we would never fail.

S5: Debates help me never to take things at their face value as in most cases when my peers debate, I always took sides quickly without listening to the other side.

S19: Debates help me in my day-to-day life as I have learnt to listen first before I can be heard. The debates we have in science helped me a lot in my English Language Arts.

S10: When we are assessed using debates it removes the spirit of selfishness and replaces it with cooperation. I like the fact that I collaborate with others to come up with points and responses to those on the other side.

Station-based learning provides more room for students' interaction.

Students reported that interaction among their classmates is greatly improved when they work in smaller stations. Most students stated that they are offered more chances to contribute to their group tasks when they have smaller stations which are rotational.

S10: I can learn more from my peers when we work in smaller stations as we are not hurried. There is always enough time for everyone to contribute before we transition to the next station.

S14: I get more help from workstations than I would from bigger groups as the teacher allows us to transition from one station to another. Therefore, I have multiple support systems from my peers whenever I do not understand.

S1: My teacher is always available to attend to any disagreements in our workstations and this is more helpful as we can get more specific feedback on concepts where we would have disagreed.

S9: Workstations increase the number of peers I interact with during the lesson and that way I can stay focused as the lesson is never boring.

S22: Workstations has taught us to be more independent as we are able to interact with our peers and follow the success criteria to complete our tasks. The teacher does not have to control our every activity and it good when we successfully complete our tasks as we always celebrate together.

S33: Workstation are helpful in time management as we are given a specific number of minutes to be in one station. This helps us a lot even in my own time management outside of the science laboratory.

S34: The use of workstations has helped me catch-up with my classmates in science as I can easily understand concepts when they are explained to me by my classmates in workstations. Over and above my classmates are always patience and wait for me to complete my sentences without interrupting me.

S45: The fact that I can work with different people in the same classroom in different workstations in a day brightens up my day as I always learn something new or something different individuals in the classroom

S37: Workstations have taught us the importance of following specific directions as there are times, we tried shortcuts and could never be able to find solutions to challenges.

S48: I have learnt to respect our differences and appreciate that there are some classmates whom I would not interact with under normal circumstances, but in workstations I have been able to interact with almost everyone in my class.

S27: I like stations especially when I remain in a station where I become the team expert after having gained extra experience from other in-transit station members.

Role-plays create conducive environment for formative assessment

Another way that students reported as having been helpful to them was when they were assessed using role-play. Just like debates students reported that role-plays gave them the chance to put themselves into other people's shoes to be able to solve scientific challenges.

S1: When my teacher uses role-play to assess us, it provides me with the means to think quickly just from observing and listening to my peers' line of thought.

S18: Roles plays always gives me the opportunity to see things from someone else's point of view and this has helped me better understand and appreciate the value of diversity.

S23: I began to understand the impacts of global warming and climate change more, after I had role-played as an Islander whose land was under the threat of flooding. Role-play made me to respect my environment.

S3: Role play has taught me to be able to pursue others' perceptive into my line of thought. This has also helped in my persuasive writing skills. By putting myself into someone else position through role-play I believe I am able to make decisions about certain challenges facing the class.

S11: Sometimes role-plays make me very uncomfortable especially if I am given a role of someone who does things, the way I do not like. I remember one role-play where I was roleplaying that there was no global warming and climate change. It made me feel like I was acting against my conscience.

S13: Role-plays enables me to be creative as certain things involved in role-play demand quick problem solving. This has taught me to be a quick thinker.

S41: I become very imaginative when we have role-play, there are certain things that come into my mind during role-play, which I could not have imagined without role-play

S46: Role-play makes learning very fun, and I tend to benefit a lot from them as we always have them in a relaxed environment. I do not feel any pressure, yet I somehow remember everything from role-play even after a long time. I can personify certain roles with my classmates and that makes me feel like it was real.

S31: I am better prepared and more motivated for assessment when we use role-play because what other people say will always help me in coming up with alternatives or supporting ideas.

S50: Role-plays for me are an extension of debate and they energize me as I can act in different roles to solve scientific problems.

Lesson starters are important in motivating students

Most students were engaged in the introductory phases of the lessons with most teachers linking their lesson objectives and success criteria to their previous lessons. In all cases students were able to explain how to complete their daily tasks using the Success criteria. While most of the times teachers were initiating discussions through questions and lesson starters, in a few instances students would initiate discussions based on previous lessons and prior knowledge. In one of the lessons students introduced the lesson from the topic and generated lesson questions for each other while the teacher was facilitating the discussions. Data from the students showed that they enjoyed lessons that were started in unique ways by their teachers.

> S37: I like it when my teacher starts the lesson with fun or something interesting, this allows me to refocus from what I would have learnt from other classes and be ready for science.
>
> S2: Lesson starters in settling down and be better prepared for the lesson. I always look forward to lesson starters as they prepare me for the real lesson.
>
> S5: I value lesson starters because they are always simple to understand and no one fails them, they make our lessons more interesting.
>
> S6: Sometime my teacher uses lesson starters from our previous lessons, and this helps me a lot in remembering some concepts that I could have missed and linking them up with what we would learn on the particular day.
>
> S34: When I am disinterested and disengaged on that day, lesson starters have a way of turning me on and I suddenly want to know what comes thereafter. Lesson starters have

thus been helpful for me as I become engaged and forget about anything that would have been bothering me.

S48: I find some lesson starters so engaging and involving especially when my teacher uses word search for vocabulary of the concepts we would be learning.

S22: When my teacher uses games and lesson starters such as videos and short games it motivates me and makes me feel like science is incredible.

S27: Lesson starters are refreshing they help me refresh my mind from the stress of the other subject and prepare my mind to learn something different.

S45: I become more engaged in my lessons when my teacher introduces the lesson in a variety of ways. It makes me feel that the lesson coming will also be unique from the others.

S49: When my teacher plays music for a lesson starter all the noise just dies down and everyone listens without anyone shouting or yelling for us to be quiet. I think lesson start are very good to prepare us for the actual learning.

S50: It is always good to start our lessons with something a bit different from the topic, at least it creates a more relaxed environment where I can adjust and be ready to learn

Sitting arrangement in the science classroom is important

The physical configuration of a classroom is more than an organizational or stylistic choice by the instructor. In-person classroom seating arrangements affect student learning, motivation, participation, and teacher-student and student-student relationships (Fernandes, et al., 2011). In the virtual classroom space, such as real-time platforms like Zoom, instructional choices to employ engagement strategies and provide opportunities for feedback also have a positive impact on student learning outcomes (Francescucci and Rohani, 2019). Another concept that came up from the focus group was that students were sensitive to their sitting arrangements in the classroom. Students reported that there some sections of the classroom that they would avoid if they needed to focus more on their progress. Some students were, however, more likely to seat in seating positions that their teachers were more likely to ask them to move especially where there were high chances of peer distractions.

> S9: I do not feel comfortable when I am assigned a seat too close to the window as this distracts me. I always prefer sitting next to the teacher's desk towards the front.

> S4: I become so distracted when I sit next to my friends, and I prefer working with people who are not noisy and are more interactive when we do group work.

> S13: I do not like the row and column sitting arrangement as it makes me feel like we are being graded or are seated according to grades. I prefer sitting in small group settings.

> S19: When I seat in larger groups, I easily lose focus and at times my opinions are not taken onboard by those who are loud to be heard.

> S23: I tend to pay more attention and focus on my learning when our sitting arrangements are either roundtable or semi-circle as this makes me feel equity as no one is seated either too far away or too close to the teacher's desk.

> S24: Sitting with my friends makes me more comfortable to contribute than when I seat with other classmates. My friends will always accommodate me when I am a bit lost without ridiculing me.

S5: I tend to feel empowered, respected, and free when I am allowed to have the freedom to choose where I want to sit in the classroom. That way I am responsible and accountable to myself. It is very disturbing when teachers force us to sit according to what they want in a free world.

S3: Sitting according to a set plan makes me feel like I have no choice to decide, but when I sit in a position that I want I feel comfortable, and this prepares me for life as I must make choices out my free-will.

S7: I prefer classroom that are not crowded where I have space enough for me to stand up and stretch without disturbing others.

S22: I am very sensitive to who sits next to me as some people make learning more interesting while others make learning very difficult due to disruptions and distractions, they bring with them.

S28: My sitting position affects the way I learn and sitting further away from the front is good for me because I can work more independently and when I need help my teacher can always come to assist me.

Sharing learning objectives and success criteria is valued by students

Data from the focus group showed that students felt involved from the onset of the lesson through the sharing of learning objectives and the criteria for success. Students felt that it was important for them when their teachers explained to them what and how they were going to learn for the day.

S13: I feel empowered and involved when start our lessons by going through the topic, the ‘I can’ or learning objectives and the success criteria before the we start the lesson.

S11: When I work with learning objectives and success criteria it is easy for me to reflect on every step, I make in the learning process and identify where things are off track and be able to adjust my trajectory thus enabling me to be more confident in my science.

S14: I feel challenged appropriately and made ready for the lesson when my teacher informs us the direction the lesson is taking.

S15: When success criteria are shared at the beginning of the lesson it helps me to link feedback from both my teacher and my peers to the same success criteria and adjust my thinking accordingly.

S17: Success criteria helps me to know the basics and thereafter I push myself to go beyond good towards producing the best for myself while always referring to the benchmark set by the success criteria

S41: It is always good to know where we go, how we are going to the destination. When my teacher shares with us lesson objectives and come up with a criterion for success it makes me feel more comfortable to learn knowing that there are no surprises.

S44: When my teacher shares the criteria for success before the lesson it helps me realize that I am the owner of the lesson together with my teacher. I am no longer taken as if I should know how things are supposed to come into place. It is like playing a game. How can one play a game without knowing its rules?

S29: By having the success criteria before the lesson it helps me have the necessary tools for my own success as the name says. I would not fear any failure as I will be equipped with the necessary tools for my own success.

S34: Learning objectives and success criteria have been very helpful for me especially after missing a lesson during the pandemic it became my go to reference point as I could follow up on what could have been covered in my absence and be able to catch up with the rest with minimal or no help. I wish these could be done in all subject areas.

S30: It is very frustrating when I do not know where I am supposed to go and how I am supposed to get there. It is like going on an adventure without knowing what and where you are going to. I tend to do better in my assessments for all topics where my teacher shares the criteria for success than for those topics my teacher does not share.

S27: 'When my teacher shares the learning objectives, I feel very honored, and it is like the teacher makes me the center of my learning universe. My science teacher makes me feel involved from the start, so it becomes my personal business'.

Linking prior knowledge with learning objectives is important for students

Every student wants to be successful, and their learning becomes more engaging when teachers link some learning objectives to things that students know already. Prior experience can be a platform from which new concepts may be developed. Many students in the focus groups revealed that they find the lessons making more meaning if they can connect with some of the objectives to things that they may have experienced or those that they have some prior knowledge of.

S3: It is very frustrating when my teacher starts teaching me something that I have no idea about, the situations is even worse when no one else knows anything about the topic. When I have an idea about the topic, I become more engaged.

S5: When I learn something that is related to what I already know it becomes easier for me to link up the different pieces like a jig-saw puzzle to come up with the final product. Learning becomes more interesting when I can build from what I already know.

S7: I always build on what I already know when new concepts are introduced, and this makes it easy from me to connect different aspects of the topic and be able to understand things that will be new.

S19: When something new is introduced and I happen to know something about the topic I can easily integrate knowledge from my past experiences to understand relations between concepts and create new meanings using the success criteria.

S36: It is usually easier to understand a topic if I have done something similar before or when I had some previous experience about a similar concept. It motivates me to learn more about the topic by linking things together.

S48: I can engage with my teacher and my peers when I have some prior knowledge about a new topic. This helps me in expanding my knowledge in a better way than if I had no idea about the topic. Prior knowledge has been helpful to me because I will not feel lost, and I can even share some of my prior knowledge with my peers.

S16: Without prior knowledge of the concepts, I learn I struggle with almost everything, Prior knowledge lets me make sense out of what I will be learning.

S47: Having an idea about the learning objective makes me feel that I am good at what I am learning and will be ready for more challenging things.

S37: It is always good to have someone with some prior knowledge about things we learn in the classroom as the lesson will not become dull with the teacher telling us everything. Even when we carry out some of our research it is always easier to start from what we know than to start without knowing anything.

S44: My previous experience with science topics may not the best as I came from a different place, but I find learning new things easier if my peers share with me their experiences from their previous knowledge. Getting some tips from peers is much easier for me than getting the same from the teacher.

S45: Just like when going on a trip, one needs to know where they are going, how far the place is, the cost of the trip and other things. I feel the same when learning objectives look familiar as this makes me want to know more about the topic as I would relate to something familiar.

Individual feedback is valued by students

Data showed that students valued feedback from both their teachers and their peers. Students reported that there is always a lot to learn and to take away from feedback. Student showed that they were responsive to feedback. Besides attaching value to feedback from the learning community it was also evident that students were very sensitive to feedback.

S6: It is always a good idea to listen to what others have to say about one's work. That way I am able to pick the positives and encourage myself and to note the negatives and challenge myself.

S7: When my teacher gives me feedback and link the feedback to the success criteria and learning objectives it helps me to know where I should put extra effort and where I would be doing well.

S8: I am sensitive to feedback provided by my teacher. I always make sure I follow up on my teacher's feedback before I proceed with my work.

S10: At times I feel embarrassed when I get negative feedback from my peers especially about my science work. It is like some of my peers are only ready to offer their feedback when they realize that I would have made errors in my work. At times it makes me shy away from presenting my work in class.

S14: It is feedback from my peers and my teacher that powers my will to learn. When feedback is positive it motivates me, and I feel that I would have accomplished something. However, when feedback is negative or does not feel like inspiring, I do not give up. I seek help from others especially from the givers of such feedback as a way of learning how I could do my work differently.

S21: Feedback from my peers and my teacher helps me as a pointer towards things that I could have done differently. I take feedback as a learning curve. The more feedback I get the better I learn.

S24: By listening to feedback, I get from class I have been able to improve my performance, so I take time to listen to feedback. It also helps me when I self-assess my work. I like the way my class offer feedback as they do not say one is wrong, but they usually make suggestions on how one could have covered a certain concept.

S41: While not all feedback is sweet news to my ears, I have learnt that by taking some notes from the feedback I receive I always come out better the next time I do my work. For me feedback is like a compass that shows whether I am doing things right or otherwise.

S44: When my teacher and my peers give me feedback, I can quickly identify where I have done well and where I could have done better, that way I can direct my energies towards where I will be struggling and improve my work.

S39: I take feedback like advice it is only those who have no direction in life who will ignore advice. Feedback from my teacher is instant and always encourages me.

S42: Unlike feedback that is written to me after a test, the feedback I get during class activities is often more effective since I will realize where I would have made a mistake and self-correct it.

Students enjoy working autonomously

Most students reported that they enjoyed being independent when they research and prepare for their science lessons. Results from the focus group also showed that more students felt motivated when they work alone and receive feedback from their teachers for their individual efforts. Students felt that they benefitted more from autonomous learning as they had more control on what they were doing which made them feel that they were not passive recipients of knowledge but rather builders of their own knowledge.

It was a clear sign that students need to do more work on their own than from teacher led activities. Most students yearn for some level of independence in their day-to-day activities. While students gave a variety of reasons for wanting to work individually one can sum it up by saying individual work leads to academic growth while at the same time ensuring that all students' needs are taken onboard.

S9: Working alone allows me to work at my own pace, I do not feel any pressure from others where I face difficulties, I have all the time to myself to find a solution.

S12: When my teacher assigns me individual work, I begin to see things differently and this challenges me to think deeply and in many cases I become more innovative.

S14: Working on my own allows me to combine my interests with what I will be learning it makes me feel like I have control over what I want to do.

S18: I rarely understand when I work with the whole class, but when I work on my own I can self-critic without feeling ashamed of myself. Working alone is great for me because it makes me be myself.

S24: I get to understand more when I work by myself, especially when I have been given enough directions on how to go about my work.

S38: Working by myself allows me to be more focused on my tasks. I will not even entertain any disturbances as I will be enjoying seeing my progress.

S11: I want to work on my own and do my work as an individual because it is I who shape my future. I feel that I benefit more when I have my own time to be creative, make mistakes and figure out how I should solve my challenges.

S19: I am confident when I do my own tasks, it allows me to take ownership of my work.

S44: When I work independently, I am more motivated when I achieve as I will know that I have achieved some of my targets. It is always good when one works for something and achieve.

S42: Accomplishing a task on my own makes me feel good about myself and I begin to imagine that if I put some extra effort. I will be able to achieve more. Working alone will help me in my dreams of being an inventor of a new form of energy infrared radiation from the sun.

S49: Working alone helps me to deal with cold calling by my teacher during some random questions as I will be better prepared. I feel that when I work alone, I can generate my own questions and research further into the concept. Working alone has always been valuable when we work with others as stations and in groups.

S13: I am generally a highly anxious person, and this is further increased when I must work with others, it kind of disturb the way I reason. Working alone allows me to be critical and I become less anxious about what I do and therefore I tend to do better when I work alone and then have time to share my findings from my peers while also learning from their own findings.

