UNIVERSITY OF CAPE COAST

SENIOR HIGH SCHOOL CHEMISTRY TEACHERS' FEEDBACK PRACTICES AND HOW STUDENTS PERCEIVE AND USE THEM

BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature ………………………………… Date 13-09-2022

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Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

The study investigated senior high school Chemistry teachers' feedback practices and how their students perceive and use them. SHS in the Greater Accra Region were categorised into three groups based on their percentage passes (A1 – C6) in Chemistry in the 2017 WASSCE. Stratified purposive sampling were used to select one school from each group for the study. A total of 118 Form 2 students and 3 teachers from the 3 schools participated in the study. The study involved class observation of Chemistry teachers and their students using a case study approach. Other data collection methods included the use of questionnaires and focus group discussions. Data was analysed using descriptive statistics and thematic content analysis. The study revealed that majority of the students found their Chemistry teachers' feedback useful. All four levels of feedback were found among Chemistry teachers' feedback practices. However, the prominent level of feedback was task level feedback. Majority of the students preferred process level feedback. It was recommended that Chemistry teachers should take time to progress feedback from task level to self-regulatory level via process level rather than over emphasising task level feedback. They should also plan assignments, tests and practical work well to ensure that students are engaged in self-regulatory feedback. Teachers should be made aware of and trained on all the four major ways students use teacher feedback to enhance students' experiences of these approaches to learning. This will help improve Chemistry teachers' pedagogy and their students learning outcomes.

KEY WORDS

Formative assessment

Feedback

Task level feedback

Process level feedback

Self-regulatory level feedback

Self-level feedback

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DEDICATION

To Jemima, Jennifer, Eden Victoria and Edward

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CHAPTER ONE

INTRODUCTION

This study investigated senior high school Chemistry teachers' feedback practices and how their students perceive and use them. This is because of the central role Chemistry plays in all the other science subjects. Various studies have established feedback as one of the major factors that influence learning and useful in boosting students' academic performance (Black &Wiliam, 1998; Hattie, 2009 & 2012; Hattie & Timperley, 2007). In consent to these benefits of feedback, many teachers assert that they provide regular and quality feedback to their students (Torrance, 2007). The basis for this study is the belief that little attention has been paid to how Chemistry students in secondary high schools perceive and use feedback, particularly in chemistry study at the senior high school (SHS) level in Ghana. The study, therefore, analyses classroom dialogue between Chemistry teachers and their students to find out the feedback levels as well as, students' perception and how they use the feedback given to them. Being interested in dialogue between students and teachers, the study employs the theory of social interaction (Vygotsky, 1978), sociocultural perspective (Mortimer & Scott, 2000 & 2003) and the feedback model (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

Background to the Study

Chemistry is regarded as a central science subject because of its role with respect to other science subjects and careers in science such as medicine, agriculture, and industry to mention a few (Adesoji, Omilani & Dada, 2017; Gongden, Gongden & Lohdip, 2011; Uchegbu, Oguoma, Elenwoke & Ogbuagu, 2016). The central role of Chemistry has implications for Chemistry study and thus students' performance in Chemistry becomes crucial. The role of teachers in students' performance in Chemistry cannot be overemphasized.

The teachers' role in the teaching and learning environment in the classroom cannot be overstated (Brown, Kennedy, Fok, Chan & Yu, 2009; Hattie, 2012). It is common knowledge that teachers play a crucial part in the lives of their students. A core aspect of educational practice is the teacher's effort to support students' learning. Therefore, teachers should regularly focus on evaluating the effects they have on their students and adjust teaching methods accordingly. In order to achieve this objective, the teacher must be attentive to students' difficulties in understanding the lesson and create a conducive classroom environment for students to overcome their difficulties. This is because a teacher's primary duty is to add value to all students' class contributions or responses and assist them to attain the lesson objectives (Hattie, 2009 & 2012; Havnes, Smith, Dysthe & Ludvigsen, 2012). This requires that teachers gather evidence from many sources. One-way teachers can measure students' performance is by using assessment techniques.

Assessment refers to how much learning has taken place as a result of teaching. It gives information about the performance of students, which teachers use to provide feedback to students. Assessment is also any act of interpreting information about a student's performance. This information is collected in different ways such as written and oral assignments, project work, practical work and tests. Most students are of the view that their performance in a test is evidence about how much they have studied (Bourke, 2016; Brown & Hirschfeld, 2008; Kumar & Stracke, 2011).

Assessment is a means to help students improve in their studies as well as provide a basis for grading or certifying them. The main types of assessment are formative and summative. Formative assessment which is also referred to as assessment for learning (AFL) occurs during the process of learning; and is mainly focused on diagnosing student difficulties and providing information to help them improve. It is specifically intended to generate information on performance to help improve and accelerate learning. In other words, it involves collecting data for enhancing student learning. Summative assessment which is referred to as assessment of learning occurs at the end of a semester or a period of study to provide a basis for certifying student learning. Summative assessments are aimed at ascertaining how much students know after segments of instruction. In other words, assessment has two main goals, that is, formative and summative evaluations of learning; the former occurring during the process of learning and the latter at the end of a period of study (Brown et al., 2009; Dixson & Worrell, 2016; Kumar & Stracke, 2011). There have been many recent moves toward assessment for learning rather than an emphasis on assessment of learning (Harris, Brown & Harnett, 2015; Torrance, 2007).

There have also been suggestions that assessment procedures and practices should support learning and strengthen students' achievement and progress. There is a global AFL movement, with an objective of persuading teachers to use assessment as a means for improving teaching and learning. Teachers are encouraged to prioritise this objective above the traditional accountability functions of assessment (Black & Wiliam, 1998; Harris et al., 2015; Hattie, 2012).

Research is replete with the fact that formative assessment does improve learning and makes a positive difference to students' achievements (Bell, 2000; Black & Wiliam, 1998; Cowie & Bell, 1999; Harris et al., 2015; Torrance, 2007). It is mainly activities such as students' and teachers' questions, written and oral assignments, project work, practical work and tests carried out by teachers, and their students, as a means of generating information to be used as feedback to modify the teaching and learning activities in which they are engaged. For assessment to be formative, feedback must occur during the learning process, and the feedback information must be used by teachers and students. Formative assessment and feedback are important features of teaching and learning and overlap strongly (Black & Wiliam, 1998; Brown et al., 2009; Kumar & Stracke, 2011; Nicol & Macfarlane-Dick, 2006).

Feedback is an important aspect of formative assessment focused on helping students to improve (Gamlem & Smith, 2013; Torrance, 2007). According to Hattie and Timperley (2007), feedback is information that is given to someone concerning his or her performance in a task or understanding of a concept that is aimed at reducing the difference between their current performance and what is expected of them. The source of the information may be a teacher, peer, book, parent or the person's own experience. Hattie (2012) introduces the notion of a gap by stating: "feedback aims to reduce the gap between where the student is and where the student is meant to be – that is, between prior or current achievement and the success criteria" (Hattie, 2012, p. 129).

Feedback is information communicated to the student for the purpose of improving performance. It allows comparison between an actual outcome and a desired outcome (Havnes et al., 2012; Kumar & Stracke, 2011; Poulos & Mahony, 2008). Feedback is one of the factors that have the strongest influence on learning and is useful in improving student's performance (Black & Wiliam, 1998; Hattie, 2009; Hattie & Timperley, 2007). According to Hattie (2012), Even though feedback is an important factor that affects students' achievement, its effects can also be influenced by other variables. It has the greatest effect when teachers receive more and better feedback about their teaching especially when it is from their students; achievement is also more likely to be increased when students accept and use feedback instead of ignoring it. For this to happen there should be initial instruction. When it is provided in a vacuum its effectiveness is limited. In other words, students must be taught first before feedback is given. Feedback can only build on something; and is of little use when there is no initial learning.

Teachers are central in turning assessment information and processes into improved learning for their students. Consequently, they need to be continually aware of the impact they are having on their students and from the evidence of this impact, make decisions about changing approaches. They are also a crucial source of feedback to their students. Therefore, they should monitor learning to gather information about the level of understanding of their students. This should form the basis of the feedback that they give to their students. Some of the ways by which they obtain information to maximize students learning include frequent testing, observing students' behaviour, asking questions of their students, especially higher order questions, and more importantly, analysing the questions that students ask (Hattie, 2009; Nicol & Macfarlane-Dick, 2006). According to Chin and Osborne (2008), the questions that students ask in class are a rich source of information to the teacher about students' understanding. This feedback from the students should guide the teacher in future teaching.

In order to develop a good assessment and provide accurate feedback to students, the learning objectives and what is expected of students must be clearly stated. That is, the more learning objectives are stated, the easier it would appear for it to be pursued and accomplished. Formative assessment exercises should, therefore, reflect the main learning objectives and should be designed to bring to the fore, evidence about the learning needs of students. The teachers should then focus on providing feedback in an appropriate and timely manner to help students attain the goals of the lesson.

Research shows that when students receive frequent feedback about their learning, it yields substantial learning gains. Also, the way feedback is conveyed to a student and how it is perceived, can affect performance or achievement (Black & Wiliam, 1998; Hattie, 2012; Torrance, 2007). When it is clear what teachers are teaching and what students are learning, then the students' achievement may increase. However, even though assessment is about the student, teachers need to see assessment as feedback for themselves about the impact of their teaching on their students and consequently make decisions based on it (Hattie, 2012).

How students are assessed influences the quality of their learning. Formative assessment is an essential part of this arrangement since it provides feedback to both teacher and student (Higgins, Hartley & Skelton, 2002). Information from formative assessment should serve to locate the individual student's attainment in relation to the learning objectives. It should also guide teachers on where they should focus next. Assessment is formative only when comparison of actual and reference levels yields information which is then used to alter the gap (Black & Wiliam, 1998; Hattie, 2012). The focus of feedback should be about how students' responses can be used to shape and improve their performance. Feedback also needs to reflect and reinforce what is taught and emphasised in class. However, it fails to be useful if it does not help students identify the major areas for improvement (Gamlem & Smith, 2013; Harris et al., 2015; Storch, 2010).

Although on average feedback has a positive impact, not all types of feedback are effective. Effective feedback should be clear and specific to the task, timely, and attainable for students. It should also help to reduce differences between current understanding and a learning goal. Effective feedback should make students aware of their performance in a context and how they can improve (Harks, Rakoczy, Hattie, Besser & Klieme, 2014; Rezaei, Izadpanah, & Shahnavaz, 2017; Van der Schaaf, Baartman, Prins, Oosterbaan & Schaap, 2013).

Feedback fails to be useful if it does not help students identify, for instance, specific aspects of a topic that require improvement. Therefore, feedback must indicate how the student can develop in relation to future work and is effective if students are able to use it to produce improved work. Research shows that feedback leads to learning gains when: (1) it includes guidance about how to improve, (2) students understand and are willing to use it and (3) students having opportunities to apply it (Gamlem & Smith, 2013; Harris et al., 2015; Havnes et al., 2012). Feedback can be provided in many ways such as confirming to a student that he or she is correct or incorrect, indicating that more information is available or needed. Feedback includes pointing to directions that the students might pursue, as well as indicating alternative strategies with which to understand information, perform a task or solve a question (Hattie, 2012).

The main types of feedback are oral and written (Black & Wiliam, 1998). Hattie and Timperley (2007) identify four levels of feedback. These are: task or product level, process level, self-regulation level and self-level. The task level aims to help students build their surface knowledge. It is effective if it is information focused; indicating if an answer is correct or incorrect. It serves as a guide to students on how to obtain more information about a topic, question or task. Examples include telling a student when an answer is correct or incorrect without explaining why. It also includes grading a student's work or asking a student to provide more or different responses. Without task level feedback, students cannot progress to the process and self-regulation level feedback and task level is the basis on which process and self-regulation feedback can be built (Hattie, 2009& 2012; Hattie & Timperley, 2007).