S17: I like working alone especially after my teacher has shared with us the success criteria as this helps me to self-assess my level of mastery of a concept. Working alone removes the potential for me to either distract others or to be distracted by my peers. I have seen that during the lockdown I was able to focus more and achieve far greater than I did during face-to-face learning because when I worked alone, I believed more in myself.

S30: I was used to working according to what my teacher and my peers saw things and that made me find science to be a difficult subject because I had to understand others' point of view and then realign my own thinking to fit what others were thinking. Now I can do things from my own perceptive using the provided success criteria and I now feel that I can understand science more than before.

The use of success criteria encourages students to innovative.

Data from the focus groups showed that students valued success criteria that was used by their teachers to assist them in coming up with solutions to their challenges. Most students would go a step further and would in most cases come up with their own modified success criteria.

A lot of students were engaged in the introductory phases of the lessons with most students linking their lesson objectives and success criteria to their previous lessons. In all cases students were able to explain how to complete their daily tasks using the Success criteria. While most of the times teachers were initiating discussions through questions and lesson starters, in a few instances students would initiate discussions basing on previous lessons and prior knowledge. In one of the lessons students introduced the lesson from the topic and generated lesson questions for each other while the teacher was facilitating the discussions.

> S39: When my teacher shares the lesson success criteria, it allows me to see how others have managed to accomplish certain scientific tasks before and I can then be able to devise my own ways of completing similar challenges.

> S32: The use of success criteria helps me to be more independent as I am able to make decisions about my learning with less input from others. It makes me feel a sense of achievement when I use the steps provided in success criteria to complete my work.

> S29: if I know where we are going and how we are going to get there I make sure I put in place everything required for the journey. It makes the whole trip fun. That is how I feel about success criteria sharing. When my teacher shares the criteria for success with us, I feel that I own my own learning and I can alter the success criteria to improve on what would have been shared and improve on my capabilities.

S27: Success criteria helps me to see how success looks like before I begin. Therefore, when armed with success criteria I can plan and set goals for myself. Success criteria helps me a lot in self-assessment and self-evaluation. I can use it to check on where I could have done wrong and where I may need to improve on.

S26: Success criteria helps me to monitor my progress and adjust when I find out that my results are not going according to the shared criteria.

S14: I use success criteria to assess my work before I submit it for grading or for teacher feedback. By using success criteria, I have become more confident of my work as I am enabled through it to know how things should be done.

S9: When I have success criteria to work with, I am motivated and have the zeal to learn because the criterion for success ensures that I will not go wrong. It is always comforting to know that you bound to be successful.

S2: I work from the success criteria to catch up with others when I am behind. Success criteria are a compass I use to be more creative as I can articulate concepts to develop my own things in science. The guide provided by success criteria makes me an independent learner and it is always good when I depend more on my own for my learning than to depend more on others for my own learning.

Peer collaboration is valued

Students reported that they valued the times that they collaborate with their peers to come up with solutions to given challenges. Most students mentioned that they tend to learn more from their peers as concepts are explained in a way they better understand. Students viewed collaboration as a necessary activity to prepare themselves for classwork and assessment as collaboration enhances the sharing of study ideas and research skills toward certain topics. Students mentioned that collaboration enhance cooperation and removes unnecessary competition. There was also some consensus among students that collaboration was useful in bringing in real life situations in the classroom thus making their lessons more reflective of how people live and work together for the common good.

> S17: When I collaborate with my team members, I find it so simple to explain to the whole class. Sharing ideas with my peer enables me to gain insights into how my peers would solve the same problem with different strategies

> S31: I learn a lot from my peers when we brainstorm over a question, this allows me to modify my thinking to be accommodative of divergent views.

> S47: I have been attending my classes virtually most of the time and I have benefitted a lot from collaborating with my peers on discussion boards and during Zoom meetings. At times I struggled on my own but after collaborating with other things become so simple and manageable.

> S49: Knowing that someone else is struggling with the same concepts I would be struggling with always assures me that all is well and that I am not alone in this situation. Collaborating with others has been important for me as I am able to pick up a lot of ideas on how to confront my challenges successfully. I also feel proud of myself when I help others with things they would have been struggling with.

> S11: Collaboration has kept me connected to other during the shutdown period and it has helped me to adjust and not lose myself as I could always have some people to discuss with

S30: When I collaborate with others there are no specific roles, and we always create and shift our individual roles to ensure group success. Collaboration helps me to plan for the future as it offers real life situations. I have learnt to value my peers as I have realized that we all work towards one goal-success.

S14: My listening and analytical skills are greatly enhanced when I listen to others during group discussions.

S3: The different views given that are presented during group collaboration have always been my source of deeper understanding of science as this has taught me to always look for the diversity of facts.

Success in individual work is effective

There was greater motivation from working alone on tasks that generated interests of individual learners and the learners also felt that when feedback was given by their teachers it was more objective as they felt their needs were addressed individually instead of getting generalized feedback for work that would have been completed by the whole class. Students reported that they had a greater sense of achievement each time they were successful in the work that they worked on as individuals.

S3: I feel that I achieve more for myself when I am given the chance to complete certain tasks on my own especially after we had debates or other class activities. Working on my own challenges me to be creative.

S17: Seeing myself being successful in my science tasks always gives me the courage to push myself more, for me success means I can do more from an improved platform.

S23: I can only feel that I have mastered concepts when the work I work on as an individual is correct. Working alone using the success criteria teaches me to follow directions on any tasks.

S36: The reason I like working on some tasks as an individual is that no one dominates me like when we discuss, but I am able to implement my thoughts.

S41: It is always a good feeling to be successful on tasks that I work on as an individual, it gives me a sense of achievement and I also feel very confident of my ability when I am successful.

S9: Each time when I am successful after working by myself, I feel like I am ready to be the next scientist who will bring solutions to some of the world's problems like coming up with a cure for virus infections.

The use of 3D models in assessment promotes innovation

When students learning includes some hands-on experiences where they come up with working models greatly promotes innovation. Students reported that the use of 3D models for their assessments drew them closer to being the kind of scientists they aspire to become. However, a minority of the students reported that they felt that some students were advantaged over others as the distribution of resources and home support were not the same for all students.

S1: Working with models has made me not to be afraid when my teacher says there will be an upcoming assessment. I now believe I can do it.

S48: 3D model assessments looked difficult at start but once I completed my plan and started working, I discovered that I can be an innovator of new things.

S26: This type of assessment allows me to work on what I have learnt and be able to modify or add other things to come up with new ideas. I am proud of myself when I design my models it makes learning science fun.

S43: I feel that the use of models for assessment disadvantages some of us as not all of us are able to design things.

Students are sensitive to teachers' actions

While a lot of positive phenomena came out from most of the students, a few students felt that they were not getting the kind of attention that some of their peers were getting. Students believed they could perform better if they also had their teachers' attention.

S11: I feel that my teacher does not really give me feedback like she does with other students, it is like some students always get all the attention and adequate explanations on their work than I receive when I present my work. Maybe I am not the teacher's favorite student.

S37: Every comment written or spoken from my teacher always affects me. I feel satisfied and ready to improve on my performance when my teacher makes a positive and encouraging comment on my work, but I also feel let down when my teacher does not comment or makes gestures of disapproval towards my work.

S40: I look forward to my teacher as my role model and if my teacher does something that embarrass me or make me feel like I lack the academic muscle to do my science, it makes me sad and at times I may even skip school.

S39: I expect my teacher to make comments that do not bring me or the class down, even if we are struggling, I like my teacher encourage us as a class that we are always the best students. It is great to have a teacher who is proud of you, and you always want to make sure that you also do not disappoint them.

S8: I could do better in my science if my teacher was fair in his comments towards my work.

S46: If we are all given the same kind of responses maybe all of us would feel valued, appreciated and this would help us catch up with others.

S49: I do better in all my work when my teacher checks on my progress as I work, and I tend to benefit more from my teacher's comments especially when comments are positive or encouraging.

S50: It is always encouraging to have your teacher showing that they appreciate your work and giving your work as an example of good work to the class. I feel very excited when my teacher uses our work to demonstrate how good we are and develop our learning objectives from there.

Students are sensitive to grades

Many students indicated that they felt stressed when they are graded in their science work, and it affects the way they relate to their peers and their teachers. Mental health issues and school violence were also mentioned as being driven by bullying that could be a result of profiling from grades attained in learning. It was evident that learners felt intimidated by grades that are associated with summative assessment and this had negative impacts on the way they felt about themselves.

S2: I feel isolated and profiled as a failure when I get lower grades than my peers and this is made worse when my friends pick on me due to low grades at times when I get low scores, I isolate myself or find a seclude place to cry. The worst part of it is when my parents have higher expectations and I fail to live up to their expectations it makes me feel like the end of my life.

S6: Getting high scores usually earns me new friends but the moment I get low scores it would be like the whole world is coming down upon you, suddenly you find yourself without friends and with no one to talk to.

S11: Scores bring in unhealthy competition for us and you ask yourself why as we would expect to be working as a team with our peers. You can also see that teachers tend to associate and help those with higher scores than those with lower scores.

S22: I have noticed that some of my friends really get hurt when they score low grades in tests, and some are even aggressive each time when we have testing. I think this could be contributing towards the surge in school violence as some students would feel like if they cannot make it academically, then they can show that they are better physically.

S33: Scoring low grades deprives us of our happiness, it makes us have mental health issues, yet adults think that mental health is not there in children, we also break down mentally and how we deal with mental health challenges may not be so good. I wish if we could have a choice on how we should be assessed as summative assessment brings nothing but stress. It encourages us as students to find ways of cheating instead.

4.6: Results from students' questionnaires

A total of 300 questionnaires were sent out to all the three schools. From these only 100 questionnaires were returned. Data from the students is shown in the sections below.

Data on how students perceived teacher instructions for science tasks are presented below with data coming from all participants. Most students reported that they either strongly agreed or agreed that they received adequate instructions from their teachers about their learning through a process which identified what would have gone well with their work and what could be done differently to improve on their efficacy, autonomy, and motivation. Table 4.7 below summarizes the data from the schools with each school given codes ranging from S1 to S3. The same data also shows that when students had a clear understanding of their expected learning outcomes from their teachers, this also improved in their abilities to progress check and self-regulation. Students also gave their responses to perceive the sharing of learning objectives and autonomy in their learning.

Results from questionnaires provided data to answer the research questions about students' perceptions and experiences with assessment. Other questions in the questionnaires were designed to collect data on how self-regulated learning could be improved. Each statement was generated from the questions in the questionnaire. Every statement has data generated from the Likert scale ranging from strongly agree, agree, neutral, disagree and strongly disagree. Data also generate a mean and standard deviation for every statement.

Table 4.7

Effects of teacher instructions

Statement	Strongly agree	Agree	Neutral /Not sure	Disagree	Strongly Disagree	Mean	SD
	S1 S2 S3	S1 S2 S3	S1 S2 S3	S1 S2 S3	S1 S2 S3		
I think my teacher provides me with directions in science lessons at school.	18 12 20	18 8 14	2 4 4	0 0 0	0 0 0	***4.4***	***0.66***
	18% 12% 20%	18% 8% 14%	2% 4% 4%	0% 0% 0%	0% 0% 0%		
I am encouraged to work on my mistakes and use success criteria to correct myself.	18 12 8	14 12 22	4 4 4	2 0 0	0 0 0	***4.18***	***0.77***
	18 % 12% 8 %	14% 6 % 22%	4% 4% 4%	2% 0 % 0%	0% 0 % 0%		
I come up with better solutions when I correct using criteria for success	20 18 14	10 0 18	6 6 4	0 0 2	0 2 0	***4.26***	***0.93***
	20% 18% 14%	10% 0 %18%	6% 6 % 4%	0% 0 % 2%	0% 2% 0%		
I check my progress using shared objectives	12 10 22	12 6 10	14 4 4	2 2 2	0 0 0	***4.1***	***0.94***
	12% 10% 22%	12% 6% 10%	14% 4% 4%	2% 2% 2%	0% 0% 0%		
I can work on my own	12 12 18	16 6 16	4 4 4	6 0 2	0 0 0	***4.14***	***0.92***
	12% 12% 18%	16% 6% 16%	4% 4% 4%	6% 0% 2%	0% 0% 0%		

Teacher provides directions on how work should proceed

Almost all the students (90%) either strongly agreed or agreed that they had adequate instructions on how they had to do their work which indicated that teachers were promoting students' autonomy. 10% of the students indicated that they were neutral as to whether directions given by their teachers were adequate or not on how they were to proceed with their work. There was a strong indication that teachers provided adequate directions to their students about how they were supposed to work. Data from the students showed that teachers were providing directions on how work should progress and large percentage of students who either strongly agreed or agreed was evidence enough that students were aware of where they were going in their learning processes. This could also go a long way in creating a conducive environment for self-regulated and autonomous learning as the students are well prepared and aware of the directions to be taken in their work. Further parametric tests were carried out using SPSS and the following data were generated with an 8% degree of freedom and an asymptotic significance of less than 0.001 as shown by the chi-square in Figure 4.4a below. The parametric statistics confirms that most students agreed that teachers were providing adequate directions through assessment for learning therefore enabling them to be able to work independently. The asymptotic value of less than 0.001 shows that students were highly comfortable of teachers' directions on how to proceed with assigned work.

Figure 4.4a

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	144.471[a]	8	<.001
Likelihood Ratio	150.545	8	<.001
Linear-by-Linear Association	79.729	1	<.001
N of Valid Cases	100		

a. 8 cells (53.3%) have expected count less than 5. The minimum expected count is .20.

Note: Chi-Square Tests for effectiveness of teacher directions

Students are encouraged to use success criteria to self-assess

A total of 48% of the students reported that they strongly agreed and a further 42% also agreed that they were encouraged to use the criteria for success to correct their mistakes. This was also reflected by another 62% who strongly agreed and 28% who also agreed that they indeed use the success criteria to self-correct. The fact that teachers were encouraging their students to use success criteria to self- assess and reflect on their work further encouraged students to be autonomous, independent and self-assertive learners. There was a strong relationship between students who were making use of the success criteria (90%) and those who were using the success criteria to self-correct (90%). This could indicate that more students were on the path to self-regulation and self-efficacy.

Parametric tests were also run for the use of success criteria with Chi-square results and Spearman Correction. Results also showed that both tests had approximate significance of less than 0.001 as shown in Figure 4.4b and 4.4c below

Figure 4.4b

Chi-square tests for effective use of success criteria

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	144.760[a]	9	<.001
Likelihood Ratio	139.001	9	<.001
Linear-by-Linear Association	74.828	1	<.001
N of Valid Cases	100		

a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is .12.

Figure 4.4c

Spearman Correlation for effective use of success criteria

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Interval by Interval	Pearson's R	.911	.019	21.929	<.001[c]
Ordinal by Ordinal	Spearman Correlation	.925	.025	24.054	<.001[c]
N of Valid Cases		100			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Students use shared objectives to check progress and to work independently

Another similar trend was also shown in the 72% of the students who indicated that they either strongly agreed or agreed that they made use of shared learning objectives to check their own individual progress. However, 6% of the students disagreed that they ever used the shared objectives to check their individual progress. An almost similar trend is also noted in the percentage of students who stated that they could work on their own. More students indicated that they could not work on their own (8%) than the 6% who indicated that they disagreed with the use of shared learning objectives. However, 80% of the students reported that they could indeed work on their own. Generally, there were fewer students who indicated that they were struggling with working independently compared to those who were assertive that they could work independently and could self-assess. Using a two-tailed t-test with a significance level of 0.05 and 98 degrees of freedom (df = n-2), we obtain a t-value of 9.64. Looking up this value in a t-distribution table with 98 degrees of freedom, we find a p-value of less than 0.0001.

Since the p-value is less than 0.05, we reject the null hypothesis and conclude that there is a significant difference in the perception of assessment between students who have adequate teacher support and those who do not have adequate teacher support. Specifically, students who Strongly Agree or Agree that they check their progress using shared objectives perceive assessment more positively than those who select Neutral, Disagree, or Strongly Disagree.

The more students who felt they owned their own learning process the higher the chances that such students could assist those who could not if more peer collaboration was inclusive during lessons. Figure 4.4d shows the relationship between how students use share objectives and their autonomy in works.

Figure 4.4d

Z-tests for progress check and learning objective usage

Paired-Samples Proportions Tests

	Test Type	Difference in Proportions	Asymptotic Standard Error	Z	Significance One-Sided p	Significance Two-Sided p
Pair 1: I check my progress using shared objectives - I can work on my own	Mid-p Adjusted Binomial	.020	.014		.125	.250
	McNemar	.020	.014	1.414	.079	.157

Students' autonomy

Data from Table 4.7 was also used to generate the Pearson correlation coefficient for between the two sets of scores showing students' autonomy using the following formula:

r = (nΣXY - ΣXΣY) / sqrt((nΣX^2 - (ΣX)^2)(nΣY^2 - (ΣY)^2)) where:

- n is the sample size (100 in this case)
- ΣX and ΣY are the sums of the X and Y scores, respectively
- ΣXY is the sum of the products of the X and Y scores
- ΣX^2 and ΣY^2 are the sums of the squares of the X and Y scores, respectively

Using the values from the table above, we can calculate the Pearson correlation coefficient as follows:

r = (100(4060) - (406)(414)) / sqrt((100(17374) - (406)^2)(100(17050) - (414)^2)) r = 0.516. Table 4. 7b gives the two data sets on students' autonomy that were used to generate the resultant correlation coefficient

Table 4.7b

Effect of teachers' instruction on student autonomy

	I check my progress using shared objectives	I can work on my own
Mean	4.1	4.14
SD	0.94	0.92
N	100	100
Sum of X	406	414

The resulting correlation coefficient is 0.516, which indicates a moderate positive correlation between the two sets of scores. This suggests that individuals who rate themselves highly on their ability to work on their own also tend to rate themselves highly on checking their progress against shared objectives. Table 4.7c shows the Pearson correlation coefficient between the two sets of scores (0.516) in the cell where the row corresponds to the Shared Objectives question and the column corresponds to the Can Work on Own question. The table also shows the correlation coefficient of 1.0 on the diagonal, which indicates the perfect correlation between a variable and itself.

Table 4.7c

Correlation analysis

	Shared objectives	I can work on my own
Shared objectives	**1**	**0.156**
I can work on my won	**0.156**	**1**

4.6.1: Students' perceptions on teacher feedback

Data showed that students valued both teacher and peer feedback. This section answers the research question on students' perceptions and experiences of assessment. Table 4.8 gives the statistics on how students valued teacher feedback and peer feedback. Feedback is indeed an integral component of assessment for learning and self-regulation. Students agreed that feedback was an important part of their learning, more students felt that they benefited from teacher feedback than from peer feedback. A total of 48% of the students reported that they strongly agreed that they understood their lessons from teacher feedback with another 48% also strongly agreeing that they valued teacher feedback. Another 42% of the students agreed that they understood their lessons from teacher feedback and a similar percentage also mentioned that they agreed to the value of teacher feedback. More students (52%) strongly agreed that they valued peer feedback a figure which was 4% higher than those who strongly agreed to the value of teacher feedback. Another 28% agreed that they valued peer feedback. Data also showed that only 2% of the students disagreed with the value of teacher feedback but 5% and 2% disagreed and strongly disagreed with the value of peer feedback, respectively. Students who reported that they got help from their science teachers to better understand learnt content had a mean of 4.1 and SD of 1 while those who valued teacher feedback and peer feedback had mean of 4.16 and 4.17 and SD of 0.78 and 1.13, respectively.

Table 4.8

Students' perception on impact of feedback

Statement	Strongly agree	Agree	Neutral /Not sure	Disagree	Strongly Disagree	Mean	SD
	S1 S2 S3	S1 S2 S3	S1 S2 S3	S1 S2 S3	S1 S2 S3		
My science teacher feedback helps me to understand the content that I learn during lessons	12 12 18	18 8 12	2 4 4	2 4 2	0 2 0	***4.1***	***1***
	12% 12% 18%	18% 8% 12%	2% 4% 4%	2% 4% 2%	0% 2% 0%		
I value teacher feedback	18 12 8	14 6 22	4 6 8	2 0 0	0 0 0	***4.16***	***0.78***
	18 % 12% 8 %	14% 6 % 22%	4% 6% 8%	2% 0 % 0%	0% 0 % 0%		
I value peer feedback	20 18 14	10 0 18	2 2 4	4 0 2	0 2 2	***4.17***	***1.13***
	20% 18% 14%	10% 0 %18%	2% 2 % 4%	4% 2% 2%	0% 2% 2%		

My teacher feedback is helpful in making me understand the content.

While more students agreed that the feedback, they got from their teachers was effective in making them understand the content (42% strongly agreed and 42% agreed), a further 10% were neutral over the issue. A further 10% either disagreed (8%) or strongly disagreed (2%) that they had effective teacher feedback to help them understand the content. There was a mean score of 4.1 over a Likert scale ranging from 1 to 5 and standard deviation of 1.

I value teacher feedback

There was an overwhelming agreement that students valued teacher feedback with only 2% of the students feeling otherwise. The levels of agreement were 42% agreeing and a further 48% strongly agreeing to the effectiveness of teacher feedback in the learning.

Most students therefore agreed on the clarity of their teachers' feedback with a minority being either neutral or disagreeing.

Data collected from students from all the participating schools revealed that their teachers commented on their presentations. They reported that they felt motivated when their teachers give them positive feedback with questions that challenge them to further expand on their presentations.

I value peer feedback

Even though fewer students valued peer feedback than teacher feedback it was encouraging to note that the percentage of students agreeing that peer feedback was valuable far exceeded the percentage of those who felt that they did not see any value in peer feedback. The percentage of those who saw value in peer feedback was 80% compared to only 12% who did not see any value in peer feedback, while 8% were not sure.

Correlation coefficient on feedback

Table 4.8b gives the Pearson correlation coefficients for data on feedback Pearson correlation coefficients between each pair of questions.

The correlation coefficient between items a and b is 0.79, which indicates a strong positive correlation between science teacher feedback helping students to understand the content and students valuing teacher feedback.

The correlation coefficient between items a and c is 0.63, which indicates a moderate positive correlation between science teacher feedback helping students to understand the content and students valuing peer feedback.

The correlation coefficient between items b and c is 0.57, which indicates a moderate positive correlation between students valuing teacher feedback and students valuing peer feedback.

Overall, the results suggest that there is a positive relationship between science teacher feedback, valuing teacher feedback, and valuing peer feedback. Students who report that science teacher feedback helps them to understand the content are also more likely to value both teacher and peer feedback. Additionally, students who value teacher feedback are also more likely to value peer feedback.

Table 4.8b

Correlation coefficients on effects of feedback

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	*Correlation coefficient*
a). My science teacher feedback helps me to understand the content that I learn during lessons	42	38	*10*	*8*	*2*	*a/b:* ***0.79*** *a/c:* ***0.63***
b). I value teacher feedback	38	42	*18*	*2*	*0*	*b/a: 0.79* *b/c:* ***0.57***
c). I value peer feedback	52	28	*8*	*6*	*4*	*c/a: 0.63* *c/b: 0.5*

Table 4.8c below shows the data from the chi-square tests on the three responses about feedback. In all three cases we can conclude that there is a significant association between the response categories and the statement.

Table 4.8c

Chi-square tests on effects of feedback

Theme	*S.A*	*Agree*	*Neutral*	*Disagree*	*Strongly Disagree*	*Mean*	*SD*	*X squared*	*df*	*p. value*
My science teacher feedback helps me to understand the content that I learn during lessons	42	38	10	8	2	4.1	1	41.00	8	1.06e-06
I value teacher feedback	38	42	18	2	0	4.16	0.78	21.87	8	0.006
I value peer feedback	52	28	8	6	4	4.17	1.13	25.50	8	0.0016

Self-directed learning

Table 4.9 below gives the statistics on how students felt about teacher feedback and peer feedback. Mica *(pseudonym)* revealed that he felt shy when presenting his work but the expectations of getting feedback from his teacher makes him strong as feedback given always inspires him to want to do more.

Data also showed that 92% of the students either strongly agreed or agreed that their teachers gave them clear directions on what to do during their science lessons. These were equally divided with 46% strongly agreeing and another 46% agreeing however 4% of the students claimed that they did not know whether teacher instructions were clear or not with another 4% reporting that they felt that their teacher instructions or directions on how to do their tasks were not clear. There was a positive relationship with the above results and how students perceived the use of success criteria in checking if they were doing the right things as they worked individually or cooperatively. A total of 94% perceived that the use of success criteria encouraged them to self-evaluate and self-correct as they worked on their tasks and 4% did not know how the success criteria helped them while 2% did not see any value in the use of success criteria. There was clear evidence of self-directed learning in students' responses with most students reporting that they were benefiting more from working on their own while following the set State Standards.

Table 4.9

Self-directed learning

Statement	**Strongly agree**			**Agree**			**Neutral /Not sure**			**Disagree**			**Strongly Disagree**			**Mean**	**SD**
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**		
I can do my work with little help from my peers and teachers	18	12	20	18	8	6	2	4	4	2	2	2	2	0	0	4.22	0.99
I am given clear direction on what needs to be done	12	10	2	10	4	18	10	6	10	8	6	4	0	0	0	***3.62***	***1.04***
Success criteria is adequate for me to work independently	14	16	20	16	2	12	8	6	6	0	0	0	0	0	0	***4.3***	***0.78***

I can do my work with little help from my peers and teachers

Data collected from students showed that more students were autonomous in their work with 50% of the students strongly agreeing that they needed very minimal help from their teachers and peers in completing their work. Another 30% of the students reported that they could also worked independently of their peers and teachers and required some help from their teachers and peers. The 8% of students who indicated that they could not do their work without either their teachers or peers' help could be the ones who may need to either close the achievement gap or those who needed a more traditional approach to learning.

Student perceptions on motivation to learn

Similar patterns were also shown in how students perceived themselves in how they generated solutions to problems, their self-evaluation, motivation, and self-regulation in learning. These results are shown in Table 4.10. An encouraging 62% of the students strongly felt that they were encouraged to be creative in the learning of science with a further 26% also in agreement. However, 2% of the students did not see any creativity in their work. A worrying trend was that 44% of the students did not have any knowledge of their curriculum or topics they were supposed study for the year, though lower than the percentage of those who knew the figure was generally too high compared to other phenomena. The use of shared learning objectives and success criteria appeared to have been creating an enabling alternative for learners who had no idea about their topics in the curriculum.

Teacher input in student's individual work had a bearing on motivation a slightly higher percentage of students (20.6%) reported that they were not motivated by comments they got from their teachers after they had submitted their individual work.

Table 4.10

Students' perceptions on motivation

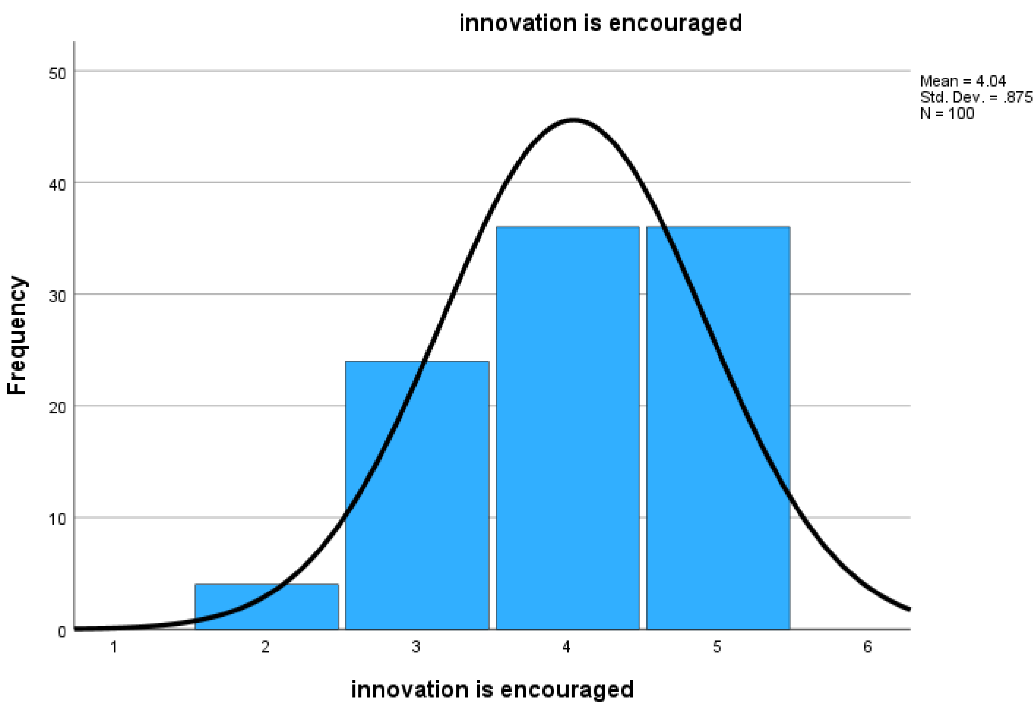
Statement	Strongly agree	Agree	Neutral /Not sure	Disagree	Strongly Disagree	Mean	SD
	S1 S2 S3	S1 S2 S3	S1 S2 S3	S1 S2 S3	S1 S2 S3		
The teacher encourages us to work on our own and produce our own work.	14 10 12	14 6 16	10 6 8	0 2 2	0 0 0	***4.04***	***0.87***
	14% 10% 12%	14% 6% 16%	20% 6% 8%	0% 2% 2%	0% 0% 0%		
I know my science topics for the year, and I enjoy reading ahead.	12 10 2	10 4 18	10 6 10	6 6 4	0 2 0	***3.6***	***1.08***
	18 % 10% 2 %	10% 4% 18%	10% 6% 10%	6% 6 % 4%	0% 2% 0%		
I feel excited, valued and honored when my teacher acknowledges my work.	16 6 18	16 10 14	6 6 6	0 2 0	0 0 0	***4.18***	***0.8***
	16% 6% 18%	16% 10 % 14%	6% 6% 6%	0% 2% 0%	0 % 2% 0%		
My science teacher encourages me to be creative.	14 16 20	16 2 12	8 6 6	0 0 0	0 0 0	***4.3***	***0.78***
	14% 16% 20%	16% 2% 12%	8% 6% 6%	0% 0% 0%	0% 0% 0%		
I think my classmates help me understand my science when they comment about my work.	12 12 18	16 6 16	4 4 4	4 0 2	0 2 0	***4.12***	***0.97***
	12% 12% 18%	16% 6% 16%	4% 4% 4%	4% 0% 2%	0% 2% 0%		

Learner autonomy is encouraged

Students' data indicated that 36% strongly agreed that their teachers encouraged them to produce their own work while another 36% agreed that they were encouraged to be independent learners, while 24% were not sure if they were encouraged to work on their own. However, a 4% minority of the learners did not feel that autonomous learning was encouraged in their science classes. A high percentage of students who felt that they were encouraged to work on their own and produce their own could indicate the levels of students' autonomy in learning science as indicate by Figure 4.5a below.

Figure 4.5a

Frequency of students' perceptions on innovation

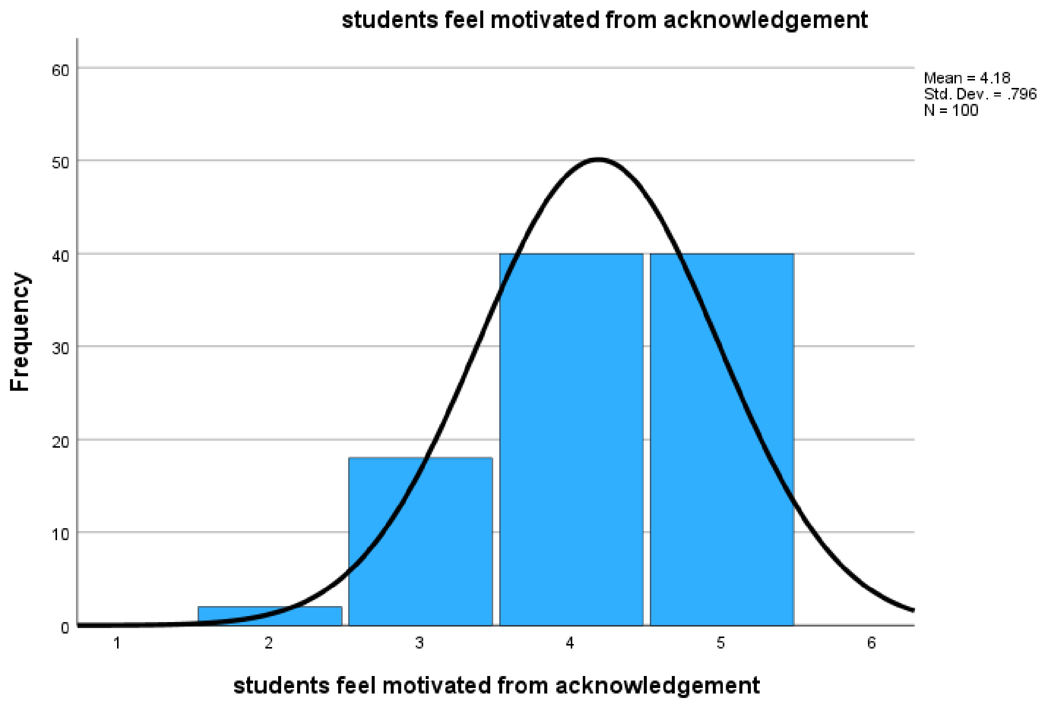


Students value acknowledgement of their work

An overwhelming 80% of the students reported that they felt valued if their work was acknowledged by their teachers and a paltry 2% stating that they did not agree that teacher acknowledgement of their work was of any effect on them. Figure 4.5b gives a summary of how they perceived acknowledgement for their work.