Feedback at the process level is aimed at the method used to answer a question, solve a problem or make a product. Process feedback can lead to providing alternative means of completing a task. It is geared toward helping the student to improve and is a deeper form of learning than at the task level. These are mainly comments that guide the student about the processes or strategies underpinning a task or problem. It can help the student understand the relationships between ideas and develop techniques for studying. It includes prompting students to seek more information as well as identify their mistakes. It involves showing how ideas are linked to each other in an area of study or topic. Examples include explaining why an answer is correct or incorrect and helping students correct their mistakes. Other examples include teaching students how to learn from their mistakes and providing clues about different approaches to solving problems (Hattie, 2009& 2012; Hattie & Timperley, 2007).

The self-regulation level is aimed at helping students to keep an eye on how they progress in their studies. Feedback at this level can help develop the student's expertise in self-assessment as well as increase their confidence in tackling challenging tasks or solving questions. Such feedback is usually in the form of introspective or inquiring questions that enable the student to utilise task and process level feedback information to boost his performance. Self-regulation level feedback affects the students' state of metacognition which helps them to independently make the effort to improve learning. Consequently, they search for and use feedback information. When feedback is provided after students have attempted a solution, it leads to more self – regulation. Examples are reminders from teachers to their students about techniques that they can use to improve their own work without relying on the teacher for help. It also includes thought-provoking questions that guide the student in self-assessment (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

The self-level is comments about effort and non-specific praise. It is personal and is commonly subsumed under the notion of praise. Examples include, 'very good', 'excellent', 'clap for him', 'neat work'. Self-level feedback does not give much information about a student's performance on a task. It may take away students' attention from the other feedback levels. The effects of praise are negative when students begin to fail or do not understand the lesson. Thus, teaching and learning need to move from the task towards processes necessary to learn the task, and then to regulation about continuing beyond the task to more challenging tasks and goals. Feedback should progress from task to self-regulation level via the process level for students to benefit. However, self-level feedback is the least effective form of feedback for boosting students' achievement (Hattie, 2009& 2012; Hattie & Timperley, 2007).

The assessment techniques that Chemistry teachers use during instruction include assignments, practical work, project work, tests, asking, as well as analysing the questions that students ask. It also includes observing students during practical lessons and when they perform tasks. The information from the assessment should form the basis of the feedback that they give their students. It should also guide teachers on where they focus next. Chemistry teachers' feedback to their students after assessment may involve one or all the levels of feedback. Students' perception of the relevance and usefulness of feedback provided will determine their response and use of it. How the students use the feedback provided is what will affect their performance in their subjects (Higgins et al., 2002; Nicol & Macfarlane-Dick, 2006; Storch, 2010). Consequently, the need to investigate Chemistry teachers' feedback practices and how their students perceive and use them.

Statement of the Problem

Many teachers think they give consistent and appropriate feedback, however students may be unable to use the feedback information when studying (Gamlem & Smith, 2013; Hattie, 2009). Majority of students are unable to understand teacher's feedback comments and may interpret them wrongly. They may also have difficulties in applying it to their learning (Hattie, 2012; Higgins, Hartley & Skelton, 2001). As a result, prescribing lots of feedback does not imply that learning will take place.

Consequently, how the student deals with feedback is critical to the success of formative assessment. The way feedback is conveyed to a student and how it is perceived, can affect performance or achievement. In other words, students' perception of the relevance and usefulness of feedback provided will determine their response and use of it. Students should find feedback relevant and be willing to use it. This is what will affect their performance or achievement (Black & Wiliam, 1998; Higgins et al., 2002; Poulos & Mahony, 2008; Storch, 2010). According to Harks et al. (2014), when students perceive that feedback is useful, they will use the information it provides. This would enable them to correct erroneous knowledge components leading to a consequent improvement in their achievement.

Studies on feedback practices in some countries in Africa such as Ethiopia, Ghana, Nigeria and South Africa have indicated that when students are given detailed feedback in technical education, they have a positive attitude towards assessment (Odu, 2010). Classroom feedback was effective in improving students' performance and writing skills in English Language in a Secondary School (Abdissa & Kelemework, 2014*)*. Feedback on students' performance in class or on tasks will enable them to restructure their understanding and that leads to the development of higher-level thinking skills (Butakor, 2016). The feedback methods that teachers make use of can shape students' self-efficacy (Adediwura & Ojediran, 2010).

It appears most of the research on feedback has focused on teachers' feedback practices; that is, on the input side of the equation; what is provided to students, how it is provided and at what time it is provided. It seems as if for the most part, research on feedback has focused on explaining and extending teachers' feedback practices (Cowie & Bell, 1999; Gamlem &Smith, 2013; Higgins et al., 2001 & 2002; Kumar & Stracke, 2011; Mandouit, 2018; Rezaei et al., 2017; Storch, 2010; Torrance, 2007). There have been some studies on peer feedback by Chemistry students in secondary school (Gan & Hattie, 2014; Gan & Hill, 2014). Harris et al. (2015), conducted a study on primary and secondary school students' peer and self-assessment comments.

However, it seems, not much is known about how students perceive feedback and even less about how they use feedback in secondary schools. It looks like, how feedback is received by students in the classroom, and how it is used in their learning is a conundrum that requires further research. It appears there have been few studies that have investigated the actual amount and nature of feedback given and received in classrooms as well as, students' views on feedback. Also, how students perceive, and use feedback is an area that remains relatively under researched, especially among students in secondary schools. Therefore, there is the need for a study on students' perception of feedback in the classroom and how they apply it to their studies (Gamlem & Smith, 2013; Harks et al., 2014; Hattie, 2012; Havnes et al., 2012; Higgins et al., 2002; Poulos & Mahony, 2008). For instance, the study by Harks et al. (2014), was on the impact of feedback on secondary school students in a laboratory setting, did not reflect classroom conditions and therefore lacked ecological validity. Thus, there is the need to develop a clearer picture of how exactly students perceive and use feedback in Chemistry.

While it may seem probable for high-achieving or higher - ability students to actively seek feedback, low-achieving or lower-ability students may not seek feedback. It appears the reasons for this have not been determined (Gamlem & Smith, 2013; Hattie, 2012; Havnes et al., 2012;). This study, therefore, seeks to fill these gaps.

The inadequacies in the type of feedback given to students could be one of the factors leading to the poor performance of students in Chemistry in Senior High Schools (SHS) in Ghana. For instance, Table 1 shows the number and percentage of candidates from Ghana and their grades in Chemistry, Biology and Physics in the West African Senior Secondary Certificate Examination (WASSCE) from 2012 - 2016.

Table 1: Number and Percentage of Candidates and their Grades in Chemistry, Biology and Physics from 2012 - 2016

	Chemistry		Biology		Physics	
Year	A1- C6	D7- F9	A1- C6	D7- F9	A1- C6	D7- F9
2012	18,466	13,289	16,616	12,032	17,351	7,661
	58.00%	41.70%	57.90%	41.80%	69.20%	30.50%
2013	37,436	33,189	45,155	27,654	34,139	23,279
	52.90%	46.80%	61.90%	37.90%	59.10%	40.30%
2014	19,413	19, 251	26,682	17,910	16,797	14,940
	50.00%	49.60%	59.60%	39.90%	52.70%	46.80%
2015	23,260	20,495	31,369	21,894	20,984	14,854
	53.00%	46.70%	58.60%	40.90%	58.20%	41.20%
2016	29,943	17,091	35,081	24,865	24,830	15,122
	62.95%	35.91%	58.26%	41.27%	62.00%	37.74%

WAEC (2014;2016)

A comparison of the results of Biology and Physics with Chemistry from Table 1 shows that students performed better in Biology and Physics as compared to Chemistry. Over the period, an average of 44.12% of the candidates obtained grades D7 - F9 in Chemistry. Whilst 40.35% of the candidates obtained the same grades in Biology and 39.31% of the candidates obtained the same grades in Physics over the same period. This shows that as compared to Biology and Physics a lot of students have difficulty getting credit passes in Chemistry.

The characteristics of formative assessment and feedback will vary based on the subject. For instance, the way feedback is practiced when teaching English will be different from Chemistry (Black & Wiliam, 1998; Havnes et al., 2012). It seems most of the studies on feedback in Chemistry in Secondary Schools have been on peer feedback (Gan & Hattie, 2014; Gan & Hill, 2014). Education is affected by the context of teaching (Gamlem & Smith, 2013), however, it appears not much has been done in our context on Chemistry teachers' feedback practices, students' perception of these feedback practices and how they use them, hence, this current study.

Purpose of the Study

The overarching purpose of this study was to evaluate SHS Chemistry teachers' feedback practices and how students perceive and use the feedback from their teachers. From this, five sub-purposes were formulated to guide the study.

Firstly, the study examined the level of feedback that is prominent in Chemistry teachers' feedback practices in SHS. Secondly, the students' perception of the usefulness of feedback that they receive from their teachers was examined. Thirdly, the level of feedback from Chemistry teachers that their students find useful was considered. How students use feedback from their teachers, and why high-performing students seek feedback, whilst low-performing students do not, constituted the fourth and fifth purposes of the study, respectively.

Research Questions

The following questions guided the study:

1. What is the level of feedback that is prominent in Chemistry teachers' feedback practices in SHS?
2. What is students' perception of the usefulness of feedback that they receive from their Chemistry teachers?
3. Which level of feedback from Chemistry teachers do their students find useful?
4. How do students use feedback from their Chemistry teachers?
5. Why do high-achieving students seek feedback, whilst low-achieving students do not?

Significance of the Study

Firstly, the outcome of the study may help teachers adjust the way they give feedback to meet students' needs in the classroom. Secondly, the outcome of the study can contribute to building a richer picture of students' views of the feedback given to them on their work and how they use it. Teacher training institutions and educators interested in pedagogical practices in secondary schools may find it useful. Thirdly, the information from the study of Chemistry teachers' feedback practices, and how students perceive and use them may be useful to course programme writers in developing lessons. Finally, the results of this study would add to existing literature on feedback practices and aid further research in science education.

Delimitations

The study focused on Chemistry teachers' feedback practices and how students perceive and use them. How students perceive and use feedback from their peers could not be covered in this study. The population was restricted to only 40 public senior high schools in the Greater Accra Region that offer General Science as a programme where students select Chemistry as an elective subject. The schools were categorized into high performing, average performing, and low performing based on their percentage passes (A1 – C6) in Chemistry in the 2017 WASSCE. One school was purposively selected from each of the categories. Therefore, only 3 schools out of the 40 public senior high schools were used for the study. This allowed in-depth study of feedback practices at the SHS level. The study also focused only on SHS Form 2 students in the selected schools.

Limitations

The feedback practices of the individual teachers observed were limited to their feedback practices with respect to the observed classes. This may not be their feedback practice because the nature of the class taught may influence the level and frequency of feedback used. However, observing different teachers giving feedback to different categories of high and low-achieving students gave insight and comprehensive perspective into the phenomenon. The research design adopted for the study was case study. Case study research is unstructured and subjective, therefore difficult to replicate. Generalizations are also very limited in scope, therefore the results are limited to the 3 schools that were purposively selected for the study and cannot be generalized to cover the rest of the public senior high schools in the Greater Accra Region that offer General Science as a programme where students select Chemistry as an elective subject.

Definition of Terms

Formative assessment: Is all activities undertaken by teachers, and their students, which generate information on performance to be used as feedback to help improve and accelerate learning.

Feedback: Is information provided by a teacher to a student concerning his performance in a task or understanding of a concept that is aimed at reducing the difference between the student's current performance and what is expected of him.

Task Level Feedback: This is feedback from a teacher to a student indicating whether an answer is correct or incorrect without giving the reason. It also includes grading a student's work which is expressed as a fraction, number or a letter.

Process Level Feedback: This is feedback from a teacher explaining why an answer is correct or incorrect and teaching students how to learn from their mistakes.