Figure 4.5b

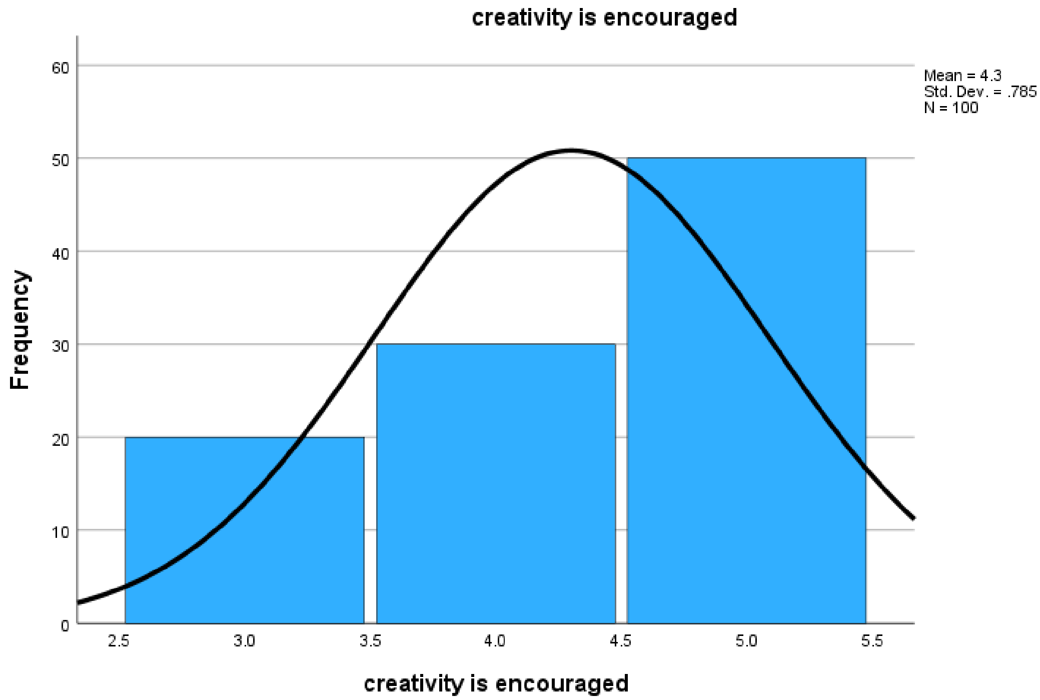
Effects of acknowledgement on student motivation



Creativity is encouraged

Most of the learners (80%) also responded that their teachers encouraged them to be creative, with no student disputing that creativity was encouraged. 20% of the students were unsure if their teachers, encouraged creativity. It was evident from data that no student felt that formative assessment did not allow for creativity. Figure 4.5c summarizes the data.

Figure 4.5c
Summary on the effects of Assessment for learning on creativity



Peer input is valued

There was a 42% strong agreement that students felt encouraged by their peers. Another 38% also agreeing that they were indeed encouraged by their peers, while 2% strongly disagreed that peers were encouraging. This was also supported by a further 8% who disagreed with the notion that peers were encouraging in their work.

Further statistical data analysis for the above using SPSS also showed similar results and are shown in Figure 4.5d below where z-scores for creativity were equal to the mean scores and z-scores for motivation were within the acceptance range. However, z-scores for whether students felt they had self-regulation were unusual as they fell far outside the parametric range for acceptance.

Figure 4.5d

Parametric test results from students' motivation and autonomy

One-Sample Proportions Tests

	Test Type	Successes	Observed Trials	Proportion	Observed - Test Value[a]	Asymptotic Standard Error	Z	Significance One-Sided p	Significance Two-Sided p
innovation is encouraged = strongly agree	Mid-p Adjusted Binomial	36	100	.360	-.140	.048		.003	.005
	Score	36	100	.360	-.140	.048	-2.800	.003	.005
self-regulation = strongly agree	Mid-p Adjusted Binomial	24	100	.240	-.260	.043		<.001	<.001
	Score	24	100	.240	-.260	.043	-5.200	<.001	<.001
creativity is encouraged = strongly agree	Mid-p Adjusted Binomial	50	100	.500	.000	.050		.500	1.000
	Score	50	100	.500	.000	.050	.000	.500	1.000
students feel motivated from acknowledgement = strongly agree	Mid-p Adjusted Binomial	40	100	.400	-.100	.049		.023	.046
	Score	40	100	.400	-.100	.049	-2.000	.023	.046

a. Test Value = .5

Correlation between subscales and student autonomy in formative assessment

In order to reveal any association between different subscales and overall student autonomy due to formative assessment correlation analysis was conducted. Using a t-distribution table with 98 degrees of freedom and a significance level of 0.05, the critical values for a two-tailed test are +/-1.984. Table 4.10a shows the association between different subscales and overall student autonomy due to formative assessment. Our calculated Pearson correlation of the association between students stating that they felt encouraged to work on their own to produce autonomous work and students having knowledge of the curriculum and working ahead of time was 1.80 which falls within the range of -1.984 and 1.984, we therefore conclude that there are no significant differences in the mean ratings of the two statements.

The calculated statistic for the relation between the two statements of students noting that they are encouraged to work on their own to produce their own work and where students felt that they could work independently of the peer support had t-statistic of 1.70. This was within the range of our critical value hence we conclude that there was no significant difference between the mean scores of the two statements.

The calculated t-statistic of 2.35 is greater than the critical value (1.984) we conclude that there is a significant difference between the means of the two statements because data shows that the first statement "… encouraged to work on my own to produce my own work…" received a higher level of agreement from respondents than the second statement, "… given clear directions … to support autonomy."

On comparing data between the statement that students felt encouraged to work on their own and produce their own work and the statement about success criteria being used to promote autonomy we can conclude that there is no significant difference between the mean ratings of the two statements as 1.40 falls within the critical value range.

When data are compared the two statements students' use of success criteria and their ability to work independent of their peer support the t-statistic (-0.422) suggests that there is significance difference between the mean scores of the two statements. Statistical data also concluded that there is a significant difference between students' views of clarity on directions to support autonomy and the use of success criteria.

Table 4.10a

Correlation between subscales and student autonomy in formative assessment

		Encouraged to work on my own and produce my own work	**Knowledge of science topics and work ahead**	**I can work independent of my peer support**	**Clear directions to support autonomy**	**Success criteria ensures autonomy**
Encouraged to work on my own and produce my own work	Pearson Correlation	1				

	Sig (2 tailed)	0.05 (95% confidence level)				
	N	53				
Knowledge of science topics and work ahead	Pearson Correlation	1.80	1			
	Sig (2 tailed)	0.05 (95% confidence level)	0.05 (95% confidence level)			
	N	23	56			
I can work independent of my peer support	Pearson Correlation	1.70	2.14	1		
	Sig (2 tailed)	0.05 (95% confidence level)	0.05 (95% confidence level)	0.05 (95% confidence level)		
	N	50	50	50		
Clear directions to support autonomy	Pearson Correlation	2.35	-0.38	2.81	1	
	Sig (2 tailed)	0.05 (95% confidence level)	0.05 (95% confidence level)	0.05 (95% confidence level)	0.05 (95% confidence level)	
	N	50	50	50	50	
Success criteria ensures autonomy	Pearson Correlation	1.40	13,85	-0.422	3.504	1
	Sig (2 tailed)	0.05 (95% confidence level)	0.05 (95% confidence level)	0.05 (95% confidence level)	0.05 (95% confidence level)	0.05 (95% confidence level)
	N	50	50	50	50	50

4.7: Results from observations

All the six classes were observed three times each during the study, with each observation lasting 50 minutes. The researcher recorded data from each of the observed lessons using a form which will be attached in the appendix section. The researcher allowed lessons to flow naturally without interfering with what was going on. The observations were staggered with the first round of observations having been carried out at the beginning of the school year and the second round was done towards the end of the first semester. The last rounds of observations were done in the last quarter of the school year.

The results from the observations further answer all the research questions on how teachers interpret and implement assessment for learning, students' experiences with assessment for learning and ways through which self-regulation could be improved. Each of the three research questions could be answered through observations as the researcher had the opportunity to observe things as they unfolded during the lessons.

It was observed that teachers linked their formative assessment to set learning goals with the aim of improving their students understanding and performance in summative assessments that were administered at the end of set times. They likened formative assessments to personal compasses that are used in redirecting the direction of learning by both learners and teachers. In addition to improved engagement, teachers agreed that formative assessment challenges students to adapt and correct any misconceptions through input from teachers, peers and self-generated feedback thus improving on their self-directed learning. The researcher observed that teachers made use of different teaching styles and formative assessment technique to keep their learners motivated. These included role-plays, games, debates models and computer-generated simulation games.

4.7.1: Students' engagement

It was observed in all schools that teachers were giving their students time to work in groups and as individuals with clear criteria for success displayed for each task. All teachers except for T3 had clear evidence of differentiated instructions for the same tasks for different students. Students were all at ease without any signs of assessment tasks as they worked from differentiated instructions towards similar ultimate goals. This was a sign that students had greater and higher expectations when assessment for learning was utilized. Whenever there were challenges with success criteria instructions in S2 students would ask their teachers to clarify. Teachers in S2 did not directly answer to students' concerns but would ask the students to explain what they thought they were expected to do before asking other students to have their input. When all students had given their input teachers would then ask their classes if they still had challenges before, they would finally give a modified instruction in line with what students would have contributed. This brought in a lot of aha moments for the students which also created more room for class interactions. The frequency of questions per teacher per class over a 50-minute period fluctuated and varied with the type of a lesson and activities that were taking place. Teacher feedback was effective for all classes as students could work from feedback given to achieve and even go beyond the lesson goals.

In all the three schools, students were giving each other feedback in blended classes for both face to face and online students through the canvas discussion platform. Peer feedback was designed to be respectful and students at all schools were instructed to start by identifying what they felt their peers had done well.

Table 4.11 below summarizes the different themes that were generated from the observations of the six classes. These themes also help in answering the three research questions on the roles played by both teachers and students while exploring ways through which self-regulated learning could be improved.

Table 4.11

Observed trends in classrooms

Theme	**Class**	**Example**
Learning objectives displayed for students to see	C1, C 2, C3, C4, C5, C6	**I can:** Identify the different organelles of plant and animal cells. Compare and contrast plant and animal cell organelles Justify why some organelles are only found in autotrophs
Learning objectives are shared with students	C1, C2, C3, C5	Going through differentiated learning focused goals with classes.
Students are reminded of their learning objectives throughout the lesson	C1, C2, C3, C5	Allowing students to identify which learning objective would have been accomplished.
Success criteria are shared with students	C4, C6	Students are given the various steps to follow to change the subject of the formula for calculating velocity.
Students use success criteria during the lesson	C1, C2, C3, C4, C6	Students dissecting the heart following the steps provided by teacher, there were many cases of students challenging each other on why they had to do certain things.
Teacher asks and follows up on questions	C2, C3, C4, C5, C6	Teacher praises students' answers and then ask them to give more detail about their findings as well as provide the possible variation for their answers.
Students are engaged	C1, C2, C3, C4, C5, C6	Students work in assigned stations and allocate each other tasks to research on
Evidence of greater students' enthusiasm with formative assessment	C1, C2, C3, C5, C4, C6	Students showed more interest in being engaged through formative assessment.
Teacher gives feedback	C1, C2, C4, C6, C5, C3	Teacher verbally responds to students' contributions
Peer feedback is given	C3, C4, C5, C2	Students comment on peer presentations and acknowledge the depth of research
Regular frequency of teacher questions	C1, C3, C4	Teacher allows students to work and moves around groups with follow-up questions

Effective feedback is provided for students	C1, C3	Teacher asks students to explain why their answers were correct and how else they could get to the answer
Students are responsive to feedback.	C1, C2, C3, C4, C5, C6	There were positive relationships between students' passion towards work with teacher feedback.
Individual tasks are given to students	C2, C4, C5, C6	Students take their chrome books after the lesson introduction and each work on differentiated assigned tasks.
Differentiated tasks and instructions	C1, C5	Students working on the same topic but at different challenge level
Evidence of peer assessment	C1, C5	I am impressed with how you solved …. Using the success criteria. I feel that it was going to be even better if….
Task given promote autonomy	C1, C3, C5, C6	Students are asked to research on projects whose theme is to create a model that demonstrate resistance forces
Evidence of students given opportunities to create individual targets with key result areas	C2, C4, C5, C6	Teachers set aside times to sit down with students where students would discuss their set targets and how they expected to achieve and go beyond set personal targets.
Self-regulation based on student data	C1, C2, C3, C4, C5, C6	Students had individual targets set in line with data from previous work.
Students setting their own assessment criteria for self-evaluation.	C1, C3, C4, C6	Students formulated how they intended to assess their individual work with steps on how they would identify personal strengths and weaknesses.
Evidence of students' self-regulation	C1, C2, C3, C5, C6	Students creating circuits with different materials and analyzing why some materials were not giving them desired results
Evidence of project-based learning	C1, C2, C3, C4, C5	Students working on different STEM fair projects for the school and district exhibition
Evidence of structured formative assessment	C1, C2, C3, C4, C5, C6	There is all way communication with questions and responses for the class community
Increased student driven learning	C1, C4, C5, C6	Students were more in charge of their learning and were allocating each other tasks to research on using curriculum pacing guides.
Increased teacher pupil interaction	C1, C2, C3, C4, C5, C6	Teacher-pupil and pupil engagement increased more than three times as the learning community discussed and responded to feedback. Students could ask their teachers higher order questions with others offering to offer solutions and answers.
Use of station-based notebooks	C3, C4, C6	Students were creating their own notes as stations and comparing their findings with lots of debates

		based on shared learning objectives and success criteria.
Evidence of increased students' participation with formative assessment	C1, C2, C3, C4, C5, C6	Student involvement and engagement increased with the use of formative assessment. Each time there was mention of summative assessment several students would show signs of stress.
Evidence of promotion of self-regulation and formative assessment in homework	C2, C3, C5, C4	Teachers gave students tasks that required formative assessment and self-regulation to be completed at home.
Teachers used a variety of methods to motivate students.	C1, C2, C3, C4, C5, C6	Role-plays, games, and rewards were used to motivate students.
Evidence of body language to stimulate discussion	C1, C2, C3, C5, C6	Teachers made some body movements and gestures, and students would rectify responses
Evidence of student work through classroom displays	C1, C2, C3, C4, C5, C6	Student generated displays and models were showcased in classrooms

Lesson objectives displayed for students to see

All the six classes had a section where the day's learning objectives were displayed. Three teachers had the objectives written as "I can" while the other three teachers had the objectives written as "Students should be able to …" All learning objectives showed evidence of differentiation with the first objectives being of a lower level and the last objectives being more challenging. T5 explained that her objectives were designed in such a way that all students would achieve the first on, while most students would easily achieve the second one, some students were expected to get teacher assistance to complete the third one and the last objective was meant to ensure that the academically gifted students were challenged through extended high order thinking tasks. In all classes there was a student who acted as classroom representative and would great visitors into the classroom and read out the learning objective for that day.

Learning objectives are shared with students

All classes but C4 and C6 had the teachers sharing the learning objectives with students at the beginning of the lesson. Students were made aware the objectives and in some cases the teachers were asking some volunteers to read the objectives for the class. Students would then proceed with their lessons after having discussed the objectives. In C1 the teacher probed the students to say what they would expect from the lesson after sharing the learning objectives. It was evident that students paid particular attention to the learning objectives as they were observed discussing how their learning objectives would link with their prior knowledge among themselves.

Students are reminded of their learning objectives throughout the lesson

In C1, C2, C3 and C5 teachers constantly reminded students of their progress by revisiting the learning objectives. In C1 the teacher would ask students which learning objectives they knew they had covered during the lesson and ask them to give their reasons why they thought the objectives had been covered and how else they would cover and research on related content to cement their understanding. These strategies ensured that teachers would always reference to the daily learning objectives while also encouraging and directing students towards the set learning objectives. In C3 students were challenging each other to link their group responses to the shared objectives and this expanded students' learning horizons as such question increased interaction among learners.

Success criteria are shared with students

Only two classes, C4 and C6 were teachers sharing and going through the success criteria with students. In the other four classes teachers only displayed the success criteria for students to follow on their own. It was evident that students in the other classes were making use of the displayed success criteria as they completed both station-based tasks and individual assignments.

Students use success criteria during the lesson

In all classes but C5 students were using the displayed success criteria with most classes utilizing the criteria for success on STEM projects and for the scientific methods in conducting experiments. In C1 students were using success criteria in the computation of velocity, time and distance with students often reminding each other whenever they would have skipped an essential step. In C3 students were using the success criteria for the flow of blood into and out of the heart.

Teacher asks and follows up on questions

There was evidence of feedback and follow up questions in all but one class. Teachers were formatively assessing their students and with every correct response to questions, teachers were following up with related but higher order thinking questions. It was the scaffolding of questions that allowed teachers to ensure that ever student's academic potential and needs were met. Most students were able to answer even the very demanding questions. In all the classes teachers allowed for some time to lapse after asking questions before they could start to accept answers hence allowing their students some time to deliberate over the questions. This allowed all learners to get the chance to digest the questions.

Students are engaged

All teachers used a variety of student engagement methods to ensure that their learners were continually engaged. In C4 the teacher made use of small groups which were rotational after every 10 minutes' interval with all students having been engaged throughout the lesson. The small groups were effective in making sure that no student was left behind and to guard against intra-student and inter-student domination which are common with whole class discussions and larger group discussions. In C2 students were highly engaged through inter and intra-group debates. The use of technology in C1 ensured that all students were kept engaged throughout the time they were having their science lesson. In C6 students were engaged through an online formative assessment.