Self-Regulation Level Feedback: This is usually in the form of introspective or inquiring questions from a teacher that enable students to utilise task and process level feedback information to boost their performance. It helps develop the student's expertise in self-assessment.

Self-level Feedback: This is mainly non-specific praise from a teacher to a student such as 'very good', 'clap for him', or 'neat work'.

Effective Feedback: Feedback from the teacher to the student is effective if it indicates the student's performance with respect to the lesson objectives or learning goals and what the student must do to attain these objectives.

Organisation of the Study

Excluding the 'Introduction' chapter, there are four other chapters made up of Review of Related Literature (Chapter Two), Methodology (Chapter Three), Results and Discussion (Chapter Four) and Summary, Conclusions and Recommendations (Chapter Five). The review of related literature chapter takes a critical look at the relevant literature that is related to this research. It includes a discussion of Vygotsky's theory of social interaction, the sociocultural perspective, its application to analyzing classroom dialogue and the theoretical basis of the study. Empirical studies on feedback in the classroom dialogue, its effectiveness and application to the levels of feedback is also discussed. The final part of the chapter highlights important views and ideas on the topic from other authors and a critique of the literature.

Chapter three discusses and justifies the research methodology used to answer the research questions and raises the strength and weakness of the design. It describes the type of study and design in detail, and the rationale for the design. Issues relating to population, sample and sampling procedure, data collection procedure, and data analysis are also discussed in detail.

In Chapter Four, the results of the study are presented and discussed to answer the research questions, using literature that supports these findings. In Chapter Five, an overview of the research problem and methodology are given. A summary of the key findings and their interpretations are also provided. Conclusions and implications relating to the findings are also discussed. In addition, recommendations are made, and the issues unearthed for possible future research are presented.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews literature related to the study. The review draws out some theoretical issues on classroom dialogue and how to analyse them. Formative assessment and feedback in the classroom were also discussed. Feedback levels and effective feedback as well as related studies were also reviewed out of which the conceptual framework for the study was derived.

Classroom dialogue, Formative assessment and Feedback

Teaching and learning Chemistry can occur only when there is exchange of ideas between the Chemistry teacher and the student. As a result, discussions between Chemistry teachers and their students are fundamental in any Chemistry lesson. It is through talk that concepts in Chemistry are introduced in the classroom. According to Smith and Hackling (2016), how students learn in class depends on the quality of classroom discourse. Talk is central to the meaning making process because meaning is developed through discourse and learners come to understand scientific concepts and ideas as they are constructed in conversation. In other words, classroom talk enables students understand scientific concepts. For that reason, talk is central to learning (Mortimer & Scott, 2003; Smart & Marshall, 2013).

During Chemistry lessons, at times the teacher takes a clear lead in talking through the ideas with the whole class. Other forms of dialogue in Chemistry classrooms start with the teacher asking questions, which prompt student thinking and the students can articulate their ideas, presenting different points of view. According to Vygotsky (1978), talk in social situations is a key requirement for learning.

The theory of social interaction (Vygotsky, 1978), propose that ideas are exchanged between people when they interact. As the interaction continues, each participant can make sense of what is being spoken of. The words used in the social discussions make available the tools necessary for individual thinking; this is how learning begins. Vygotsky placed emphasis on the contribution of culture and social interaction on mental development. An underlying principle of Vygotsky is that higher mental functioning in the individual originates from the individual's social life. That is, to gain knowledge, study and develop have to do with a gradual progress from social contexts to individual understanding. In other words, one encounters new ideas in social situations where those ideas are exchanged between people, using different ways of communication such as talk, gesture, writing and visual images. He refers to these exchanges as occurring on a social plane.

The social plane may be equivalent to a teacher working with a class of students in a school, a parent explaining something to a child or a group of friends chatting. The different ways of communication used in the social exchanges serve as a means of transition from the social environment to the individual; enabling the individual to appreciate what is being communicated. For instance, Chemistry teachers' discourse with their students in the classroom is what makes concepts in Chemistry available to their students on the social plane of the classroom (Childs & McNicholl, 2007).

Mortimer and Scott (2000 & 2003), using Vygotsky's theory as the basis, combined Vygotsky's theory with viewpoints of the sociocultural perspective to analyse classroom dialogue between Science teachers and their students. They use this to illustrate how science classroom dialogue might give support to student learning. The fundamental idea of the socio-cultural perspective is that all mental activities such as studying Chemistry is sited in cultural, historical and institutional settings. Accordingly, a body of knowledge accepted for teaching a subject for example, Chemistry in schools is shaped by the historical, cultural, social and economic conditions of that period as well as the school settings.

Learning involves being introduced to a new social language, for instance, teaching Chemistry involves introducing the student to the social language of Chemistry. A key aspect of this process is the Chemistry teacher who explains and facilitates students' understanding of this language. This is akin to the Chemistry teacher supporting students' progress in the zone of proximal development (ZPD). The ZPD refers to the gap between what a person can do independently and what they can do with the help of someone more knowledgeable or skilled than themselves. It is another method of assessing a student's ability in an area of learning or topic and measures not only what the student can achieve working alone but also what they might achieve with assistance from a teacher. According to the sociocultural theory, concepts and clarifications are co-constructed socially during classroom discussions and internalised by students (Kaya, 2014; Mortimer & Scott, 2003; Vygotsky, 1978).

In line with the sociocultural perspective, if one wants to investigate the ways in which people think about the world around them, the place to start is to investigate the ways in which they talk and communicate about the world. Therefore, to understand the processes of teaching and learning in a specific school, one needs to examine the social, cultural and historical contexts that frame them. For instance, to investigate how learning occurs in Chemistry classrooms, the place to start is to examine the talk and other modes of communication in Chemistry classrooms (Mortimer & Scott, 2000 &2003).

An important aspect of classroom dialogue is formative assessment. Formative assessment is a conversational activity because teachers and students communicate with each other using language. It is also seen as a sociocultural activity because it takes place within the social and cultural norms of the classroom. A focus of formative assessment is on ways in which language is used to promote teaching and learning in the classroom with an objective of improving students' on-going learning (Bell, 2000; Harris et al., 2015; Torrance, 2007). In formative assessment the teacher is expected to give feedback to the student. The student then acts on the feedback information to progress from current performance to what is expected of him or her. These actions by both student and teacher are what lead to the attainment of lesson objectives. Therefore, feedback is recognised as a key element of formative assessment and classroom instruction aimed at improving the performance of students. A strategic objective of formative assessment is to engage students in tasks that will generate feedback information. These tasks may take various forms such as practical work, group presentations as well as through written and oral questions. For that reason, a key aspect of classroom dialogue is feedback that teachers give to their students (Bell, 2000; Black, 2000).

An essential part of teaching Science including Chemistry is the teacher providing opportunities for students to try out and practise scientific ideas for themselves and make these ideas their own. This step of applying ideas might be first carried out by students, with the assistance of their teacher. This assistance is usually in the form of feedback that the teacher gives to the students. According to Hattie and Timperley (2007), feedback has no effect when students have not yet been taught. For feedback to be effective, students should be taught first before given feedback after assessment. In other words, there must be a learning background to which feedback is directed.

Classroom dialogue and its analysis

Any form of classroom teaching is a social event in which the teacher is trying to achieve a shared understanding of the subject matter with his students. For instance, teaching Science including Chemistry involves three stages; in the first stage, the Chemistry teacher must make the concepts and ideas in Chemistry available on the social plane of the classroom. Secondly the teacher needs to assist students in understanding and internalizing those ideas. Finally, students must be encouraged to apply and use the ideas. These leads to unique forms of communication and language use in classrooms (Childs & McNicholl, 2007; Mortimer & Scott, 2000 & 2003).

This unique form of communication in the classroom begins when the teacher initiates a dialogue usually by means of a question. The student responds to the question and the teacher evaluates the student's response. This pattern of communication is described as Initiation-Response-Evaluation (IRE). This three-part conversation has been found to be widespread in classrooms. It is the most common form of discourse between teachers and their students in the classroom. Another form of this discourse takes place when instead of evaluating the student's response; the teacher gives the student feedback or explains the student's answer. This pattern is described as Initiation-Response-Feedback (IRF). The IRF form of discourse can also occur in a series of exchanges as an I-R-F-R-F chain where the elaborative feedback (F) from the teacher is followed by a further response (R) from the student and so on (Bansal, 2018; Chin, 2006; Mortimer & Scott, 2000 & 2003).

Feedback Levels and Effective Feedback

There are four levels of feedback, these are task or product level, process level, self-regulation level and self-level (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

The task level aims to help students build their surface knowledge. It is effective if it is information focused; indicating if an answer is correct or incorrect. It serves as a guide to students on how to obtain more information about a topic, question or task. Examples include telling a student when an answer is correct or incorrect without explaining why. It also includes grading a student's work or asking a student to provide more or different responses. Without task level feedback, students cannot progress to the process and self-regulation level feedback and is the basis on which process and self-regulation feedback can be built (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

Feedback at the process level is aimed at the method used to answer a question, solve a problem or make a product. Process feedback can lead to providing alternative means of completing a task. It is geared toward helping the student improve and is a deeper form of learning than at the task level. These are mainly comments that guide the student about the processes or strategies underpinning a task or problem. It can help the student understand the relationships between ideas and develop techniques for studying. It includes prompting students to seek more information as well as identify their mistakes. It involves showing how ideas are linked to each other in an area of study or topic. Examples include explaining why an answer is correct or incorrect and helping students correct their mistakes. Other examples include teaching students how to learn from their mistakes and providing clues about different approaches to solving problems (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

The self-regulation level is aimed at helping students to keep an eye on how they progress in their studies. Feedback at this level can help develop the student's expertise in self-assessment as well as increase their confidence in tackling challenging tasks or solving questions. Such feedback is usually in the form of introspective or inquiring questions that enable the student to utilise task and process level feedback information to boost his performance. Self-regulation level feedback affects the students' state of metacognition which helps them to independently make the effort to improve learning. Consequently, they search for and use feedback information. When feedback is provided after students have attempted a solution, it leads to more self – regulation. Examples are reminders from teachers to their students about techniques that they can use to improve their own work without relying on the teacher for help. It also includes thought-provoking questions that guide the student in self-assessment (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

The self-level is comments about effort and non-specific praise. It is personal and is commonly subsumed under the notion of praise. Examples include, 'very good', 'excellent', 'clap for him', 'neat work'. Self-level feedback does not give much information about a student's performance on a task. It may take away students' attention from the other feedback levels. The effects of praise are negative when students begin to fail or do not understand the lesson. Thus, teaching and learning need to move from the task towards processes necessary to learn the task, and then to regulation about continuing beyond the task to more challenging tasks and goals. Feedback should progress from task to self-regulation level via the process level for students to benefit. However, self-level feedback is the least effective form of feedback for boosting students' achievement (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

Effective feedback should be unambiguous and specific to the task, timely, and attainable for students. It should also help to reduce discrepancies between current understanding and a learning goal (Harks et al., 2014; Rezaei et al., 2017). According to Hattie (2012), effective feedback should help students know if they are making headway towards lesson objectives and what needs to be done to improve on their performance.

Review of other studies in formative assessment

Generally, it is acknowledged that increased use of formative assessment (or assessment for learning) leads to higher quality learning. However, it is often claimed that most schools preclude the use of formative assessment due to pressure in schools to improve the results achieved by students in externally-set tests and examinations. Crooks (1988) reviewed and summarised results from 14 specific fields of research that evaluated the relationships between classroom evaluation practices and student outcomes. The review focused attention on outcomes involving learning strategies, motivation, and achievement. Crooks' work demonstrated that substantial learning gains are possible when teachers introduce formative assessment into their classroom practice.