Evidence of greater students' enthusiasm with formative assessment

In all classes observed it was evident that students welcomed formative assessment without any signs of panic or stress. Learners were relaxed when they were assessed formatively, and it showed that the process was more of a learning experience with teachers able to probe students in more details about the concepts they were being assessed in. This was very different from the way students were reacting when they heard about summative assessment. In C3 students revealed that formative assessment in science was enabling them to better understand the subject. One student in C1 mentioned that formative assessment allowed her to expand her knowledge as it offered her extended learning opportunities.

Teacher gives feedback

Teachers were always giving feedback to students both as individuals and as groups. Teacher feedback was more focused on the learning objectives and in most cases, they would link their feedback to one or two learning objectives. In all cases feedback was both positive and encouraging to students giving the students the willingness to continue participating in the class formative assessment. Teacher feedback encouraged maximum interaction between the students and their teachers.

Teachers' feedback was done during lessons and was mostly in form of praise, deeper discussion into concepts and reward stamps for exceptional work which students could redeem for coupons at the school shop. Feedback given as part of formative assessment proved that it helped learners become aware of any gaps that exist between their desired goal and their current knowledge, understanding, or skill and guides them through actions necessary to obtain the goal. Teachers also gave feedback which in most cases was tied to further questions that challenged students to think critically into concepts under discussion. T1 probed students who were presenting a model a cup anemometer which they had made about how they thought their model could be improved upon so that it could operate during a hurricane storm. Students did not show any form of stress due to formative assessment as they were showing eagerness to learn, they linked their answers to durability of materials to be used as well as using materials that would not rust.

There was a strong link between teacher feedback and students' willingness to think outside the box and to come out of their comfort zones making learning more interactive and engaging. Teacher feedback created an environment of student learning to be self-confident and more proactive during lessons.

Peer feedback is given

Peer feedback was evident in all but two classes with students giving feedback to their peers after a presentation. Feedback was respectfully and thoughtfully given. In C5 students were giving feedback first by addressing the concepts they believed had been effectively addressed and then pause questions on concepts they felt were not fully addressed. Thereafter they would give their input on what they felt would have made their peers' presentation better. Students were using such phrases as "Your presentation was great…. Have you considered …? However, it could be even

better if …."

Students in C1 had feedback statements that started with such phrases as.

> Thank you for highlighting your facts about the concept, I agree with you on issues such as the ones you pointed out, you really covered objectives a, b and c by expanding on the links between the different objectives.

Such phrases ensured that students who offered feedback were also giving feedback in line with lesson objectives and shared success criteria. Peer feedback was constructive and whenever there was some criticism to be done, learners did so respectfully and offer what they felt would have been correct. When students did not understand what their peers would have written about, they were encouraged to respectfully differ and offer alternative solutions or ask their peers to explain on any concepts that they would need clarity on only after giving a positive comment on their peer's work. Some examples that were common were.

> You covered the first or second or last part of our lesson objectives and success criteria, however your presentation could have been different if you had included the requirements of success criteria number x which is in line with objective 1 or 3.

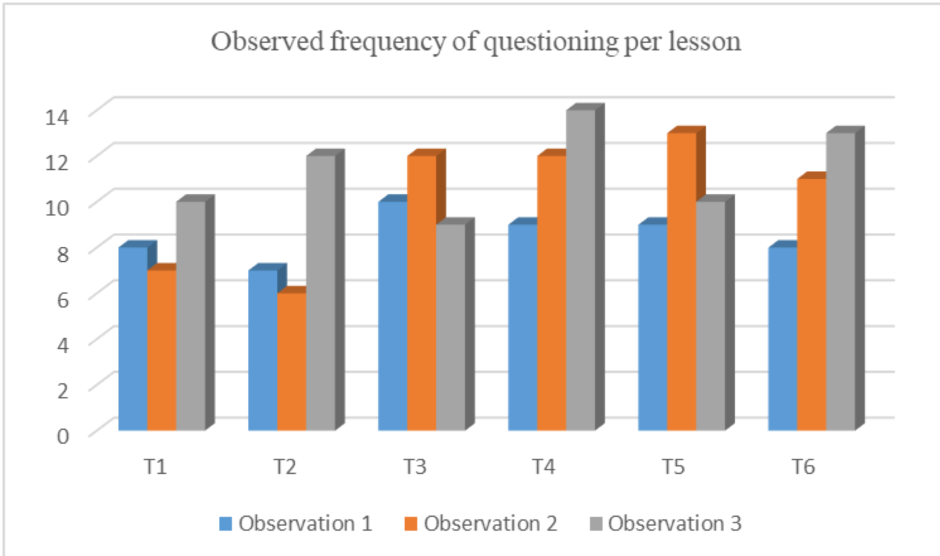
Regular frequency of teacher questions

Half the classes observed were having their teachers asking questions at regular intervals. Teachers were giving students time to work on tasks and would then pause the lesson to formatively assess the students before they could move on to sometime new. Giving students some time to think over questions before answering proved to be effective in encouraging critical thinking. Teachers who had planned for assessing the classes formatively were better prepared and had regular time intervals for assessing their learners. Their questions had better structure and allowed for students to be challenged with higher order thinking questions each time they got their answers correctly and for students who struggled teachers' questions were structured in a way that allowed for some recovery and support toward students being able to recover and offer guided answers from either their peers or from follow-up questions.

The frequency of questioning varied greatly among the six classes with only T4 and T6 showing a progressive increase in the number of questions with each observation. T1 and T2 had some positive fluctuations of questions where during the second observations there were fewer questions than the first and the last observations. T3 and T5 had more observed questions during the second observation period than at any other time as shown in Figure 4.5e below. Each teacher's observation is represented by different color codes with every observation.

Figure 4.5e

Observed frequencies of questions per lesson



A comparison of observed frequencies of questions per lesson over a three-lesson observation. Questions were from multiple sources but focus on the graph was on teacher questioning which led to students answering and asking follow-up questions. Questioning created an environment of interaction among members of the learning community which ensured effective and directed feedback.

Effective feedback is provided for students

Feedback given to students in two classes was deemed effective as teachers gave feedback that prompted students to think critically and beyond their initial presentations. Feedback in these two classes were unique in that students were challenged through feedback and were more enthusiastic as the feedback offered them a chance to self-reflect, self-assess, and introspect on their answers which in most cases became a platform for further research. Teachers structured their feedback in such a way that their students were always able to self-introspect and correct their errors. The linking of teacher feedback to lesson objectives made both peer and teacher generated feedback very effective for students as feedback ensured that was no disconnection between students' responses and the set lesson objectives. Feedback was immediate and in most cases was specific to either a group or an individual. Teachers allowed for a rapport with their students as learners were also able to provide peer feedback and in some instances the learners would provide useful feedback to their teachers' input. This in the researcher's view was important as it provided teachers with the necessary data to either recalibrate or continue with the lesson.

Students are responsive to feedback

Students responded effectively and affectively to both teacher feedback and peer feedback about their work. Positive feedback gave students some form of increased energy and zeal to expand on their work while there were signs of withdrawal which was followed with greater determination when feedback challenged students to provide more detail from their work. Students demonstrated more energy and zeal whenever they would have solved a puzzle after the first feedback. Learning focused feedback which directed students towards shared learning objectives were more effective and allowed for improved interactive feedback with students using the shared objectives to justify their answers. However, when students did not get positive feedback there were also sign of disappointment on their part.

Individual tasks are given to students

In all but two classes, students were given tasks that required them to work individually and during that time teachers were creating platforms for individual contact and individual based assessment for learning with learners privately receiving their personal feedback and interacting more with their teachers on any grey areas. Students were also able to ask their teachers why certain answers and methods of doing things were not correct. Where students were working on their individual tasks, teachers were able to assist those who were struggling. In one of the classes the teacher had to provide a slightly different set of instructions and objectives to three students who appeared to have been struggling with the lesson of the day.

Differentiated tasks and instructions

Differentiated instruction were evident in C1 and C5 more than in any other class. These differentiated tasks and instructions were visible from the way the learning objectives were structured, the use of two or more success criteria and the use of station-based learning centers. In these stations students were working on the same concepts but the task for the groups were structured using a scaffolding approach. Academically gifted students were place in stations where the questions focused more on synthesis, analysis, and critic of concepts while some students had tasks scaffolded from the recall towards the higher order questions. At the end of the lesson, it was evident that students in the same class were reached by their teachers at their levels and challenged to reach a higher level than before the lesson.

Evidence of peer assessment

Only C1 and C5 had evidence of structured peer and self-assessment. Students were using green pens for peer assessment and pencils for self-assessment. Teachers made sure that students would identify the strengths of the peers' work and write comments starting with acronym W.W.W (What went well) and then end with E.B.I (Even better if) where they would offer suggestions of how their peers could have solved the problem. Students understood how to conduct peer assessment on both written and verbal presentations.

Task given promote autonomy

Four classes had systems in place to promote autonomous learning among students. After completing a topic, students were tasked with coming up with either a 3-dimensional model or a research project where they would use the scientific methods to carry out detailed research about any phenomena that would have generated interest for them. Students were then expected to expand their knowledge about the topic from such activities. Some students could be observed researching on the internet on concepts related to their lesson and pausing questions to their teachers on any new findings from the same topic.

Students given opportunity to formulate individual targets with key result areas.

In most classes students were given the tasks of coming up with their own individual targets based on the previous performance. Teachers and students discussed on how achievable and attainable targets were to be set. Students and teachers made use of available data and previous feedback. Learners would then set for themselves realistic targets and the different steps they were going to take to achieve their set targets. Most learners were creating these data driven targets by consulting with their peers for feedback and using their self-assessment feedback.

Students set their own success criteria for self-evaluation

In all but two classes, students were observed to have been creating their own success criteria on tasks that were to be self-assessed. This gave students the opportunity to self-critic and introspect. Students' success criteria were in most cases aligned to the teacher generated success criteria. Teachers encouraged learners to be more involved in the way they were assessed. Data from self-assessment were compared to data from peer and teacher assessment.

Evidence of students' self-regulation

All classes had evidence of self -regulated learning, with students being encouraged to be responsible for their work, keeping due dates and ensuring that all work posted on the online platform was completed on time. Students also demonstrated that they could work on their own following the county and State standards. Students were aware of the expectations that the schools had for them and were additionally calm and ready to accept or kindly refuse input from their peers.

Evidence of project-based learning

Teachers in all but two classes had their students working on some STEM projects or topic review and reflection projects where students were able to implement what they had learnt through some 3D models and other working models. The use of models was seen to have been encouraging a lot of learner collaboration as well as peer feedback as students were always giving each other feedback as they worked on their projects. In C3 students had a lot of the "*Ahaa*" moments when they were using their projects to explain the progression of simple machines to complex machines. Students were able to realize the different types of simple machines that were making complex machines making them form connections with their previous lessons. It was evident that the various projects which students were working on where from previous lessons and learners were working on extended time with their projects. In some projects there was evidence of cross curriculum links with students working on science projects while using skills that had been learnt from other subject areas.

Evidence of structured formative assessment

There was a lot of evidence that teachers were to an extent planning and preparing for formative assessments. In all classes teachers had prepared such learning tools as cards, debate assessment tools, foldable tasks, and worksheets which they were using to assess their students formatively. Teachers also made use of their set success criteria and learning objectives to redirect their students in cases where students were making mistakes. There were means of ensuring that every student needs were addressed. There was time allowed for students to work on a question in their stations or as individuals before they could respond to questions. In C6 the teacher encouraged students to discuss their answers to questions in pairs or in small groups before they could present their answers to the class and in all cases the teacher allowed peers to give their feedback to responses from other students.

Evidence of improved students' participation with the use of formative assessments

During lesson observations it was noted that in all classes, teachers and students were more engaged in a relaxed atmosphere as lessons progressed. This was despite that, teachers were asking high order thinking questions which some students could have struggled with in summative assessment, due to the class support structures students worked together to complete given tasks. Students and teachers had more time to ask follow-up questions and responses when students were asked on why they could answer some difficult questions more comfortably during formative assessment than they would otherwise do in summative assessment. Observed students' participation showed that formative assessment allowed for both learning and assessment rather than being asked questions without any room for a conversation. Both face to face and synchronous students could interact with their teachers and passed constructive as well as respectful comments to each other's presentations.

In all observed classes there was a high degree of self-efficacy among students during formative assessment as students were showing high confidence levels in their interactions. Observed trends on students' engagement showed that more students were able to participate and answer the simple recall questions than the number of students who could participate and answer higher order questions that required analysis and synthesis of scientific material.

Evidence of student work through classroom displays

All classes had sections where students' work was displayed. This was motivating to students, and they were proud to refer to their work each time they were discussing related concepts. Students could easily identify with their work and also had time to go through their peers' displayed work. Teachers also provided space for students to display their models.

Evidence of formative assessment and self-regulation in homework

There was enough evidence from the observations that teachers were working towards encouraging both self-regulation and formative assessment among their students through some of the following observed features in homework that was given to students.

Rubrics and feedback: Teachers provided students with clear rubrics and expectations for their homework assignments and used them to provide formative feedback on their progress towards meeting these expectations. This feedback can help students self-regulate their learning by identifying areas where they need to improve and setting goals for future assignments.

Reflection activities: Teachers included reflection activities as part of homework assignments, asking students to reflect on what they would have learned, what they still needed to learn, and what strategies they could use to improve their learning. This helped students to develop self-regulation skills by encouraging them to monitor their own progress and adjust their approach as needed.

Self-assessment tools: Teachers provided students with self-assessment tools, such as checklists or rating scales, to help them evaluate their own work and identify areas where they needed to improve. This had the potential helping students develop self-regulation skills by encouraging them to take ownership of their own learning and identify their own strengths and weaknesses.

Peer review: Teachers were incorporating some peer review activities into homework assignments, where students reviewed each other's work and provided feedback. This could help students develop formative assessment skills by giving them the opportunity to provide feedback on their peers' work and learn from their own mistakes.

Goal setting: Teachers encouraged their students to set goals for their homework assignments, such as identifying specific skills they wanted to develop or areas where they wanted to improve in. This had the potential of assisting students develop self-regulation skills by giving them a clear target to work towards and encouraging them to monitor their own progress towards that goal.

4.8: Summary of the Section

Students' and teachers' perception of assessment for learning is a direct reflection of what takes place in the classroom. The inclusion of students in terms of interaction through feedback and differentiated questions showed that students had positive perceptions towards assessment for learning. When teachers make effective and learning focused use of formative assessment, the community of learners and the teachers tend to view formative assessment as an aide to learning that improves on self-efficacy, motivation, and self-regulation in their learning process. Learning-focused feedback directs students on what would have been done well and what could have been done differently and this creates an enabling environment for learning hence generating positive viewpoints for formative assessment. Formative assessment allows students to be actively involved in their learning through a plethora of engagement platforms offered by assessment for learning.

Teacher perception of formative assessment reflected a lot on how well they implemented the various forms of formative assessment. While all teacher perceived formative assessment to be effective in promoting self-regulated learning their implementation was a mixed with some using formative assessment for grading while others used it in aiding learning. It was also clear that when students are motivated, they are always ready to work on their own to achieve shared learning goals.

Chapter 5: IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSION

5:1: Introduction

This Chapter presents the limitations, delimitations, implications, recommendations, and conclusion of the study marking the end of the research document. Suggestions for further studies will be provided in this Chapter. This Chapter will also give summaries of the research questions and how data was relevant or otherwise to the research questions. Implications and recommendations on how teachers perceive and implement assessment for learning are discussed. This chapter also discusses and provide the implications and recommendations of how students perceive assessment for learning and how self-regulation may be improved in learning science.

5:2: Implications of the study

The study was set out to probe the way teachers and students perceive formative assessment and how formative assessment could be used to promote students' autonomy, motivation, self-efficacy, and self-regulation in the process of learning science. Findings might be useful for scholarly work and may also be used by curriculum specialists to ensure improvement in students' learning and participation in science. Findings from this Study may revolutionize the way students are assessed in science and could help bring about the full potential of every student. Three research questions were set out as part of the probe, and these are discussed in the following sections. This study may also be used in making future research towards how students may be assessed effectively in other subject areas. Some findings from this study may form the basis of future related studies.

Findings from this study where from a single county, but it may also be generalized for other counties in the State of North Carolina and may be generalized for other regions. Results from a single county may have presented some limitations to the study, however, the demographic composition of the county is reflective of other counties in the State. The study could therefore be used in other geographical regions to improve students and teachers' perceptions on assessment and possibly help in closing the achievement gaps and encourage positive perception towards assessment for learning in particular and assessment of learning in general.

5.3: Limitations and delimitations

While the researcher put in place every possible measure to ensure that the results of this study were reflective of what was in the study area, there were some factors that could have affected the quality of data collected. The study area was a single county and data for this study were only collected from the study area. This means any data that could have been collected from nearby jurisdictions could not be used or collected as there are jurisdictional boundaries even in some places where learners could be from the same or nearby neighborhoods. Including other nearby counties could have added more data to the study and such data could have been analyzed to see if there were any similarities or variations for analytical purposes. While this could look as if there was going to be some additions, it could have added more pressure on the researcher as time was another limiting factor even for the single county. Collecting data for 7th graders was limited to one year and time to collect data was further limited due to school closures because of the COVID-19 pandemic. The number of available participants thus became another limiting factor. The way students were learning during the pandemic was alien to all involved as there were a lot of changes, challenges, and fears of the unknown and known effects of the pandemic. This may have certainly impacted the study as the way students were being assessed was slightly different from the pre-pandemic era. This presented additional limitations as there were restrictions on the number of students who could be met at a single time. Social distancing protocols that were put in place during the time of study presented barrier to normal human interactions meaning that the way students interacted during the study was not the usual way they would interact without such restrictions as face masks, hand sanitization and social distancing.

The frequency and duration of interviews was also compromised, and this could have been different if the pandemic had not come at the time. Both the frequency and duration of interviews were at minimal to ensure that all those involved in the study were safe. Traveling restrictions and having to seek additional permission to visit schools also presented additional and unplanned phenomena. This could have presented some limitations for the researcher in observing and discussing with teachers on their perceptions and planning for assessment for learning. Facemasks created another barrier as facial expressions were not as visible with masks which could have also altered the way some qualitative data were being generated.

Time spent with focus groups could have been increased from three times for the duration of study to double or more than double the time to collect more data from both similar times of the year and different times of the school year. This could have improved the way the study could have witnessed how self-regulated learning in science may have been improved.

While it was cost and time effective to sample 7th graders, a larger sample could have been included even from other middle school classes and other counties as this could have generated more data which could help in generalizing data. Such data would have added to this study a wider selection of students' responses to how they perceived assessment. The same data could have also added to this study other ways of improving self-regulated learning in science from varied perceptive.

5.4: What are students' experiences and perceptions of the way formative assessment is used in science?

The way students perceived formative assessment evolved from the initial time until the end of the study period from being negative towards being positive. The more students understood the concept of assessment for learning the more they appreciated it. Generally, students were more comfortable with formative assessment due to its non-judgmental character and the fact that it encourages students to gain in their knowledge. Most students stated that formative assessment encouraged them to have greater motivation and self-efficacy as they could take control of their learning experiences. Students reported that formative assessment removes the spirit of competition and failure and replaces these with cooperation, personal academic growth, and success. Students reported that they had control in their learning since they could build new ideas from their past experiences which further supports the constructivist theorists such as Matthews (2006).

Formative assessment helps in redressing inferiority complexes that are experienced by low achieving students from summative assessment. Students also stated that assessment for learning was important for their mental health and greatly reduced bullying in their schools as nobody would pick on others due to low grades. Some students also mentioned that they felt that assessment for learning made them feel involved, valued, and welcome in their learning. Assessment for learning proved that students feel involved in their learning and through this involvement they shed off their fear of failure and inferiority complexes. Students then develop a sense of ownership of their assessment as well as their learning leading to positive learning experiences that eventually help them in closing the achievement gaps. The experience of foregoing fear and replacing it with hope and confidence was an important student experience from formative assessment.

Students felt that while summative assessment offered some boundaries as to what they learn, formative assessment offered them limitless opportunities for following their educational imaginations. This was the same with the concept that was coined by Bandura (1991) that states that self-efficacy incorporates peoples' cognitive, motivational, affective and selection processes as they learn. Students also revealed that formative assessment gives them autonomy over their work enabling them to explore and research over and beyond what they would have been doing in the classroom. This was also evident in studies by Reeve (2006) who also mentioned that when students have a say in setting their goals, selecting learning activities, and making decisions about their education, they are more likely to be motivated and engaged in the learning process.

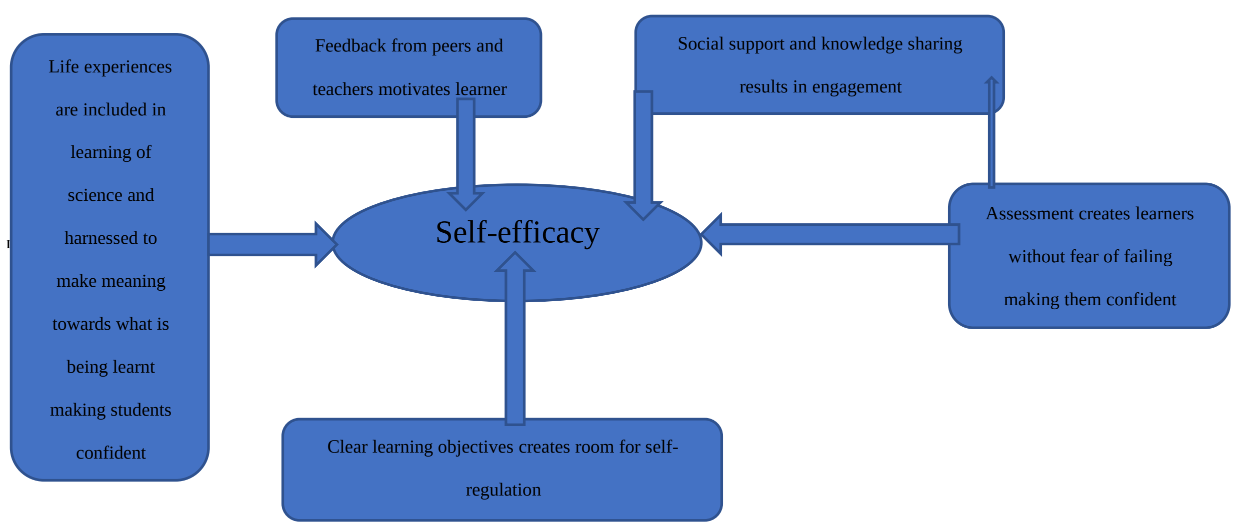
It was evident from the study that the effectiveness of formative assessment was anchored on students' involvement in their learning process. The way students perceived and explained their experiences with formative assessment had five characteristics which were congruence, authenticity, consultation, transparence, and accommodation. Students believed that their learning should reflect their shared success criteria and be related to their own previous experiences and study context.

Students highlighted that they needed to have a say in how they are assessed and that the process should be clear and responsive to their individual differences. Autonomy helps students develop a sense of responsibility and accountability for their learning outcomes. When students have the freedom to make choices, they also learn to take ownership of the consequences of those choices, which fosters personal growth and development (Deci and Ryan2008). Students held high beliefs that they were more capable of reaching greater academic heights through assessment for learning when they are involved in the way they are assessed. It was clear from the students' perspectives that when assessment is meaningful to them, then they are most likely to perceive assessment from a positive point of view. Autonomy promotes self-regulated learning, where students learn to monitor and manage their own learning strategies. They develop skills such as goalsetting, planning, self-reflection, and self-evaluation. These skills are valuable not only in academics but also in various aspects of life.

The challenge with assessment is that most of the times assessment tends to be teacher centered, teacher and curriculum sensitive while ignoring the needs of those it is supposed to be intended for. Assessment should not end in the classroom, there is need for the process to be continuous even outside the classroom. Parents, guardians, and peers need to be involved and play a role in the process. Figure 5.1 below summarizes how students created a link between self-efficacy and other focus areas of the study.

Figure 5.1

Self-efficacy and related phenomena



The link between self-efficacy and students' learning experiences.

Data from both students and teachers showed a symbiotic relationship between student motivation and self-regulated learning as well as autonomy. Of the few students who reported that they were not aware of their curriculum pathways, the same also had difficulties in working independently. Studies by Beecher and Sweeny (2008) also confirmed something almost similar to this when they reported that when students were aware of their curriculum pathways, they were able to close the achievement gaps. They also argued that when students have knowledge of the curriculum, and it is enriched to suit individual student needs it encouraged families to support their children towards their schoolwork thus improving students' engagement. There was a positive relationship between students who were motivated from feedback by either their peers or teachers and creativity in their individual work. These students had greater roles in controlling their learning needs and coming up with self-generated solutions to challenges. There was also an agreement from both students and teachers that formative assessment was important in motivating students and formed the basis for them developing interest in venturing into complex scientific concepts of their curriculum.

Most of the students who took part in this study pointed out that formative assessment gave them a rare window of learning opportunities as they felt that assessment for learning offered them the best form of assessment. Such findings may need to be taken onboard by the State curriculum planners to ensure that assessment for learning is given equal value with assessment of learning in schools.

Students felt that their work was valued, and teachers were taking time to listen to them, which was unlike the case in assessment of learning where they had very little say and spent most of their learning time listening to what teachers had to offer and trying to complete what was subscribed by the syllabus. Students revealed that assessment for learning made learning more interesting as it created a real-life opportunity for them, where challenges arise and then people must assess the challenges before coming up with possible solutions. Students felt that formative assessment gave them the assurance that it is ok to make mistakes unlike developing a feeling that once a mistake has been made then it is the end of the road. The philosophy of 'no child left behind' would be realized if assessment for learning were to be valued. Many students reported that with assessment for learning they could identify their weaknesses and had the chance to self-correct and consult with their peers before they attempted again. One student even cited the quotation from the Basketball icon Michael Jordan, who once said that he had missed more baskets than the shots he had made in the game. The student then justified this by stating that no matter how many times you fail to make it in formative assessment there is always a way of success as the assessment type is there to make student achieve not to make them fail. While students perceived assessment for learning to have been beneficial, more can still be achieved if greater emphasis is put into research about how best to achieve the benefits of formative assessment.

Formative assessment gave students the will to come to school every day, knowing that they would be listened to and communication among members of the school community created an enabling environment. They saw formative assessment as a way of encouraging them to be more independent in their learning and be able to be more innovative. Students viewed formative assessment positively and were more willing to be assessed formatively than being assessed otherwise. They exhibited no fear of assessment for as long as it was assessment for learning with most students reporting that it was beneficial to them.

The learning environment created using formative assessment resulted a different atmosphere from what would obtain when students were taking some summative assessment. Observations revealed that the later imposed a tense atmosphere and undue competition instead of cooperation among students. Students perceived formative assessment with a positive mindset, and this is a necessary link in ensuring that learning is inclusive of both meaning and interest among students. The inclusivity of learners' input that is offered by formative assessment if properly administered, has the potential of unlocking the hidden academic talents which is among many students (Mangwaya, 2015). Students also perceived formative assessment to be an enabler of learning which was on its own highly motivating for them. The Covid-19 pandemic has increased the use of formative assessment in schools and students have come to embrace assessment that is learning-focused than assessment that is focuses on how much has been learnt (PowerSchool, 2022).

Students have also shown that even when they are on the outer edges of the normal curve such as the struggling and the gifted, they particularly benefit from formative assessment. These students have learning needs that are often unique and specific, and the teacher needs timely data in order to address them. Such data can only be possible when formative assessment is consistently and effectively employed in the classroom (NCDPI, 2020). In related studies it was also revealed that when formative assessment is effectively implemented it helps students in closing the achievement gap (Greensetin, 2010). This was also revealed by Black and Wiliam (1998) who mentioned that students reported that they were more engaged and saw the link between their curriculum and set learning targets when formative assessment was used in their classes. The use of formative assessment has been known improve student motivation as formative assessment instructional activities feeds into their natural curiosity about the world (Filsecker and Kerres, 2012).

Data from students showed that students embrace assessment for learning as encouraging deep learning. Deep approaches to learning are associated with students' intentions to understand and construct the meaning of the learned content, whereas surface approaches to learning refer to students' intentions to learn by memorizing and reproducing the factual contents of the study materials (Gijbels et al., 2005a, 2005b). Students can learn more through formative assessments than they would otherwise do through assessment of learning. Formative assessment, therefore, encourages students' motivation, self-efficacy and self-regulation.

Assessment should no longer be seen as something separate from instruction, administered at the end of the learning process, but also as a powerful tool for promoting deep learning activities (Dochy and McDowell, 1997; Sambell et al., 1997). Students have shown that when they are assessed formatively, they are better suited to link instruction with reality and be able to be more innovative. It is innovation that is lacking in today's science classroom and the danger is that going forward is the future is void of innovative minds then we cannot face a future so uncertain (Dochy and McDowell, 1997).

Results from this Study have shown that students change their attitudes towards assessment when they realize that they will be actively involved. Formative assessment encourages giving students a say in how they learn through opportunities to practice skills and to consolidate learning as well as providing knowledge of outcomes and corrective feedback and helping students to monitor their own progress and to develop self-evaluation skills, guiding the choice of further learning activities to increase performance; helping students to feel a sense of accomplishment (Gijbels and Dochy, 2006).Through assessment for learning our assessment processes shift from assessing students on what we want them to know but rather on what they want us to know from their learning experiences. The way students perceive assessment determines the way they would prepare and involve themselves in the perceived subject area.

Furthermore, some of the benefits of formative assessment that were realized during the Study included enhanced student motivation because formative assessment involves setting learning goals and measuring the progress towards those goals, motivation increases. When students have a focus on where they are aiming, results skyrocket with greater intrinsic motivation. Students need to find meaning in the work they are asked to do in the classroom. Connecting the learning objectives with real-world problems and situations draws students into the instructional activities and feeds their natural curiosity about the world. This Study showed that there was increased student engagement due to the various activities embedded in assessment for learning.

The way students perceive success in learning is also another contributory factor towards how they perceive assessment. Success in learning tends to be linked to passing in summative assessment. The process of learning is often ignored as all attention is on the results of assessment of learning. Society has been structured and geared to perceive success only in terms of grades from tests. As a result, students' experiences with assessment have been associated with stress, anxiety, and fear of failure where effort is more about avoiding failure than acquiring lifelong learning.

Lastly the way students would perceive formatives assessment reflects the culture of assessment at the school. Schools that tend to utilize formative assessments had more students who perceived assessment with all positivity than those that rarely utilized them. Van Kleij (2019) found that higher-achieving students were more positive in their perceptions of formative assessment through the feedback given by their teachers than were lower-achieving students. Students' perception of assessment is therefore cultivated through the school assessment culture. When students are exposed to formative assessment, they develop confidence with any other forms of assessment (Dochy and McDowell, 1997).

5.5: How do teachers interpret and implement assessment for learning in science?

There was no single answer from teachers about how they implemented and interpreted assessment for learning in science, though from the variety of answers it was evident that assessment for learning created an environment where learners were really having a say and a role in their learning. The challenge of lack of clearly defined and universality in how teacher interpret and implement assessment for learning could also be contributing to why assessment still frightens learners. Assessment for learning does not yet represent a well-defined set of artefacts and practices (Bennett, 2014). Teachers were facilitating learning in different ways which improved student to teacher, and student to student interaction. This made learning science more interactive and joyous for the students. All teachers agreed that formative assessment was a game changer in the learning of science as it encouraged smart working instead of hardworking. They pointed out that formative assessment relieves them of pressure during the lesson execution and allows their students to do most of the work while their roles were more of facilitation and redirecting the way and direction the lessons were to progress. Formative assessment in teachers' views provided a platform for students to express themselves more than they would through written work. Teachers agreed that formative assessment makes learning more natural and as such allows students to adapt naturally to instructions. Formative assessment enhances teaching and learning especially for those students who face challenges with summative assessment (Alverez et al., 2016). Some teachers were using station-based learning, projects, and interest-based learning in implementing formative assessment in their classes. Although most of the teachers were not assigning any grades for students' work from formative assessment, a minority were using formative assessment for grading, and this helped in improving their students' preparedness and motivation. Teachers also noted that when they used formative assessments the data, they generated allowed them to examine and adjust their instructional methods. This ensures that students would consistently produce the desired results as students would be exposed to personalized learning experiences (Black and Wiliam, 1998). Data driven decisions from formative assessments can help ensure enhanced students' success. Data gathered from formative assessment helps teachers make sounder, and informed decisions regarding their approach to class material (Power School, 2022).

Teachers were also in agreement that formative assessment enabled learning and allows students to perform better in their science tasks when they are formatively assessed. The frequency of formative assessment implementation differed with individual teachers. Teachers who took time to plan and prepare for formative assessment took more time engaged with students than those who used formative assessment as a way of ensuring that the lesson goes on. There was more engagement and more scaffolding of questions with the former than with the latter. Assessment for learning entails carefully designing situations or asking questions so that the elicited evidence can be connected to critical components of domain understanding, an issue (Bennett, 2014). Assessment for learning involves making inferences about what teachers perceive in students hence the need to ensure that such inferences are backed by data thereby establishing evidence-based instructions to improve students learning (Chudowsky, and Glaser 2001).

Teachers have been innovative in the way they teach and with the promotion of formative assessment students are able to showcase what they know and be directed towards improving what they already know to the unknown and undiscovered scientific knowledge. The use of formative assessment allows students to be innovators and drift away from the passive recipients of knowledge and be the creators of new knowledge in a dynamic world (Black and Wiliam 2008). When students were asked to research on topics of their interest it was clear that the work, they produced was always way above their expected standards. Teachers, therefore pointed out that formative assessment was in a way more inclusive to all involved making students become architectures of their scientific knowledge.

When teachers modelled the way students should offer feedback to their peers, the results are always impressive. There is a lot of value in what students can see, they offer alternatives and multiple insights into what would have been presented. Feedback from all directions encourages critical thinking which in most cases challenges students to improve on their work. Peer feedback and self-feedback are health for autonomous learning as students are able to critic their own work basing on how they would critic their peers' work. Teachers also mentioned that formative assessment in science went over and beyond the core standards of science as it helped students to become excellent negotiators and critical thinkers in situations that would otherwise turn nasty.