However, the work of Black and Atkin (1996) in science, mathematics and technology show that achieving gain in students' outcome via formative assessment is not a straightforward issue. Black and Wiliam (1998) collaborated this assertion by pointing out that these changes are hard to implement even in ideal conditions:

> "Thus, the improvement of formative assessment cannot be a simple matter. There is no 'quick fix' that can be added to existing practice with promise of rapid reward. On the contrary, if the substantial rewards of which the evidence holds out promise are to be secured, this will only come about if each teacher finds his or her own ways of incorporating the lessons and ideas that are set out above into her or his own patterns of classroom work. This can only happen relatively slowly, and through sustained programmes of professional development and support. This does not weaken the message here—indeed, it should be a sign of its authenticity, for lasting and fundamental improvements in teaching and learning can only happen in this way" (Black and Wiliam, 1998, p. 15).

Notwithstanding Black and Wiliam's caution of real difficulty in implementing formative assessment in the classroom, Newmann, Bryk, and Nagaoka (2001) found that students whose teachers used authentic classroom tasks out-performed students not given such work, and that the size of the effects (as measured by standardized effect size) was substantial. Authentic tasks are defined as requiring construction, rather than reproduction of knowledge, disciplined inquiry, and value beyond school. The study evaluated Chicago teachers' assignments in reading, mathematics and writing in grades 3, 6, and 8. In reading, writing and mathematics, the standardised effect sizes were 0.43, 0.52 and 0.64 respectively, with significant aptitude-treatment interactions favouring high-achievers in reading and low-achievers in mathematics. Data for the study were from assignments collected in 1997, 1998, and 1999. The sample sizes involved: (1) grade 3 writing, all 3 years with 1,785 assignments; (2) grade 6 writing, all 3 years with 1,686 assignments; (3) grade 8 writing, all 3 years with 1,425 assignments; (4) grade 3 mathematics, all 3 years with 1,794 assignments; (5) grade 6 mathematics, all 3 years with 1,522 assignments; and (6) grade 8 mathematics, all 3 years with 1,278 assignments. Assignments were scored by teams of teachers and scores were equated across years. Contrary to some expectations, the study found some high quality assignments in some very disadvantaged Chicago classrooms. It was evident that all students in these classes benefited from exposure to such instruction. Results suggest that if teachers, administrators, policymakers, and the public at large place more emphasis on authentic intellectual work in classrooms, yearly gains on standardized tests in Chicago could surpass national norms. Nevertheless, Newmann et al.'s (2001) study was not conducted under well controlled experimental condition. For example, one may argue that the teachers using more authentic activities were just better teachers and that the choice of authentic activities was incidental to their success (Wiliam, Lee, Harrison & Black, 2004).

Another quasi-experimental design to measure the effect of formative assessment on students' learning outcome was conducted in England (Boaler, 2002). Boaler's work involved three-year study of two secondary schools comprising 11-16-year olds cohorts in England. Boaler (2002) compared two schools which are Phoenix Park and Amber Hill. The former school used a 'reform' approach to the teaching of mathematics, emphasising higher-order thinking, and students' responsibility for their own learning and the 'traditional' approach emphasising practice of test items. Measurement of gain from the intervention was based on matched in terms of prior achievement of both schools. The result showed that students at Phoenix Park outperformed those at Amber Hill in the national school-leaving examination (the General Certificate of Secondary Education, or GCSE). The observed gain average of one third of a grade, equivalent to a standardized effect size of 0.21 in favour of Phoenix Park School, however, cannot be cleared of possible influence from confounding factors. For instance, the teachers teaching at Phoenix Park may have been just better teachers, drawn to the school by its progressive ethos (Wiliam et al., 2004).

In the quest to draw clear policy implications regarding the utility of formative assessment, Wiliam et al. (2004) undertook a more direct experiment with reduced confounding variables which produced a mean effect size in favour of the intervention of 0.32. This study asked teachers to incorporate formative assessment into their classroom practice and compare the performance of their students with those of other classes at the same school. Wiliam et al.'s work was undertaken in the King's-Medway-Oxfordshire Formative Assessment Project (KMOFAP), funded initially by the Nuffield Foundation (as the Developing

Classroom Practice in Formative Assessment project) and subsequently by the United States National Science Foundation through the support of partnership with the Stanford Classroom Assessment Project to Improve Teaching And Learning (CAPITAL; NSF Grant REC-9909370).

The central tenet of the research project KMOFAP was that traditional research designs were inappropriate if the promise of formative assessment was to be realised. This belief by inference perhaps emanate from Black and Wiliam (1998) as expressed in the following:

> "Teachers will not take up attractive sounding ideas, albeit based on extensive research, if these are presented as general principles which leave entirely to them the task of translating them into everyday practice—their classroom lives are too busy and too fragile for this to be possible for all but an outstanding few. What they need is a variety of living examples of implementation, by teachers with whom they can identify and from whom they can both derive conviction and confidence that they can do better, and see concrete examples of what doing better means in practice" (Black & Wiliam, 1998, pp. 15–16).

The belief of the researchers led to an approach that considers a kind of quasi-experimental design with non-rigid control of variables and no randomisation. The sampling technique used was multifaceted. Initially two local education authorities were selected purposively with the following in mind: (1) the need for authority with capacity and support to develop formative assessment (2) the need for an individual officer who could act as a link between the research team and the schools, and provide a local contact for ad hoc support for the teachers. The purposive sampling was followed by various methods which are expressed in their own words as:

> "The choice of teachers was left to the school, and a variety of methods was used. In some schools, the heads nominated a head of department together with a teacher in their first or second year of teaching. In another school, in order to ensure a commitment to the

> project, the head teacher insisted that both the heads and deputies of the mathematics and science departments were involved. In other schools, teachers appeared to be selected because, in the words of one head, 'they could do with a bit of inset'. In the event, while our schools were not designed to be representative, there was a considerable range of expertise and experience amongst the 24 teachers selected—five of the teachers were heads of department, five were deputy heads of department and the remaining 14 occupied a range of positions within their schools, mostly at a relatively junior level" (Wiliam et al., 2004, pp. 52-53).

Also based on the central tenet of the project, the researchers decided to work in a genuinely collaborative way with a small group of teachers, suggesting directions that might be fruitful to explore, and supporting the teachers without dispensing prescribed model of effective classroom action. Each teacher was expected to find own way of implementing acquired general principles via in-service training in their own classrooms. Table 2 contains in-service sessions used for the project.

Table 2: Pattern of in-service sessions held

INSET	Held	Format	Focus
A	February 199	whole day, London	Introduction
B	May 1999	whole day, London	developing action plan
C	June 1999	whole day, London	reviewing and revising action plans
	September 199	half-day, LEA based	reviewing and revising action plans
D	November 1999	whole day, London	sharing experiences, refining action plans, planning dissemination
E	January 200	whole day, London	research methods, dissemination, optional sessions including theories of learning
F	April 2000	whole day, London	integrating learning goals with target setting and planning, writing personal diaries
G	June 2000	whole day, London	action plans and school dissemination plans, data analysis 'while you wait'

(Wiliam et al., 2004, p. 53)

The key feature of the inset sessions was the development of action plans. The project observed ethical obligation on the part of teachers to re-negotiate the 'learning contract' between teachers and their students and implemented the formative assessment project at the beginning of a new school year. However, for the first six months of the project, teachers were encouraged to experiment with some of the strategies and techniques suggested by the research, such as rich questioning, comment-only marking, sharing criteria with learners, and student peer-assessment and self-assessment. The in-service training gave teachers the opportunities to draw up, and later to refine, an action plan specifying which aspects of formative assessment they wished to develop in their practice. Teachers also identified a focal class with whom the strategies developed were to be implemented in September 1999 which was the beginning of new academic year. According to the researchers the action plans of the teachers involved, evolved into the headings which are organised in Table 3.

Table 3: Frequencies of activities in the action plans of 24 teachers

Category	Activity	Frequency
Questioning	Teacher questioning Pupils writing	11
	questions Existing assessment: pre-tests	8
	Pupils asking questions	4
		4
Feedback	Comment-only marking	6
	Existing assessment: re-timing	4
	Group work: test review	4
Sharing criteria with learners	Course work: marking criteria	5
	Course work: examples	4
	Start of lesson: making aim clear	4
	Start of lesson: setting targets	1
	End of lesson: teacher's review	1
	End of lesson: pupils' review	4
	Group work: explanation	2
	Involving classroom assessment	2
Self-assessment	Self-assessment: traffic lights	11
	Self-assessment: targets	5
	Group work: test review	6
	Self-assessment: other	7
	Pupil peer-assessment	5
	Group work: revision	1
General	Including parents	1
	Posters	1
	Presentations	1
Total		102

(Wiliam et al., 2004, p. 54)

The first four headings in Table 3 became the practice and procedure as well as the 'Trojan horse' in formative assessment also known as Assessment for Learning (AfL). Marshall and Drummond (2006) assert that "the KMOFAP work explored four main areas of classroom practice in relation to formative assessment: questioning, feedback, sharing criteria with the learner, and peer and self-assessment" (Marshall & Drummond, 2006, p. 134). They further suggested that the procedures of AfL were always seen as a 'Trojan horse' for a particular view of pedagogy (Black, McCormick, James, & Pedder, 2006). Particularly, the view that the practices and procedures of AfL promote and enable pupils to become more independent learners is inferred to be central to the Learning How to Learn (LHTL) Project (James, Black, McCormick, Pedder, & Wiliam 2006). Yin et al. (2008) also used the practices of formative assessment and evaluated the effect on students' science achievement and conceptual change. Unlike the preceding reviews in which all showed significant effect, the outcomes of Yin et al.'s work were statistically not significant. The following summarises their work:

> "Formative assessment was hypothesized to have a beneficial impact on students' science achievement and conceptual change, either directly or indirectly by enhancing motivation. We designed and embedded formatives assessments within an inquiry science unit. Twelve middle-school science teachers with their students were randomly assigned either to an experimental group (N = 6), provided with embedded formative assessment, or control group (N = 6). Teachers varied significantly as to their impact on student motivation, achievement, and conceptual change. But the impact of the formative assessment treatment on these outcomes was not statistically significant" (Yin et al., p.336).

Yin et al.'s work is distinguishable from Newmann et al. (2001), Boaler (2002) and Wiliam et al. (2004) in that the former used traditional experimental design with the latter all using quasi-experimental approaches. Perhaps, the findings of Yin et al. supported Wiliam et al.'s belief that the promise of formative assessment cannot be realised in traditional experimental research designs. Yin et al.'s study examined the effect of formative assessment on student outcomes by using a randomised experiment in a field setting. The study explored whether formative assessment would improve student motivation and achievement, and lead to conceptual change. They used two groups of teachers. One group, the experimental group employed embedded formative assessment while teaching a science unit and the other group, the control group taught the same unit without embedded formative assessment. The design approach used involved the following steps:

1. Twelve teachers along with their students were randomly assigned to either the experimental group or the control group;
2. All students were pre-tested on motivation, science achievement and conceptual change.
3. Both groups of teachers taught the same curriculum unit provided by the curriculum developer. Teachers in the experimental group were also provided embedded formative assessment and trained to use the information collected to help improve their teaching and students' learning.
4. All the students were post-tested on motivation, achievement, and conceptual change.

To find out whether the embedded formative assessment treatment affected students' motivation, achievement, and conceptual change, the experimental and control groups were compared using students' scores on the pre-test and post-test.

The participants were informed that the study was to assist curriculum designers to improve the curriculum to conceal the fact that they were participating in an experimental study during their recruitment. The concealment was done to avoid a Hawthorne effect (alteration of behaviour by the subjects in the study due to their awareness of being observed) on the experimental group and a John Henry effect (tendency for the control group to work harder to overcome perceived deficiency emanating from awareness of being disadvantaged to the experimental group) on control group.