As pointed out by Venkatesh (2017) formative assessment proved that improved learning could take place during assessment when this is done formatively, students and teachers utilized formative assessment in both their synchronous and asynchronous classes with encouraging outcomes. This Study agrees with scholars like Liu and Matthews (2005) who coined the statement that knowledge is not mechanically acquired, but actively constructed within the constraints and offerings of the learning as most students who were exposed to formative assessment demonstrated that they were indeed the drivers of their own learning processes. It could be observed in the focus groups that indeed students were comfortable with formative assessment as every student could be seen contributing to their learning processes, no student was left behind as every student had a role to play during the lessons. Teachers also revealed that before taking part in the research they never envisioned the impact of formative assessment in the teaching processes but due to both the pandemic and the study they realized that students could benefit more when assessment was done formatively than it would have been through summative assessment.

While this study confirmed what earlier researchers have pointed out about the positive effects of assessment for learning, the study also included how students perceived assessment and added on to knowledge about how their perceptions may be harnessed towards improving the process of assessment in schools. During the study it was evident that students enjoyed and immersed themselves into science when their teachers were using assessment for learning. While the study was limited to a district in North Carolina, the same results would likely come out from a similar study under similar environments around the world.

Another implication of the study was that it provided stage for utilizing formative assessment for asynchronous students by ensuring purposeful engagement with members of their learning communities. The study also showed that when students were exposed to formative assessment, they are more likely to expand on their learning horizons through research into their areas of interest. Formative assessment motivates students and provides a good platform for both interest-based learning and project-based learning. This study also revealed that the interpretation of assessment for learning by teachers was mostly dependent on what the school departmental heads of science prescribed, it was evident that some teachers needed more research into the concept of formative assessment as some used formative assessment as an after-thought without due planning. Clearly laid out curriculum expectations on formative assessment at school and district level would certainly give structure to formative assessment. Teachers need to realize that assessment for learning is more than giving positive or encouraging questions or asking students to clarify, but it should have more to do with developing learners into critical and analytical thinkers who should go beyond just addressing the trivial phenomena (Black and Wiliam, 2008). Such was the challenge observed in some classes where formative assessment rarely addressed higher order thinking skills. Some teachers did not fully challenge their learners for fear of breaking their students’ egos and levels of confidence.

Teachers also revealed that formative assessments have helped them in generating data driven decisions when planning for their lessons through reflections from observations during lessons.

5.6: How can assessment for learning be used to encourage self-regulation in science?

It was evident during this study that students are unique, and they learn differently. If it is acceptable for learning to be directed toward individual student needs, then assessment should also migrate from the one size fits all approach towards the way students would prefer to learn and be assessed (Black and Wiliam, 2008). This study provided some unique ways that are used by teachers in different scenarios to enhance self-regulated learning in science. It is important for students to own their learning and for learning to be personalized to the student for learning to be student-centered (Bloomberg, 2015). From the study it was clear that students felt motivated to learn when they were empowered, as such assessment for learning must be used to empower students academically. The use of formative assessment proved to be important for students as they were showing improved self-confidence and reporting on what other science work they had done on their own. Having self-regulated learning encourages students to be lifelong learners with lifelong learning capacity (Zimmerman and Moylan, 2009). The theory of formative assessment is found to be a unifying theory of instruction, which guides practice and improves the learning process by developing self-regulated strategies among learners (Clark, 2012). It was evident from this study that when learners were involved in formative assessment, they became more engaged thus creating an interactive learning community where everyone has a role to play.

The over-reliance on summative assessment has been creating a lot of bottlenecks in the education system often relegating some capable students to being spectators of the whole learning process. Teachers who adjusted the way they assessed their students towards assessment for learning created lively learning environments where all students were autonomous, motivated, and successful. The value attached to assessment for learning need to be adjusted to suit the needs of modern societies. Assessment does not need to be discriminatory in a world that speaks of embracing differences. Science classes can be changed from being places of competition to being places of collaboration, innovation, and cooperation. The use and proper implementation could unlock the individual talents that could not be unearthed by assessment of learning.

The purpose of education is not to catch students who are struggling and dump them, but rather to assist all students to reach their full potential. It is through assessment for learning that the system will be able to increase students' achievement in science. When assessment is learner friendly, then there are higher chances that the learners will be able to produce work that is to the best of their abilities (Black and Wiliam, 2008). The education system should desist from the one size fits all approach in assessment as has been the trend and norm with individual students needs in learning. Most of the students who could not pass summative assessment were able to provide the answers to the missed questions when assessment was carried formatively. Maybe if learners who struggle with summative assessment were assessed through formative assessment approaches, then only could the philosophy of 'No Child Left Behind' would be realized. Assessment needs to afford learners multiple chances and alternatives to be successful and this is one of the several characteristics of assessment for learning.

Understanding students' concerns and challenges with assessment could help teachers address how students perceive assessment for learning and this could result greater student motivation and autonomy. When students are autonomous in their learning, they are likely to be innovative, creative and tackle higher order thinking tasks in science. Teacher involvement and support in students' emotional and mental wellbeing could also help in promoting self-regulation in students' learning.

All teachers described formative assessment as important in generating student interest and motivating them to aim for higher academic achievements.

One of the areas that students were struggling with was on self-assessment. While teachers were making use of self-driven assessment and feedback, students did not demonstrate the same level of zeal and engagement compared to peer feedback and teacher feedback. Learners could work with provided success criteria, but the majority could hardly self-critic their own work. This was also shown by students' response to questions about working independently and being creative. Students did not value self-assessment as they did with teacher assessment. Because assessment is evaluative, teacher assessments impact students' grades and perceptions of their writing competence (Andrade, Wang, Du, and Akawi, 2009). As a result, assessment should not be entered into lightly and must be based on best practices. There is need for teachers to cultivate a culture which promotes self-assessment from informed self-feedback to promote a better perception of the evaluative nature of self-feedback and self-assessment as this feed directly into students' self-efficacy. Self-evaluation procedures ranged from teaching students to use a rubric to assess their work and modeling of science projects. Though self-evaluation has a potential to improve students' perceptions and competency in formative assessment it was one area where research findings showed the need to come up with a paradigm shift from both learners and teachers. Close to 14% of the students did not know the pathway of their curriculum and this probably impacted on how their ability to generate solutions to challenges where 9% of the students, lacked ideas of coming up with solutions and creativity where 4% of the students felt that they were not encouraged to be creative enough.

Another area where formative assessment could be improved was on how teachers structured both their comments and instructions. Some students were struggling with literacy as they were not English language speakers. Differentiation and scaffolding of instructions, comments and criteria for success could be improved to ensure equity and justice for students who were having challenges with language barriers. Asking students questions with language adjustment for second language speakers could also go a long way in addressing the language barrier for such learners. Teachers could also utilize station-based learning and have second language speakers in stations where they are most likely to benefit through modified instructions and feedback.

Assessment for learning incorporates self-regulation which encompasses the monitoring and managing of one's cognitive processes as well as the awareness of and control over one's emotions, motivations, behavior and environment as related to learning (Schraw and Dennison, 1994). Self-regulated learning is learning that is guided by metacognition, which is thinking about one's thinking, strategic action such as planning, monitoring, and evaluating personal progress against a standard, and motivation to learn. Self-regulated learners should therefore take control of an evaluating one's own learning and behavior. To ensure the success of self-regulation through assessment for learning Schraw and Dennison (1994) proposed that students should have cognitive knowledge which is declarative knowledge of "What", procedural knowledge of "How" and conditional knowledge of "Where, When and to apply". When formative assessment is structured in a scaffolded pattern it allows learners to control how they learn, use their intellectual strengths to compensate and build on the weaknesses (Bloomberg, 2015). This Study also showed that self-regulation improved with formative assessment as students could change strategies whenever they did not understand and think about what they really need to learn before they begin. This was also mentioned by Bloomberg (2015) who stated that self-regulated learners consider several alternatives to a problem before they can attempt to come up with a solution. The author also stated that self-regulated learners make use of thinking maps such as diagrams and drawings. It is therefore important to encourage learners to come up with various and independent ways of summarizing and planning their work.

Including other related teaching / learning activities such as lesson starters in science lessons should not be regarded as being time wasting as such activities carry a lot of value and significance in the way students prepare to learn and engage in the actual learning processes. Such activities help students to transition from one activity to another and this reenergizes them and make them more alert and better prepared for what would come thereafter. Lesson starters unlock the lesson and makes the lesson lively while building a strong bond between students and their teachers (Ghana Education News, 2021). This lays some fertile ground for effective assessment for learning, feedback, self-efficacy, and motivation of students.

Formative assessment requires a lot of interactions in the learning community and these interactions include collaborating with others. This study revealed that when students collaborate with their peers and their teachers, they adapt their learning skills and better able to self-regulate and self-assess. Not every student learns the same way, and with interaction creativity and modifications are done to ideas thus expanding knowledge and scientific skills. The interpersonal interactions that are generated through collaboration create a good basis for peer review of each other's work and that fosters the concept of self-regulation in learners where the learner activates and sustains their cognition, motivation, behaviours and feelings towards the attainment of a learning goal (Schunk and Green, 2018b).

5:7 Recommendations for application

The following recommendations were made after the study these recommendations may be combined with others from similar or allied studies. There is need for a paradigm shift with regards to the weighting of students' assessment from giving too much value towards assessment of learning towards assessment for learning as the latter is a true reflection of what students know. That way our learners should be assessed in what they really know as opposed to encouraging rote learning. Grading of students' work should put greater emphasis on formative assessment as this will motivate students towards autonomous learning. Grading needs to be reflective of real-life situations where when one makes an error of judgement there should be room for reflection and correction of reasons and reasoning behind having reached at a certain decision.

Assessment for learning needs to take an equity approach and shift away from an equality approach as methods used are more inclined towards majority groups while ignoring how learners from minority and marginalized groups are socialized and exposed to their environments. Assessment should be more embracing towards differences in people's way of lives rather than expecting all students to be experiencing uniform experiences. Indigenous knowledge systems of local communities need to be included in the way students are assessed, that the assessment environment is levelled. Assessment should be sensitive of where learners are coming from, lest some students are put at a disadvantage and disenfranchised even before the assessment process begins.

Counties could look into possible ways of involving local leaders and the community at large on how they could input their ideas about students could be assessed formatively in a way that resonates with the way society functions.

More focus should be given to formative assessment in the science curriculum than is the case now as students tend to be more engaged in their learning when they are assessed formatively than when they are assessed using summative assessment methods. Formative assessment presents a healthy learning environment where learners do not have anxiety and stress associated with assessment of learning. Therefore, teachers should recognize that learners stress because of summative assessment and adjust assessment for learning to ensure that learners are motivated through formative assessment which in itself presents a learning platform.

There may be need for formative assessment to have a common structure or guideline for the county which could be formulated and implemented by teachers, Teachers need to plan for assessment for learning implementation with scaffolding of questions towards improving students' understanding in a similar manner as they do for summative assessment. This will ensure that formative assessment in the classroom is not an afterthought set of questions that are paused to ensure that students are seen to be engaged but an integral part of lesson planning and implementation. In most cases it was observed that teachers would have a set of written questions for assessment of learning, yet they rarely had any written questions for assessment for learning. This could be compromising the quality of teacher formative assessment questions and the quality of feedback provided. Teachers should have a set of questions to be used as skeletal assessment for learning guides. Having well set out questions should not form a straight jacket approach toward formative assessment as these questions could be modified to fit individual needs and lesson demands. Another important and related paradigm shift should an evolution from student centered learning toward student-driven learning where there is greater student autonomy on the science learning process.

While lesson plans have proved to be very effective in lesson delivery, they should not be used an assessment for learning tool. There should be some separation between lesson plans and assessment for learning. Teachers may feel that planning and witting down questions for assessment for learning is time consuming but once they have been put to use the long-term benefits are worth the time spent on preparing them as this would improve both the quality of questions and the quality of learning. Properly created assessment for learning questions would take a lot of work away from teachers in the classrooms as students would do most of the work while the facilitation role would the only function of the classroom practitioner. Teachers should also encourage students to structure their own questions by using the shared learning objectives and success criteria. More project-based and interest-based learning could be included in the science in the science curriculum as these promote greater student participation, motivation, and self-regulation. This was also advocated for by Scott (2021) who pointed out that project-based learning drives learning and builds students' engagement and confidence. In this way our schools will produce more innovative students who are able to come up with workable solutions to world problems. Facts are there to prove that an increasing number of present-day innovators are either school dropouts or had very minimal formal education, if the young boy from Malawi could harness the wind and a school dropout in Zimbabwe could build a drone from scratch. Scholars should be asking questions and generate answers about why it is that many of our science students who pass the summative assessment have not done much in innovation? That should be a possible indicator on the ineffectiveness of what we are currently implementing. Our curriculum should take a systems approach with clear inputs, processes, and outputs. We need to challenge our students to learn from a futuristic point of view than to learn science from a historical perspective. Teacher feedback towards students' work should challenge students in such a way that they will be able to generate both interest and the zeal to better their understanding. Teachers should never take the effect of their feedback lightly as it has far-reaching impacts on the students they serve. The same should also apply to peer feedback as research has shown that students learn better when they interact with their peers than from teachers. Learners should be encouraged to give feedback that points out what would have gone well and what could have been done differently without being judgmental. The role of the teacher will become more of a facilitator of learning than that of someone who knows it all. Formative assessment tasks should be used to create more room for learning than to expose learners' shortcomings.

When using any form of assessment of learning to probe for answers and reasons from students, teachers need to give their students ample time to think about the answers as well as the possible reasons for such answers. There is no need to rush students into giving answers, this will allow the critical students to have time to think about thinking, reflect on their answers and then give well thought out responses. Assessment for learning should be considered as a form of communal learning where every student should feel the value of contributing towards their learning process. Teachers should therefore ensure that their students are given equal opportunities to contribute towards the knowledge tank. Competition should in most cases be replaced by cooperation when students are engaged in formative assessment. No students should feel bigger than the class and neither should student feel belittled and unable to make their contributions.

There is need for teachers to share objectives and the success criteria for the concepts they would be introducing to the learners. It was evident during the study that when objectives and success criteria were clearly spelt out in a simple language that learners understood there was more engagement during the learning process and learners were easily motivated. It is always a good idea for people to know where they are going before embarking on a journey. That way if, learners are made aware of the success criteria they are better positioned for success compared to a situation where they are not aware of what they need to do to succeed. Linking success criteria to lesson objectives is also helpful in self-assessment, peer assessment and above all learner progression.

Learning community collaboration needs to be encouraged as learners tend to gain more and retain more from their collaboration than from the traditional classwork. More collaboration makes learners become the owners and sculptors of their own learning process, which helps in student self-regulation. Allowing students greater collaboration teaches students life skills such as negotiation, cooperation, and innovation through modification of ideas and experiences. It is through such experiences that some learners will be able to develop and sustain self-regulation and autonomy in learning. This should allow for the construction of knowledge from shared experiences.

Teacher training curriculum should equip trainee teachers with skills that allow them to administer formative assessment during classes in a way that would remove the fear of failure but encourage the philosophy of trying to improve from what is already known. Formative assessment should be responsive to students' affective and emotional domains so that no student should feel isolated or rejected due to low achievement. When teachers have a clearer and better understanding of how to implement assessment for learning they will be comfortable with using formative assessment with a positive mindset. Formative assessment should allow students to take control of their learning and be able to formulate their learning goals.

Communities that are served by schools also need to be informed of the benefits of formative assessment as they are also a vital cog in the learning process for students. Community perception of formative assessment determines how well students will embrace it. Public awareness has been used to convey different messages across the globe with high success rates, the same could work if the general public is made aware of the benefits of assessment for learning as acceptance of formative assessment at community level will positively impact students' perceptions of formative assessment.

Science teachers should be encouraged to make their lessons more interactive by including activities from across the curriculum to motivate their students. This is because not all students learn science the same way. Using the cross-curriculum strategy in assessment ensures that no science student is left behind while at the same time the strategy will encourage some students who have interest and strength in other subject areas to have something that they know and combine it with science. This will encourage self-efficacy and innovation thus allowing students to make meaning of their learning.

Teachers need to constantly monitor student growth and adjust instruction to ensure continuous improvement. This could be done through individualized and immediate feedback that addresses the learners' strength and shortcomings as well as possible or alternative ways of creating self-regulated and autonomous students. Feedback should challenge learners to think outside the box and be able to scrutinize themselves. They would find it easier and more predictable to progress towards meeting the standards on summative assessments. To achieve this there is need for teacher to realign their teaching methodologies more towards student centered and learner driven lesson from the traditional teacher driven lessons

By understanding exactly what their students know before and during instruction, educators have much more power to improve student mastery of the subject matter than if they find out after a lesson or unit is complete. When teachers understand where their students are coming from, they are better positioned to formulate assessment for learning tasks that meet the needs of their students where they are and not at the teachers' levels. To attain this, teachers should be encouraged to be part of the communities they serve instead of separating themselves from such communities.

The strength of formative assessment lies in the critical information it provides about student comprehension throughout the learning process and the opportunity it gives educators to provide students with timely and action-oriented feedback and to change their own behavior so that every student has an opportunity to learn and re-learn.

The students who are performing on the outer edges of the normal curve the struggling and the gifted particularly benefit from formative assessment. These students have learning needs that are often unique and specific, and the teacher needs timely data to address them. Therefore, when teachers effectively use formative assessment methods, they are better placed to provide timely remediation hereby improving student achievement.