Both the experimental teachers and the control teachers used their regular teaching practice, helped to videotape one classroom lesson, and collected data related to student learning. However, the experimental teachers implemented the embedded formative assessments designed by the researchers. The researchers avoided the effect of confounding variables emerging from treatment diffusion by selecting participants from different states. Nevertheless, the researchers seemed to have failed to pay much attention to the concepts of fair treatment which is a hallmark of traditional experiment paradigm with positivist construction. For example, time spent to complete the curriculum unit was not the same for the experimental and the control groups. According to their report, teachers took varying amounts of time, from 63 days to 249 days (Experimental: M = 130, SD = 49; Control: M = 106, SD = 47). Furthermore, on average, the experimental teachers took 24 days more than the control teachers. This unequal treatment attracts confounding variables that cast doubt on both the validity and reliability of the work. The report admits that the embedded formative assessments were designed to be completed in 12 more class sessions than in the regular curriculum. This seem to be the situation where Black and Wiliam (1998) affirm that "Teachers will not take up attractive sounding ideas, albeit based on extensive research, … which leave entirely to them the task of translating them into everyday practice" (Black & Wiliam 1998, p. 15). If the experimental teachers were given a variety of living examples of implementation, and allowed to identify and derive their own conviction and confidence in the areas they can do better, and connect with concrete examples of what can be done to meet curricular needs, the embedded formative assessment would have been followed with the 'spirit and letter' of assessment for learning (Black & Wiliam, 1998; Marshall & Drummond, 2006). The promise of formative assessment is only achieved in the 'spirit' of assessment for learning where teaching and learning is committed into producing learners who are independent to self-regulate their own learning leading up to conceptual change. Teachers whose practice illustrates the spirit of formative assessment should have essentially progressive, rather than fixed, view of what went on in any given lesson. In contrast, Marshall and Drummond consider the situation where practices and procedures embedded in formative assessment are merely implemented in curricular units as following the 'letter' of formative assessment. The latter appears to be the situation in the design of Yin et al. (2008) and hence the lack of the statistical difference realised between the experimental and the control groups.

Marshall and Drummond's (2006) work explored the connection between formative assessment and pupil autonomy to contextualize the analysis of classroom observations and teachers' beliefs about learning. The researchers having the initial perspective of hypothesis that assert that Assessment for Learning (AfL) is built on an underlying pedagogic principle that focuses on the promotion of pupil autonomy, set up to analyse the ways in which teachers instantiate this principle in practice. Contrary to the expectation that these researchers' resort to quantitative approach to test their initial hypothesis, qualitative approach which analyses natural classroom environment was sought after. Marshall and Drummond entitled their work 'How teachers engage with Assessment for Learning: lessons from the classroom'. Data were collected using two main sources involving video recordings of 27 lessons, which is part of wider sample of focal teachers on the project: and interviews with these focal teachers on their beliefs about learning. The quest for Marshall and Drummond was development of a strategy for understanding teachers' classroom practices, which would be useful to decision-makers and practitioners. There was therefore the need to develop descriptive accounts of teachers' observable classroom behaviours and the thinking that underpins such practices. The descriptive accounts approach chosen by the researchers seemed justifiable in view of the complexity of classroom teaching and learning in general, and of formative practices in particular. Adherents of qualitative approach to research believe that truth depends on one's perceptive and therefore there is the need for different views in order to understand the complexities of classroom teaching and learning. The researchers seem to have adhered to this tradition by collecting different kinds of data using a variety of methods. Initial interviews which were conversations that encouraged teachers to talk about their experiences and beliefs across a wide range of contexts and purposes were carried out. Marshall and Drummond triangulated different data sources using interviews, together with Staff Questionnaire data which provided a rich data resource to analyse alongside the observation data that were generated from the initial video recordings. The use of video data seems superior to field notes, or observation schedules. This assertion emanates from the fact that video recordings can be re-observed and watched with other viewers. This data collection approach has higher reliability of analysis since the observed behaviours can be interpreted, discussed and re-interpreted with reference to the primary data.

The researchers identified from the data that transforming AfL procedures or strategies into classroom cultures that promote pupil autonomy was not an easy task for most teachers. Only about a fifth of the lessons observed appeared to promote pupil autonomy. They classified lessons that apply AfL procedures or strategies into classroom cultures that promote pupil autonomy the 'spirit' of AfL. The spirit of AfL lessons are characterized as 'high organization based on ideas', where the underpinning principle is promoting pupil autonomy. The analysis of the staff questionnaire collaborated the finding that only one fifth of the observed lessons are characterised with the 'spirit' of AfL. This collaboration was evidenced with the proportion of teachers who reported that learning autonomy was promoted in practice corresponding with only around a fifth. The 'spirit' of AfL lesson are contrasts with those lessons where only the procedures, or 'letter' of AfL, seem in place. The rational for dichotomising classroom interactions into the 'spirit' and 'letter' of AfL is seen in the following explanation:

> "We use these headings—the 'spirit' and 'letter'—to describe the types of lessons we watched, because they have a colloquial

> resonance which captures the essence of the differences we observed. In common usage adhering to the spirit implies an underlying principle which does not allow a simple application of rigid technique. In contrast, sticking to the letter of a particular rule is likely to lose the underlying spirit it was intended to embody. The lessons under consideration are divided, then, between those where the balance is towards the spirit of AfL and those where only the letter is evident. Any crude binary opposition is, however, unlikely to capture the complexity of the way in which teachers implement changes in their practice" (Marshall & Drummond, 2006, pp. 137 - 138).

In concluding Marshall and Drummond (2006) point out the following:

1. Only a few teachers promote student's autonomy during classroom interaction. This lack of agency to promote student's independency may be due to the belief's teachers hold about learning impact on the way they apply AfL in the classroom.
2. There is the need for teachers to engage in debates about learning, as well as act on practical advice, to bring about change.
3. Teachers who value students' autonomy and see a key goal of their teaching as not only promote student's autonomy but also see the classroom as a site of their own learning.
4. Neither circumstance nor the disposition of pupils was beyond change.
5. Lessons characterised as the spirit of AfL is instantiated in the way teachers conceptualize and sequence the tasks undertaken by pupils in the lesson.

The above points raise important need to reassess the practices and procedures of AfL. The point one indicates that the belief of teachers and perhaps that of students on AfL is crucial for formative assessment to be relevant to the process of teaching and learning. Furthermore, if teachers are to be progressive in the classroom and also if there is the need for change in the disposition of students as stated in the points above, then one may say that classroom interaction should be dialogue where both teachers and learners are aware of their learning state. There should be the constant feedback of information between the teacher and the student. The implication is that feedback is the heartbeat of AfL. According to Black and Wiliam (1998) AfL is to be interpreted as encompassing all those activities undertaken by teachers, and/or by their students. This teacher - student activities provide information to be used as feedback to modify the teaching and learning activities in which they are engaged. Black and Wiliam used the term 'classroom evaluation' which coincided with the purpose for 'formative assessment'. The classroom evaluation involves assessment cycle, which starts from purposes, then moves to the setting of tasks, criteria and standards, then through to appraising performance and providing feedback and outcomes. The mechanism of obtaining information and providing information to improve learning and to secure student independent shifts the focus of attention, towards greater interest in the interactions between assessment and classroom learning and away from concentration on the properties of restricted forms of test which are only weakly linked to the learning experiences of students (Black & Wiliam, 1998). Hattie (2009) has identified feedback which is "conceptualised as information provided by an agent (e.g. teacher, peer, book, parent, self, experience) regarding aspect of one's performance or understanding" (Hattie & Timperley, 2007, p. 81) as one of the most powerful influences on the learning process.

The perception that feedback is one of the most powerful influences of the learning process has been empirically explored generally in three major beneficial characteristics. These three attributes are (1) error correction and achievement change (Azevedo & Bernard, 1995), (2) motivational effects (Hoska, 1993), and (3) metacognitive consequences (Butler & Winne, 1995).

On the attribute of achievement change, Azevedo and Bernard (1995) conducted meta-analysis on the literature concerning the effects of feedback on learning from computer-based instruction (CBI). They reported that despite the widespread acceptance of feedback in computerized instruction, empirical support for particular types of feedback information has been inconsistent and contradictory. Effect size calculations from twenty-two studies involving the administration of immediate achievement post-tests resulted in a weighted mean effect size of 0.80. Also, a mean weighted effect size of 0.35 was obtained from nine studies involving delayed post-test administration. Their analysis showed that feedback effects on learning and retention were found to vary with CBI typology, format of unit content and access to supplemental materials. The meta-analysis indicates that the diagnostic and prescriptive management strategies of computer-based adaptive instructional systems provide the most effective feedback. The implementation of effective feedback in computerized instruction involves the computer's ability to verify the correctness of the learner's answer and the underlying causes of error.

Hoska (1993) explores computer-based feedback to motivate students to increase their effort in learning tasks. The summary of Hoska work is as follows:

> "One of the major benefits of computer-based instruction (CBI) is its ability to provide a one-on-one interaction between the learner and computer program, which functions as coach. Within most lessons, the coaching responsibility of CBI are provided through feedback, which includes such activities as (1) reacting to learners as they respond to questions or interact with simulations, (2) advising learners about the scope and sequence of lessons assignments, and (3) focusing learners' attention on critical program elements. Most CBI lessons, however, overlook an important responsibility of any coach – to motivate. Yet this seldom explored function of feedback can be critical to the learning situation because it affects the way learners both perceived and react to learning tasks. What we refer to as motivation is potentially a powerful tool for helping learners invest the effort required to gain knowledge and skills. This chapter explores current theory on motivation and provides guidelines for using CBI feedback that, at minimum, does not encourage task avoidance and, at maximum, causes the learner to invest increased effort in the learning task" (Hoska, 1993, p. 105).

Butler and Winne (1995) argue that students' achievement depends on Self-Regulated Learning (SRL). Butler and Winne explained how feedback is not only inherent but also a prime determiner of processes that comprise SRL. Their work involved review of areas of research that elaborate contemporary models of how feedback functions in learning. These reviews were used to synthesize a model of self-regulation based on contemporary educational and psychological literatures. The synthesised model constituted a structure which was used to analyse the cognitive processes involved in self-regulation, and for interpreting and integrating findings from disparate research traditions. Another aspect of their work is proposal of elaborated model of SRL that can embrace these research findings and that spotlights the cognitive operation of monitoring as the hub of self-regulated cognitive engagement. The model re-examines two main research areas being (a) recent research on how feedback affects cognitive engagement with tasks and (b) the relation among forms of engagement and achievement. Conclusion was drawn that research on feedback and research on self-regulated learning should be tightly coupled, and that the facets of their model should be explicitly addressed in future research in both areas. Harks et al. (2014) asserted that the impact of feedback on self-evaluation-related outcomes was examined empirically frequently in studies dealing with a concept known as calibration. According to Harks et al., calibration expresses the degree to which a student's judgement about his or her own capability or performance represents the student's competence (Pieschl, 2009). Therefore, the concept of calibration is related closely to the metacognitive concept of self-evaluation (Stone, 2000).

Harks et al. (2014) aimed to contribute to a deeper understanding of the three-characteristic benefit of feedback as achievement, motivational and metacognitive. Keeping in mind of perceived importance of feedback, the effects of two independent variables (written process-oriented feedback and grade-oriented feedback) on the three dependent variables were compared in secondary mathematics.

The study adopted an experimental laboratory design. Participants in the study were assigned either to a group who are given process-oriented feedback or grade-oriented feedback. The participant in the study comprised 146 ninth-grade students (48% female) with a mean age of 15years, 3months (SD months = 7.70). Students were drawn from 53 intermediate track classes or courses in 23 German intermediate secondary schools or comprehensive schools. The study's conceptual framework is shown in Figure 1.

According to the study design students were given written feedback. The written feedback distinguished between students' performance on what the researchers called inner mathematical problems and on real-world problems. Inner mathematical problems were defined to primarily require technical competence (the use of knowledge about mathematical facts and skills); the real-world problems noted as primarily demanding modelling competence (the transformation of a real-world problem into a mathematical problem and vice versa).

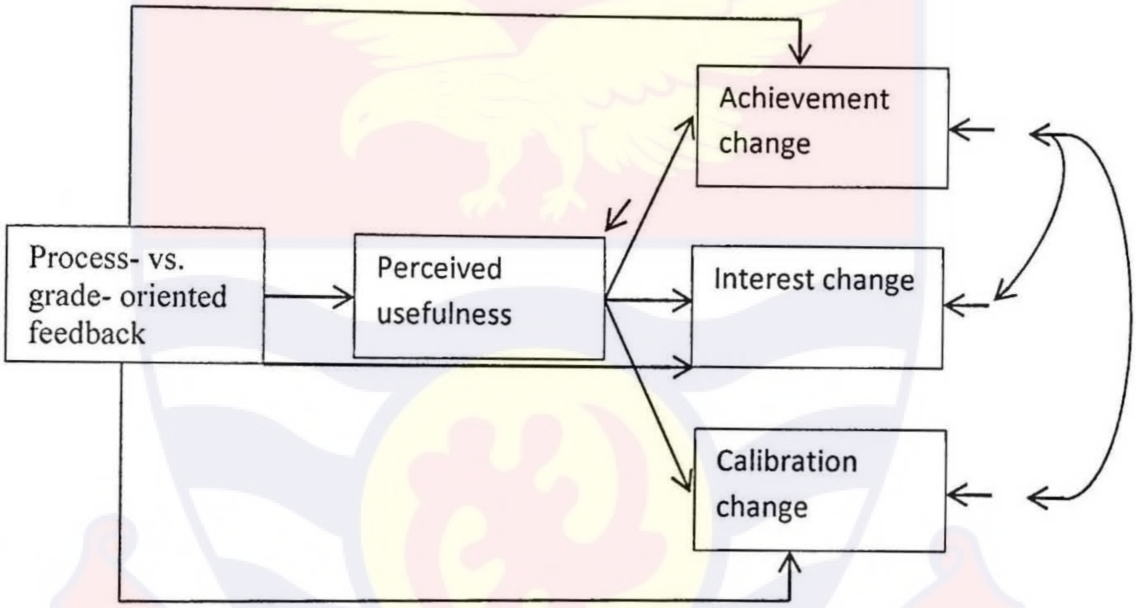

Figure 1: Path diagram for analysing the impact of feedback on change of achievement, interest and calibration via feedback's perceived usefulness (Harks et al., 2014).

The item types used was made distinct to enable a higher degree of elaboration for process-oriented feedback. The distinction between item types was held constant in both the process-oriented and the grade-oriented feedback conditions. In the first part of both process-oriented and grade-oriented feedback, the differences between inner mathematical problems (referred to as arithmetic problems) and real-world problems (referred to as arithmetic word problems) and the scoring criteria for both types of items were explained by means of two sample items. In the second part of the feedback, separate information on the student's achievement on inner mathematical problems and on real-world problems was provided.

Measurement of change in mathematics achievement was done using 30 pre-test and 12 post-test items. Students' change in interest was measured on a scale with four items. Students were asked to rate how interesting they found the topic of the forthcoming test on a four-point scale ranging from 0 (completely disagree) to 3 (completely agree). The key item was 'I like the topic of the test.'

Finally, the effect of the two feedback conditions on calibration was assessed using pre-test and post-test. For each item in the pre-test and each item in the post-test students were asked how confident they were about giving the correct answer (Dunlosky & Hertzog, 2000). The six-point rating scale ranged from 0 = my answer is definitely wrong through 20 = my answer is correct with 20% certainty, 40 = my answer is correct with 40% certainty and so forth to 100 = my answer is correct with 100% certainty. Among the findings from Harks et al. (2014) are (1) process-oriented feedback was perceived as more useful than grade-oriented feedback (2) feedback's perceived usefulness, in turn, had a positive effect on changes in mathematics achievement and interest. These findings show that perception is crucial to the three-characteristic attribute of feedback. Harks et al.'s work collaborates Marshall and Drummond (2006) to assert the importance of belief or perception in effective feedback that leads to learners' autonomy.

A study was conducted into students' perception of effective feedback by Poulos and Mahony (2008). The participants were undergraduate students of varying levels and from a range of Schools in the Faculty of Health Sciences, University of Sydney. Four focus groups involving student volunteers from different Schools within the Faculty were convened. No direct contact was made between the researchers and the students, also no was any participant identified. The facilitator of the focus groups used prompt questions relating to the meaning and role of feedback. The focus groups were audio-taped and subsequently transcribed. The results of the study showed though the students had different perceptions regarding what feedback is, they preferred early feedback. The students did not hold a homogenous view of what effective feedback is and how it could be used. Another finding of the study was that, feedback usefulness and its credibility was related to the students' perception of the lecturer providing the feedback.

Harris et al. (2015), applying Hattie and Timperley's feedback model, used that to analyse New Zealand primary and lower secondary students' peer- and self-assessment comments. The focus of the study was to find the feedback levels in the assessment comments. Data were naturally occurring feedback statements students provided to themselves or their classmates in English and Mathematics. These were collected from students in the classrooms of 11 teachers who volunteered to take part in the study. The classroom teachers supplied examples of peer and self-assessment comments their students had generated to the researchers. The students were in grades 5–10 and their ages ranged from 10–14 years. A total of 74 self-assessment examples from 9 classes and 32 peer assessment examples from 7 classes were submitted by the teachers and analyzed by the researchers. The results of the study showed both peer and self- assessment comments were predominated by task level feedback. Peer assessment had a much higher percentage of task level feedback than self-assessment, and there was no self- regulation level feedback in peer assessment. The researchers did not collect the data directly from the students. It was provided by teachers and based entirely on teacher willingness to share with the researcher. Therefore, teacher bias in the data collection procedure may be possible. Also, when students know teachers will be reading their feedback, they may feel a need to provide the kind of comments they believe teachers want which may decrease honesty in responding.

Havnes et al. (2012), explored how assessment information is received and attended to in upper secondary schools in Norway. The study involved six Norwegian upper secondary schools offering vocational and academically oriented education. The focus of the study included feedback practices in the three core academic subjects in secondary schools in Norway: English, Norwegian and Mathematics. The vocational programmes included cookery, carpentry and hairdressing. A mixed-method design was used to collect both quantitative and qualitative data from the respondents. Survey data were collected from five of the schools, whilst focus group interviews were conducted in three schools. A total of 192 teachers responded to the survey questionnaire, whilst 391 students in the first year of upper secondary school also responded to the questionnaire. Three focus group interviews were conducted with groups of teachers and three focus group interviews with school leaders; one group from each school. Six focus group interviews were conducted with groups of students, two groups of students from each school. Each focus group discussion was conducted separately.

Majority of the students experienced feedback on tests and assignments as useful, providing information about how well they performed and what was expected of them. However, a small group of students did not find the feedback they received to be useful. The use of feedback from tests and assignments were particularly weak. On the other hand, both teachers and students reported more extensive feedback while students were working on assignments than on completed tests. Both teachers and students reported more student engagement with assessment and feedback in vocational subjects than in the academic subjects. In other words, students found feedback they received more useful and attended more to it in vocational training than academic programmes. Even though there were no significant differences between feedback practices in Norwegian, English and Mathematics across academic and vocational programmes, a finding of the study was the fact that feedback practice is subject-related. There were different feedback practices in the teaching of languages, mathematics and vocational training. For instance, in a workshop setting immediate oral feedback from teacher as well as peers seemed to be more common, whilst in Mathematics there was more emphasis on corrections of mistakes.

Conceptual Framework of the Study

The preceding review has provided conceptual perspective for the study. However, some ideas (Black & Wiliam, 1998; Hattie, 2009 & 2012; Hattie & Timperley, 2007; Marshall & Drummond, 2006; Wiliam et al., 2004) which are summarised in Figure 2 forms the conceptual framework that guides and directs this study.

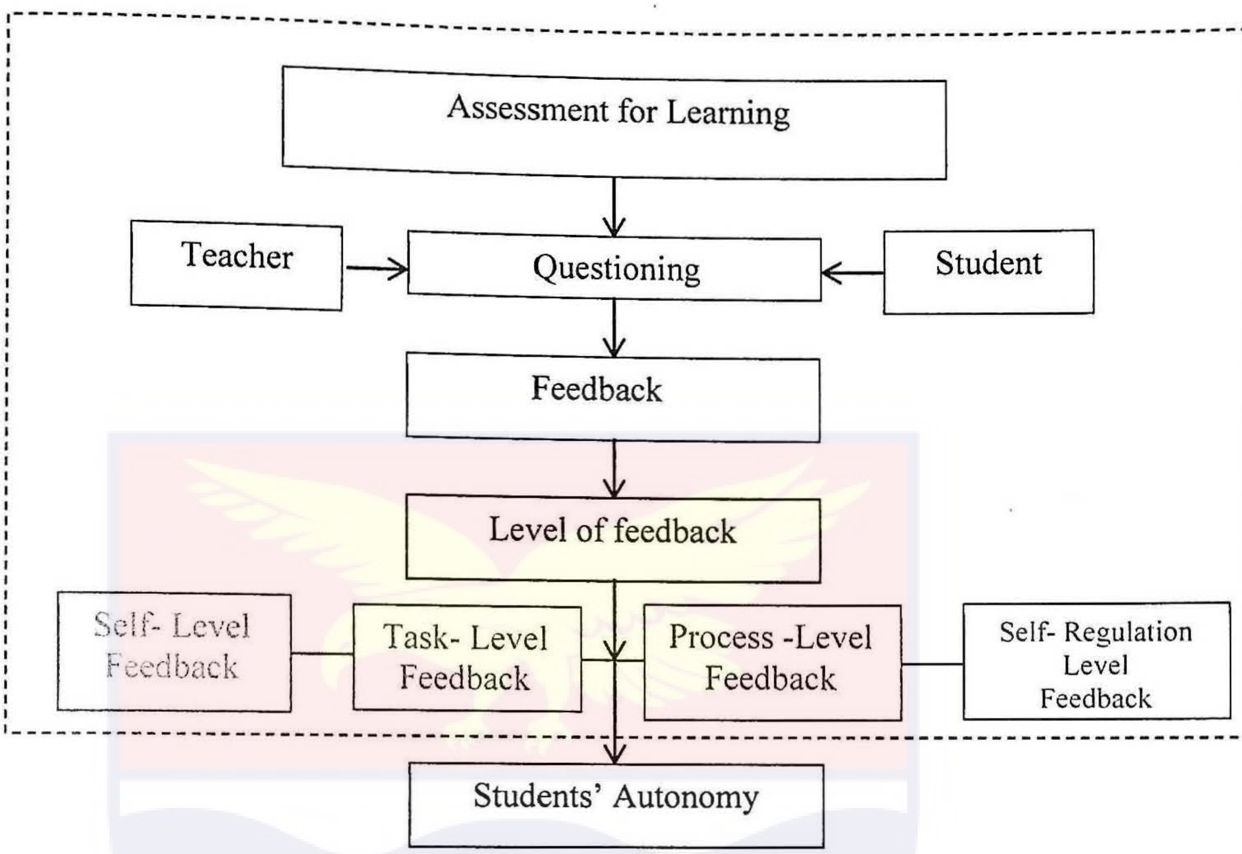

Figure 2: Conceptual Framework for Instructional path towards making students autonomous via effective feedback (Author's construct)

Assessment for Learning has key aspects and practices including questioning and feedback (Wiliam et al., 2004). Questions can be from the teacher and student which then lead to feedback. When AFL is implemented properly there is a promise of making students autonomous learners (Marshall & Drummond, 2006). Nonetheless, implementing AFL properly is challenging and complicated. It requires teachers and students with a disposition to change and progress in the teaching and learning process (Black & Wiliam, 1998; Wiliam et al., 2004). This necessitates the constant flow of information between the teacher and the learner, where teachers organise this feedback information to scaffold learners into independency. This use of feedback information which enables teachers to see learning through the eyes of students, whilst students see teaching as fundamental to their ongoing learning, is crucial to the successful implementation of AFL (Hattie, 2012).