Teachers should be encouraged to have cross curriculum links for most of their lessons as this helps students learn from multiple fronts. Students need to realize that the curriculum is inter-connected and Mathematics skills can be used in Physics while science as a subject is not only about the lab but a holistic subject that impacts on their daily lives.

There should be flexibility in the way students are assessed and the use of formative assessment should be allowed for students' final grades as research has established that all learners learn differently. As such the same should the case with the way students respond to assessment. They are individuals who are capable of producing their best if assessment is student centered and not curriculum and teacher centered as it currently appears to be.

Formative assessment in the schools that took part in this study seem to be more Eurocentric in approach and as such learners with Eurocentric backgrounds could draw more their cultural experiences than those from other backgrounds. The use of other forms of assessment such as graffiti was viewed as being from the ghettos and was not used yet the schools had high student populations from such neighborhoods. This could be a perception phenomenon which may be negatively affecting such students' experiences and learning hence negatively affecting their own perceptions of assessment which could eventually affect their motivation and self-regulation.

The concept of assessment remains dynamic as education itself hence the need to research on contemporary assessment methods that resonate with the ever-changing world. It is the link between assessment for learning and stakeholder perception that is missing in most research. There is need for a holistic approach which takes account of teachers' and students' concerns, where both stakeholders and stockholders are taken onboard instead of looking at them separately.

The students' voice is missing in most cases and decisions are always made with little or no consultations. Understanding the way children learn can never be fully realized if the children themselves are often alienated from the planning processes. Many educationists advocate for student-centered approaches in learning, yet the same students are seldom involved in issues of assessment. While inters-school and intra-schoolteacher collaboration is evident in some instances, it is highly likely that more teacher interaction within and without their schools on methods of assessment for learning would be helpful to many who could benefit from expanded professional communities. It is time that education policy planners and educators should include students in how they should be assessed a transition toward student-centered should accompany student-centered learning. Teachers should shift from administering assessment to facilitating assessment in the learning environment.

If the way students interact in sports and clubs could be extended to inter-class and intra-class conversations and symposium many students would benefit a lot. Teacher should encourage cross class interactions through online quiz and scientific puzzles that would require students across the school to be participants.

5:8. Recommendations for future research

The study highlighted the need for students' assessment grades to be based on the process of learning through formative assessment and summative assessment instead of the end of the learning process where achievement is only reflected by summative assessment grades. It would be valuable if more research is carried out to establish how formative assessment can be used for asynchronous learners in a way that would have similar outcomes with synchronous learners. The aspect of students being active participants in their assessment processes instead of them being relegated to being passive recipients of pre-generated assessments should be further investigated. Science teachers need to include more problem-based learning in their lessons. Such lessons should include real-life problems that may be unique to the students' environment or those that may be of global nature. These would promote research into real-life problems as well as reflections and review of envisioned solutions. Teachers need to create room for learning that is data driven from what students would have collected. Challenging students to expand on the known and to refuse accepting what would have been previously accepted as facts is another way promoting the generation of new and innovative ways of thinking. Research could also be carried out in establishing how the gap created by lack of clarity and understanding on how to implement assessment for learning in science could be closed or at least reduced among practicing teachers and those training to become teachers.

Middle school science needs to have sections where students are encouraged to come up with simulations of their ideas where such ideas are brought into virtual reality. This will help science students to reflect and analyze their solutions to problems before such solutions are implemented. The science curriculum needs to have more room for students to be able to create assessment questions for their peers and be able to upload science puzzles online for peer review and answers.

It is time that students become involved in the process of assessment. In future, more research could be carried out on how to promote creativity and inter-student feedback as an innovative way of science learning. It is further recommended that future science curriculum reform should focus more on what students can create from their interaction with their peers in learning science rather than what they should know from what is already there. There is also need for further research on how the curriculum can be realigned and differentiated to allow students to more independent and self-regulated in their learning experiences.

It is time to consider new ways of learning and generating ideas. Curriculum specialists need to be challenged to do away with summative assessment where grades are carrying more value than knowledge. Students need to be assessed formatively if science is to take us to unimaginable levels. The current situation only serves to maintain the status quo, some potential scientists are being channeled towards failure as wrong tools are being used to determine and encourage scientists. The zeal and the high motivation that students have towards science vanishes each time as students are assessed using summative assessment. Not all innovators need to learn the way everyone else, the uniqueness of individual students should be upheld, and schools should be places for sharing ideas and academic growth and not places where students are stratified.

All assessment should take into consideration the individual differences, that way schools will become places of learning where innovation, change and transformation originate. That will be a departure from the current trend whereby schools have become places of pride and humiliation passes and failures. Assessment for learning will produce learners who are ready to take into the world their capabilities. No child should be left behind in schools and as such no student should be allowed to be failed by the same system that made sure they are not left behind. A real paradigm shift is required in the way students are assessed in the science classrooms and laboratories.

Assessment needs to be a part of the learning process and not an indication of the end of the learning process.

More research needs to be done to establish the links between assessment for learning and student achievement as well as how students who graduate from school with only formative would fair at university level. Formative assessment is an essential component of effective teaching and learning, yet it is often perceived negatively by students, parents, and the community at large. This negative perception is often due to a lack of understanding of what formative assessment is and how it can benefit students. To address this issue, it is important for schools to involve parents and the community in the formative assessment process and educate them about its benefits.

One way to involve parents and the community in the formative assessment process is to hold parent-teacher conferences. During these conferences, teachers could explain to parents how formative assessment works and how it can benefit their child. They could also share examples of formative assessments that their child has completed, highlighting the feedback that was provided and how it was used to improve learning. By involving parents in this process, they may gain a better understanding of how formative assessment can support their child's learning and development.

Another way to involve parents and the community is to host information sessions or workshops about formative assessment. These sessions could be held in the evening or on weekends to accommodate parents and community members who work during the day. During these sessions, teachers could provide an overview of formative assessment and share examples of how it is used in the classroom. They could also provide practical tips for parents on how to support their child's learning at home and how to interpret the feedback provided by the teacher.

Involving the community may also help to positively change perceptions towards formative assessment. For example, schools could partner with local businesses or community organizations to showcase how formative assessment is used in real-world settings. This could include inviting community members to the school to observe formative assessments being conducted or organizing field trips to local businesses or organizations where employees use formative assessment to improve their work. By demonstrating the real-world applications of formative assessment, community members can gain a better understanding of its importance and value.

Additionally, social media may also be used to engage parents and the community in the formative assessment process. Schools could create social media accounts, such as Twitter or Facebook, to share updates on how formative assessment is being used in the classroom. Teachers may share examples of formative assessments and the feedback that was provided, as well as provide tips for parents on how to support their child's learning at home. This can help to create a sense of community and involvement, as parents and community members can share their own experiences and insights.

Involving parents and the community in the formative assessment process is crucial for positively changing perceptions towards this important component of teaching and learning. Parent-teacher conferences, information sessions, and social media can all be used to educate parents and community members about formative assessment and its benefits. By showcasing real-world applications of formative assessment and involving the community in the process, we can help to create a culture that values and supports this important component of education.

Schools need to create school wide enrichment teams comprising of teachers, parents and students to provide experiences that enrich and enhance autonomous student learning. This could be complemented by having teachers trained in differentiation, cross-curriculum links and autonomous student-based learning. Rigorous curriculum standards with highly engaging and thought-provoking activities should be nurtured from the elementary school level.

The COVID-19 pandemic has also brought about the need to research more on the impacts of online peer and teacher collaboration on students' achievement. This could also be linked to the socio-cultural impacts on education systems in different settings.

5:9. Conclusion.

Results from this Study revealed that when students are given an active role in their assessment in the learning of science, they become intrinsically motivated and are better prepared for assessment. This was also confirmed by different constructivists as the research demonstrated that knowledge requires those who are learning to be actively involved in the process of learning instead of being passive members of the learning community. Making use of the constructivist theory thus ensured that the researcher was always looking out for cases where learning was actively built upon from learners' experiences and how that was affecting their learning. It was also evident during the study that students could change the way they perceive assessment from being negative towards being optimistic. The way students are assessed shapes the way they perceive assessment, when assessment is linked to learning and offering learning opportunities then learners are more proactive to work towards achievement. However, when assessment is about failing or passing, then a lot of students would stress and are anxious due to fear of failure. Learning should not be about failure or passing but about the development of knowledge and ideas. Assessment for learning allows students to perceive learning from an independent point of view rather than from a dependent point of view. The study showed that students' perception of assessment for learning was positive but slides towards negative perception when assessment of learning was involved. There was evidence from the study that students' perception of assessment feeds into the way they involve themselves and eventually their achievement. Self-regulated learning improves how students perceive assessment especially if they are involved in self-assessment/ feedback and peer assessment and feedback. It was also evident during the study that when students are encouraged to collaborate with their peers, they improve in self-evaluation and autonomous learning. When teachers plan for formative assessment and modify questions and feedback to suit individual student's capabilities the results will improve both the quality of assessment and how the perceive and implement assessment for learning. Tying learning objectives and criteria for success for each lesson to formative assessment promotes student autonomy and motivates them to tackle more challenging tasks as they would be better equipped to work independently and be innovative. I hope that this study will help us understand how formative assessment can be used to improve students' perception towards assessment. A positive perception of assessment from the students' point of view has multiplier effects on students' motivation, autonomy, self-regulation, and self-efficacy. By giving learning-focused feedback, students can be able to gain more from assessment for learning. The future of science lies in the hands of the present than it would in the hands of the past. Students should view assessment with positivity and not with fear of failure. Assessment should enhance the learning process rather than impede it.

Assessment for learning ensures that students own their learning process. When students own the learning process they cultivate cool geeky interests in the learning process, they become more creative. Another positive aspect of formative assessment is that it allows students to view mistakes as learning opportunities and they learn to experiment using the scientific methods. The study also revealed that formative assessment develops a growth mindset and are even able to learn project management. It is an assessment method that helps learners in closing the achievement gap where no child will be left behind.

When people perceive assessment with a positive mindset there are greater chances of success in the whole process compared to where fear becomes part of the process. Formative assessment offers the route where fear of failure is eradicated, where learners perceive assessment as part of learning rather than a process that condemns them.

Assessment is a matter of paramount importance as it affects the whole process of instruction. Regarding the significant role of assessment, Paris and Paris (2001) argue that we need to know both the product and process of learning so that we will discover what is learned, what additional effort is required, and what skills are effective. This was one of the reasons why this Study was carried out. Owing to the fact that learning and assessment are intertwined, the growing demand for lifelong learning demands a reevaluation of the relationship between learning and assessment. This reevaluation has influenced the development of the “new era of assessment” according to Dochy, Segers, and Sluijsmans (1999) understanding the various factors that are impacted by assessment in general and assessment for learning in particular could be the answer towards understanding and improving students’ achievement in learning. The core principle in formative assessment is the process of eliciting and using information about students’ learning to adjust the teaching to better meet their needs. Other aspects consider include the use of feedback and students’ involvement in this process. The theories and principles guiding formative assessment practice are developed in regular schools, and their applicability in other educational contexts, such as for students with different learning abilities, is yet underexplored (Butler and Schnellert, 2015).

The way teachers perceived assessment for learning had a bearing on how they implemented the process in the classroom. Teachers who had a positive perception and high regard for assessment for learning took time to plan for formative assessment and included key phenomena in their lesson protocols and this resulted in high quality assessment for learning implementation where student participation and achievement improved. It is therefore necessary for teachers to fully understand the advantages of formative assessment before they can implement it. Data from assessment for learning were used in formulation of follow-up lesson, interventions, and future lessons. On the other teachers who were not taking assessment for learning seriously did not have their questions ready-made and had to use formative assessment as stop-gap measures to ensure that they kept their students engaged.

When students are exposed to assessment for learning they are challenged to employ high order thinking skills and they also developed more independence and autonomous learning traits as they became self-starters who depended less on their peers and their teachers.

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APPENDICES

Appendix 1: Teacher interviews

Years of teaching experience: ____ Number of years at this school: ________

Gender: Male ○ Female ○

Highest Educational Qualification: Associate degree ○ Bachelor degree ○ Graduate degree ○ other ○

1. How do you assess your students?
2. Do you know what formative assessment is?
3. What are the benefits of formative assessment?
4. Do you make use of formative assessment in your classes?
5. What kind of formative assessment do you use?
6. Describe the ways you use formative assessment and summative assessment in your lessons?
7. Describe how you and your students perceive formative assessment/ assessment for learning
8. In what ways does formative assessment impact on students' motivation to learn?
9. Do you link your formative assessment to learning goals and how does this impact on summative assessment?
10. How does formative assessment encourage self-regulated learning among your students? (in terms of motivation, self-assessment, feedback, and self-efficacy)
11. To what extent does formative assessment promote student autonomy in science lessons?
12. What kind of feedback do you offer to your students in the process of assessment for learning?

13. How does this feedback differ from the feedback you would give from assessment of learning/summative assessment?
14. How do you ensure that your students are motivated through formative assessment?
15. How do you structure your students' tasks to ensure self-regulation in learning?
16. What measures do you employ to your formative assessment to motivate your students?
17. Describe how you promote student autonomy through formative assessment?
18. In which ways does formative assessment improve your students' performance in summative assessment?
19. How can formative assessment be used in your science classroom to improve on your students' learning and understanding?

Appendix 2: Student interviews

Gender: Male ○ Female ○ **Age: _____**

1. What are the different ways that your work is assessed in science?
2. Does your teacher share with you a review of the lesson before it starts?
3. Are you asked questions that help you to explain or expand on the shared lesson expectations?
4. Do you usually work with other students on a science task?
5. Are you given time to ask each other how to solve any challenges that would have been presented for the lesson?
6. How do you and the other students know that the answers you have from your discussions are correct?
7. Does your teacher assign you any work in science that you need to work on as an individual?
8. Are you expected to explain your work either to your science teacher or the class?
9. Does your teacher comment when you are making a science presentation on work that you would have produced?
10. Do you feel motivated by your teacher feedback?
11. Do you feel motivated to work alone?
12. Why do feel so?
13. Do you feel like you are in control of your learning when you work at your own pace in science?
14. What are the things you like about working on your own in science?
15. Do your classmates comment on your work during science lessons?

16. Do you feel that the comments you get from your classmates help you in science?

17. Why do you feel so?

Appendix 3: Questionnaire for students

My name is Shelton Jeri and this questionnaire is meant for my doctoral studies in education. I am researching into the field of assessment in the learning and teaching of science education in middle schools. Your participation is voluntary, and you are free to decide whether to complete the questionnaire or not. Your responses will be kept confidential and will not be shared with anyone other than myself and my supervisor. Should you need to review your responses after posting please cite the number on your form and I will allocate you a code to view your responses from the Remind App.

1. Are you responding as a student in, i) FMS ☐ ii) HMS ☐ iii)WMS ☐ .

   Please mark the appropriate box.

2. Tick √ the box with the emotion that represents your opinion about each statement

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I think my teacher provides directions in science lessons at school					
I am encouraged to work on my mistakes and use criteria for success to correct myself.					
I come up with better solutions when I correct myself using the criteria for success					
I think of my own progress and check my progress and try to understand if I have improved or not by using shared objectives					
My science teacher feedback helps me to understand the content that I learn during lessons					

My science teacher feedback helps me to understand the content that I learn during lessons					
I think my classmates help me understand my science when they comment about my work					
I feel that I can work on my own when clear tasks are assigned to me by my science teacher					
The teacher encourages us to work on our own and produce our own work					
I know my science topics for the year, and I enjoy reading ahead					
I feel excited, valued, and honored when my science teacher acknowledges my work					
My science teacher encourages me to be creative					

Appendix 4: Observation template

Observation schedule to be used when making observations during lessons with participating teachers

Class code: ______________________________ Duration: ________________________

Number of students: ________________ Male:_________ Female:___________

Date: ______________________

Sharing learning outcomes	Yes	No
	comments	Comments
Learning outcomes and objectives shared with students		
Students are aware of what they are learning.		
Are concepts fully explained to students?		

Is the frequency of questions adequate for meaningful learning?		
Do students ask questions or for clarity as they work?		
Does teacher offer feedback to students?		
Is feedback effective?		
Are students given time to work as individuals?		
Does the teacher provide students with clear tasks and criteria for success?		
Is there any evidence of differentiated instructions and tasks for students?		
Is there room for peer assessment during the lesson?		

Is the level of peer assessment and feedback effective?		
Does the environment in the classroom create a conducive atmosphere for student motivation?		
Do assigned tasks promote self-regulation among students?		
Did the teacher assign any homework or extra work that could motivate students?		
Does the work provide for autonomous learning?		

UU_GIC_Guardian Inform Consent Form

UU_GL_Gatekeeper letter (Shelton Jeri).pd

S_Jeri_REAF_Revised_ Documents_Combinec

Shelton_Jeri_UU REAF documents.zip

Teacher questionnaire link

https://docs.google.com/forms/d/17sg7DN_xw6dV_24Nvkp3We0DszUe9RFzhrDXVIxBZ3M/e

dit?usp=sharing

Student interview link

https://docs.google.com/forms/d/1qVd3xEFIH-

oLyZiDSyeV06YRFYVtKXDW0n6irkQuqyig/edit?usp=sharing