Four levels of feedback have been introduced; these are task level, process level, self-regulation level and self-level feedback (Hattie, 2009 & 2012; Hattie & Timperley, 2007). The self-regulation level is aimed at helping students to keep an eye on how they progress in their studies. Feedback at this level can help develop the student's expertise in self-assessment as well as increase their confidence in tackling challenging tasks or solving questions. Such feedback is usually in the form of introspective or inquiring questions that enable the student to utilise task and process level feedback information to boost his performance. Self-regulation level feedback affects the students' state of metacognition which helps them to independently make the effort to improve learning. Consequently, they search for and use feedback information. When feedback is provided after students have attempted a solution, it leads to more self – regulation (Hattie, 2009 & 2012; Hattie & Timperley, 2007). Examples are reminders from teachers to their students about techniques that they can use to improve their own work without relying on the teacher for help. It also includes thought-provoking questions that guide the student in self-assessment.

The self-level is comments about effort and non-specific praise. It is personal and is commonly subsumed under the notion of praise. Examples include, 'very good', 'excellent', 'clap for him', 'neat work', 'you are a good student'. Self-level feedback does not give much information about a student's performance on a task and often directs attention away from the task, process and self-regulation levels. The effects of praise are negative when students begin to fail or do not understand the lesson. Thus, it is asserted that teaching and learning need to move from the task towards processes necessary to learn the task, and then to regulation about continuing beyond the task to more challenging tasks and goals. Feedback should progress from task to processing to self-regulation. In other words, the first three feedback levels form a progression, whilst the fourth is the least effective form of feedback for enhancing achievement (Hattie, 2009 & 2012; Hattie & Timperley, 2007).

However, experience shows also that many a time students became motivated when praised appropriately. External motivation is known to stimulate internal motivation which leads to increased effort in learning tasks. The author, therefore, believes that progression in the feedback levels should start from the self-level instead of task level. A demotivated learner is unlikely to engage in any feedback task.

The conceptual framework in Figure 2, therefore, focuses on all four levels of feedback. Though Hattie and others assert that feedback should start from the task level towards self-regulation level feedback via process level feedback, it is also when the learner has reached a state of meta-cognition where feedback becomes self-regulated that students can become truly autonomous learners (Hattie, 2009 & 2012; Hattie & Timperley, 2007; Marshall & Drummond, 2006). Even though Hattie and others looked at how students' progress through the levels of feedback (i.e., task level to self –regulatory level feedback) to students' autonomy, this study focussed basically on determining Chemistry teachers' dominant feedback practices the levels of feedback students prefer. The focus of this study is shown within the dotted border, as shown in Figure 2.

CHAPTER THREE

RESEARCH METHODS

This chapter describes and explains how the study was conducted. It discusses the research design, population, sample and sampling procedure, instruments for data collection, ethical and confidential issues, and how the data was analysed.

Research Design

The first step of the study was to investigate what level of feedback is prominent in SHS Chemistry teachers' feedback practices in the classroom. The second step was to find out how students perceive and use feedback from their teachers. A key requirement to achieving these was an extensive observation of Chemistry teachers and their students in their classroom setting, to allow for analysing classroom dialogue between Chemistry teachers and their students.

Since the study required observing Chemistry teachers and their student's everyday behaviour in the classroom and observing participants as they engage in activities, qualitative research methods of data collection suited the study (Creswell, 2014). Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live; is done in the natural settings, where variables are not manipulated (Fraenkel & Wallen, 2009). Approaching this study quantitatively implies selecting a point of view and imposing or exploring among participants. This will defeat the study's purpose of understanding a phenomenon from the point of view of participants in their particular social and institutional context.

Qualitative researchers go directly to the setting of interest to observe and collect their data. There are several approaches to qualitative research; these include narrative research, phenomenology, grounded theory, case study, ethnography, historical research, and action research (Cohen, Manion, & Morrison, 2007; Fraenkel & Wallen, 2009; Silverman, 2013).

Based on the purpose of the study, case study was adopted as the research design. A Case study is a qualitative design in which the researcher investigates in detail a program, event, activity, course of action, or one or more individuals (Creswell, 2014). It is a research design in which the researcher probes to develop an understanding of a case or phenomenon using a variety of data collection methods (Cohen et al., 2007). The case is usually a program, event, activity, process, or one or more individuals (Creswell, 2014). Some examples of case studies include a student who has trouble learning to read, a situation that can be identified easily like an activity going on in a Chemistry classroom or an ongoing process like student teaching to mention a few. They involve looking at a case or phenomenon in its real-life context, usually employing many types of data. The principal idea governing case study research is looking into the case in detail, using whatever methods seem applicable and apposite to develop a full understanding of it. Cases are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time (Fraenkel & Wallen, 2009).

In this study, dialogue in Chemistry classrooms was observed, audio recorded and analysed to find out Chemistry teachers feedback practices and how their students perceive and use them. According to Creswell (2014), case study research for the most part is suitable for investigating educational processes and activities. Consequently, it was adopted as the research design. "The case study approach is particularly valuable when the researcher has little control over events" (Cohen et al., 2007, p. 253). The researcher had no control over choice of topics by the Chemistry teachers as well as their assessment techniques after teaching. The feedback levels that the Chemistry teachers gave their students after assessment was also beyond the control of the researcher. Therefore, the case study approach was suitable for the study.

In this study Chemistry teachers' feedback practices was looked at whilst their students' perceptions and use of feedback were probed. A characteristic of case study that made it appropriate for the study was the fact that it was conducted within the setting under study. The researcher used the natural setting of the classroom to collect data, obtaining meaning from the context and the participants' perspectives because case study is contextual. Throughout the study, the researcher did not manipulate the phenomena under investigation and did not take part in any classroom discussions. The researcher is the main research instrument. During the chemistry lessons, when the Chemistry teachers were teaching, the researcher observed and took notes. All the Chemistry lessons were audio taped with a Samsung galaxy S7 phone that the Chemistry teachers kept in their pocket when teaching. The researcher who usually sat at the back of the class had a digital voice recorder which was also used for audio taping the Chemistry lessons. All the recorded Chemistry lessons were transcribed verbatim. No transcription software was used; it was manually transcribed word for word with the help of one assistant. Whenever the students finished assignments, tests and practical lessons, their marked books and scripts were inspected and analysed by the researcher.

The researcher assumed the role of an observer-participant, this is sometimes referred to as 'observer-as-participant' or non- participant observer (Bansal, 2018; Cohen et al., 2007; Gravetter & Forzano, 2006), without impinging on the classroom's social system or performing any function in the school and evaluated what was going on in the classroom as objectively as possible. This was better than using a quantitative instrument that might only reveal numbers that fit into statistical models. Data analysis was inductive and interpretative. The researcher analysed the data regarding answers to the research questions.

The first research question required a determination of the level of feedback that is prominent in the feedback that Chemistry teachers' give to their students. This required an extensive observation of the Chemistry teachers and their students in the classroom because there is a rich feedback environment in the classroom setting (Havnes et al., 2012; Nicol & Macfarlane-Dick, 2006), as well as an inspection of students marked assignments, tests and practical work. Figure 3 shows a flow chart of the procedure used in obtaining this information.

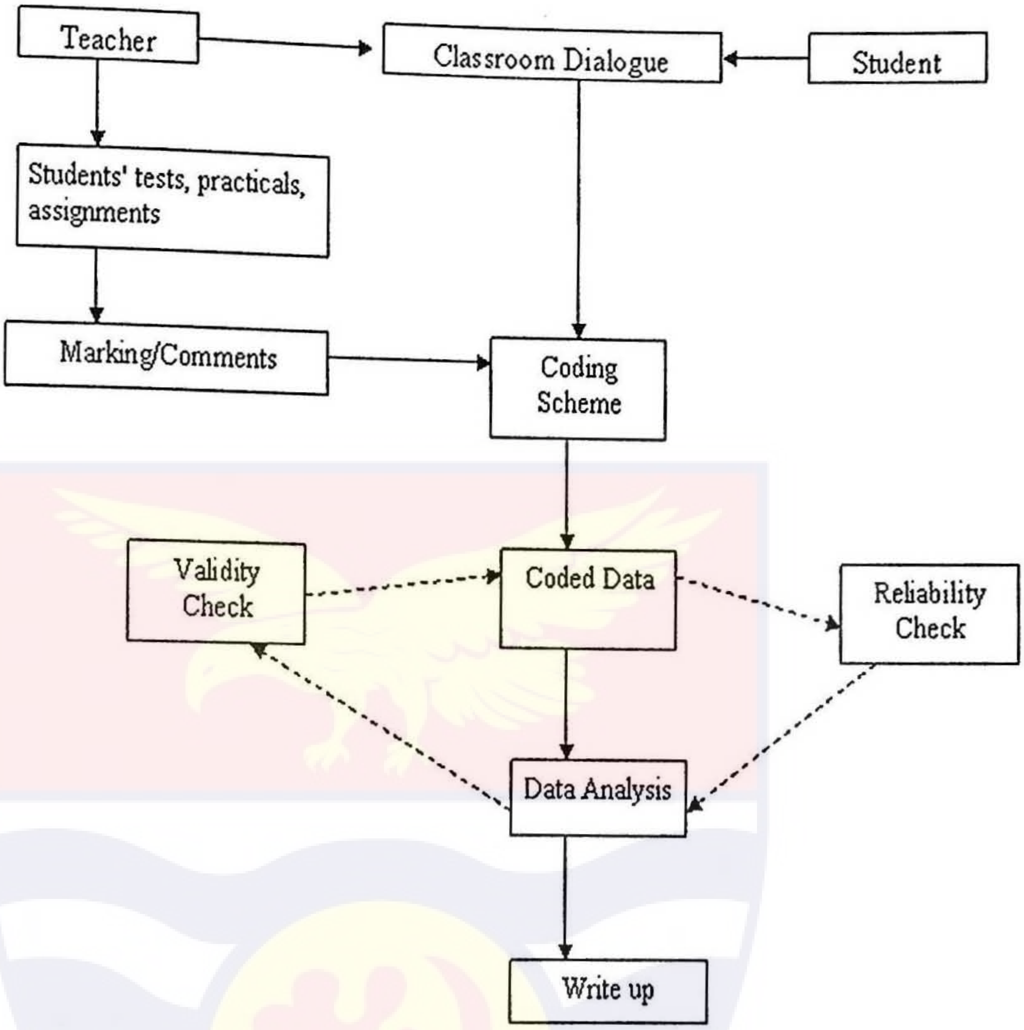

Figure 3: Flow chart of the procedure used for determining Chemistry teachers' feedback practices.

The second research question required an investigation of the students' perception of the usefulness of feedback that they receive from their Chemistry teachers. Research question 3 required finding out which level of feedback from their Chemistry teachers that the students find useful. Whilst research questions 4 and 5 required a determination of how students use feedback from their Chemistry teachers' and the response of high and low - achieving students to feedback, respectively. Figure 4 shows a flow chart of the procedure used in obtaining this information.

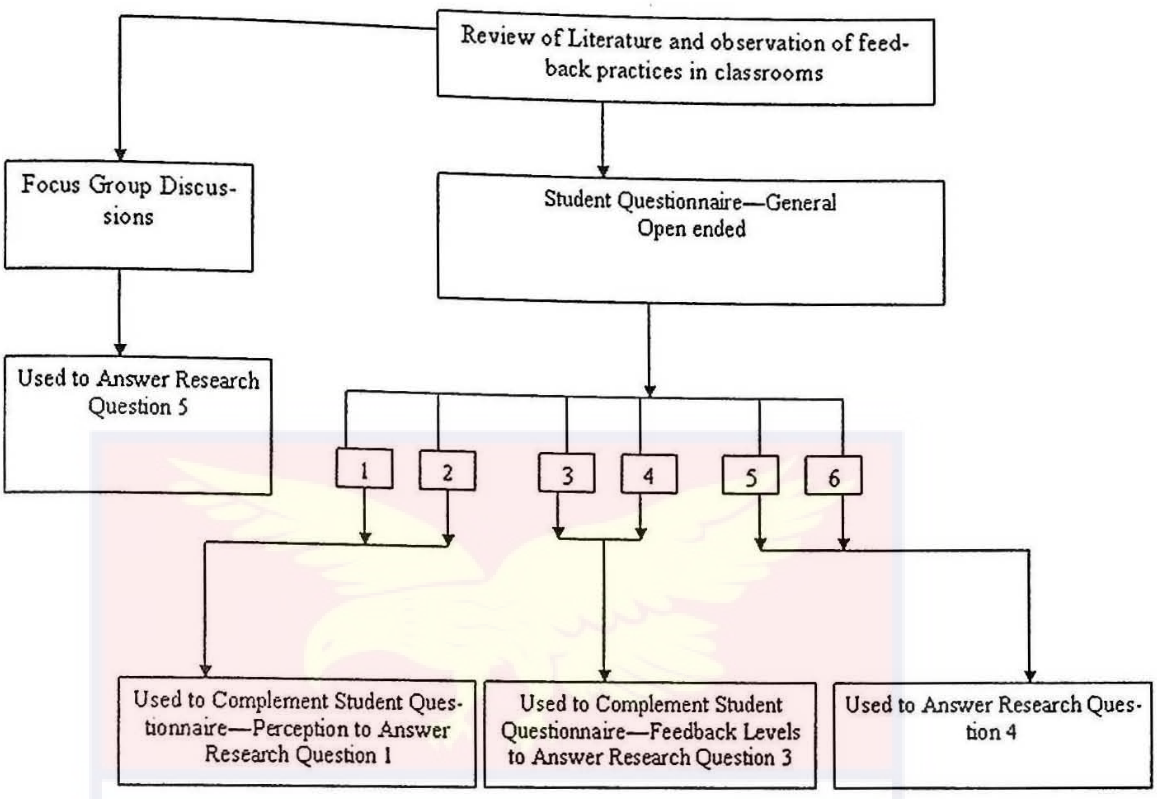

Figure 4: Flow chart of the procedure used to determine students' perceptions, use and response to feedback.

Strength and weakness of the design

It provides the researcher with a much more comprehensive perspective. In other words, by observing the actual behaviour of the Chemistry teachers and their students in the classroom, which is their natural settings, the researcher may gain a much deeper and richer understanding of such behaviour. Therefore, it can reveal nuances and subtleties that might escape researchers using other methodologies. Consequently, it is the means to understand the complexities of an educational practice from the participants involved in implementing the practice. The researcher as the main research instrument, can handle sensitive matters, examine atypical or idiosyncratic responses, as well as adapt and respond to issues as they arise during the study.

Despite these strengths, it is subjective and therefore difficult to replicate. There is also the possibility of observer bias; this was minimised by observing the Chemistry teachers and their students over a period of time. Case study research is time consuming and requires spending a lot of time in the field; this study covered the whole of the second semester. It started on the 14th of March 2019 and continued till the 25th of June 2019 when the schools started the end of semester examinations, with at least two visits per week to each school. Generalizations are usually limited in scope; however, the results of the study may enable other researchers anticipate but not predict what may occur in similar situations.

Study Area

Three schools in one metropolis and two municipalities in the Greater Accra Region were purposively selected for the study. Pseudonyms A, B and C were used for the names of the schools. School A is at the Accra Metropolitan Assembly, the capital city is also the nation's capital, Accra. It is among the elite SHS in Ghana where most parents prefer their children to attend. School B is at the Ga West Municipal Assembly; the capital city is Amasaman. School C is at the Ga Central Municipal Assembly; the capital city is Sowutuom.

Ghana Education Service (GES, 2019), groups all SHS in Ghana into three categories A, B and C schools based on academic performance and facilities available to the students. Even though the schools were not selected based on GES categorization, Schools A is a category A school while school B is a category C school and school C is categorized B by GES. All 3 schools are mixed schools. Schools A and C have boarding facilities with some students' resident in the boarding house and others day students. School B has no boarding facilities, all the students are day students.

Population

The target population was Form 2 students and their teachers in the 40 public SHS in the Greater Accra region that offer General Science as a programme where students select Chemistry as an elective subject in the 2018/2019 academic year. Only Form 2 students were used because the Form 3 students were busy preparing for their final examination and will not have time for such a rigorous study. Secondly, most schools do not permit their final year students whose focus is on WASSCE to be used for research. Finally, there had been recruitment of new inexperienced teachers because of the double track system who mostly teach Form 1 students. The Form 1 students who were just starting their second semester may not have been taught a lot of topics in chemistry. As a result, it was the view of the researcher that the use of form 1 students and their teachers will not give a better picture of teachers' feedback practices and how students use them. Therefore, Form 2 students and their teachers in the 40 public SHS in the Greater Accra region that offer General Science as a programme where students select Chemistry as an elective subject was the population for the study.

Sampling Procedure

Stratified purposive sampling was the main sampling procedure used in selecting participants (Cohen et al., 2007, p. 176). This method was the most appropriate because high-achieving and low-achieving students react differently to feedback (Gamlem & Smith, 2013; Havnes et al., 2012). Consequently, SHSs were categorised into three groups based on their percentage passes (A1 – C6) in chemistry in the WASSCE in 2017. Table 4 shows how the SHS were categorised for the study.

Table 4: Categorisation of senior high schools for the study

Percentage Pass in Chemistry (A1 – C6)	Category of School
70 - 100%	High Performing School
50 - 69%	Average Performing School
0 - 49%	Low performing School

(Author's construct, 2019)

During the categorisation, it came to the fore that, while some schools present a lot of candidates, other schools present only few candidates. Therefore, only schools that presented 50 or more candidates in chemistry for the WASSCE in 2017 were categorized for the study. When the grouping was done, there were 13 high performing schools with percentage passes ranging from 70 to 100%. There were 7 average performing schools with percentage passes ranging from 50 to 69% and 9 low performing schools with percentage passes ranging from 0 to 49%. Based on this categorisation, one school was selected from each group for the study. Table 5 shows the number of candidates and their percentage passes for each of the selected schools.

In each participating school, using the first semester of the 2018/2019 academic year results, the best performing class in chemistry was selected for the study.

Table 5: Number of Candidates and their Percentage Passes of the Selected Schools

School	Number of Exam Candidates	Candidates with (A1 – C6)	% Passes
A	400	370	93
B	78	46	59
C	238	61	26

WAEC (2017)

Table 6 shows the average class mark in chemistry for all classes offering elective chemistry in school A.

Table 6: Average Class Mark in Chemistry for all Classes offering Elective Chemistry in School A

Class	Average % Mark in Chemistry
2AG	51.0
2HE2	39.9
2SC1	64.5
2SC2	63.9
2SC3	55.5
2SC4	56.9
2SC5	56.1
2SC6	60.0
2SC7	55.2
2SC8	61.2

End of first semester examination, School A, (2019)

Since 2SC1 had the highest mark of 64.5%, it was selected for the study. School B has two classes offering elective chemistry. Table 7 shows the average mark in chemistry for each class.

Table 7: Average Class Mark in Chemistry for all Classes offering Elective Chemistry in School B

Class	Average % Mark in Chemistry
2AG	19.1
2SC	26.1

End of first semester examination, School B, (2019)

Since 2SC had the highest mark, it was selected for the study. School C has seven classes offering elective chemistry. Table 8 shows the average mark in chemistry for each class.

Table 8: Average Class Mark in Chemistry for all Classes offering Elective Chemistry in School C.

Class	Average % Mark in Chemistry
2AG1	28.7
2AG2	41.4
2HE2	35.5
2SC1	63.1
2SC2	61.3
2SC3	49.2
2SC4	44.2

End of first semester examination, School C (2019)

2SC1 had the highest average mark in chemistry and therefore was selected for the study. Table 9 shows the total number of students in each school that participated in the study.

Table 9: Total Number of Students in each School that participated in the Study

School	Class	Number of Students Male	Female	Total
A	2SC1	26	22	48
B	2SC	18	15	33
C	2SC1	27	10	37

Field survey, (Author's construct, 2019)

The total number of students who participated in the study is 118 with an average age of 17 years. The oldest student is 21 years and the youngest 15 years.

Description of the sample

The names of the schools and the names of the teachers are all pseudonyms. School A has 5 elective chemistry teachers teaching the 10 classes; Bismarck whose class 2SC1 was selected has BSc in Chemistry from the University of Cape Coast and is in the final year of a post graduate diploma in education from the University of Education, Winneba. He has been teaching at School A since 2011. All the chemistry lessons were conducted in their classroom. The students only go to the laboratory when they have practical lessons. There are two laboratory assistants who prepare the solutions for Chemistry practical lessons based on Bismarck's instructions. School B has 1 elective chemistry teacher teaching the 2 classes; Frederick has BSc in Chemistry and an MPhil in Geology from the University of Ghana, Legon. He has been teaching chemistry at School B since 2016. He also taught mathematics for three years at a private SHS. All the chemistry lessons were conducted in the laboratory. Throughout the entire period of the study, only two chemistry lessons took place in the classroom because there was WASSCE practical taking place in the laboratory. School B has one laboratory assistant. School C has 3 elective chemistry teachers teaching the 7 classes; Prince whose class 2SC1 was selected has BSc in Chemistry and MA in Alternative Dispute Resolution (ADR) from the University of Ghana, Legon. He also has a Professional Executive Masters in ADR from Gamey & Gamey ADR Institute. He has been teaching chemistry at school C since 2012 and has a private ADR practice where he spends his after-school hours. In school C just like school A, all the chemistry lessons were conducted in the classroom. The students only go to the laboratory when they have practical lessons. School C has no laboratory assistant.

All three teachers have similar teacher led or teacher centred method of teaching, however, Frederick uses a projector to project information on the board for students and engages the students in discussions after that. Sometimes when the teachers are teaching, they give questions to the students and go around inspecting students work and giving them feedback. During one lesson on solubility, Prince put the students into groups and gave them questions to solve. A member of each group did the presentation on behalf of the group. The rest of the students critiqued the work of the group and decided with Prince the marks to be awarded each group.

Data Collection Instruments

Besides the researcher being the main instrument for data collection, other research instruments were used for the study. The first instrument used was an open-ended questionnaire with six items titled student Questionnaire-General (Appendix A). It comprised seven items initially but was reduced to six after pilot testing. Item numbers 1 and 2 were on students' perception of the usefulness of the feedback they receive from their teachers. Item numbers 3 and 4 were on the level of feedback from teachers that students find useful while item numbers 5 and 6 was on how students use feedback from their teachers. It was developed by the researcher from an extensive review of related literature and observation of Chemistry teachers' feedback practices in the classroom. This was particularly important for the study as observations made it possible to relate the items in the questionnaires to actual feedback practices in the students' classrooms.

The second instrument was titled student Questionnaire-Perception (Appendix B). It comprised four two-tier items, students selected an option to each item and provided reasons for the option selected. Each item was a statement, the students were expected to choose from four options and give reasons for their choice. The statements were to find out if feedback from their Chemistry teachers helped the students to improve, showed the students how much they have studied and showed how well prepared they are for tasks. It was mainly to find out if students perceived feedback from their Chemistry teachers useful or not and their reasons for that. It was adopted from Harks et al. (2014), the students were asked to give reasons for the option they chose to enable them to qualitatively express themselves in terms of their perception of feedback from their Chemistry teachers.

The third instrument was titled student Questionnaire-Feedback levels (Appendix C). It was adopted from the feedback model of Hattie (2009, 2012) and comprised four two-tier items. Each item was a statement on one of the feedback levels. It was to find out which level of feedback from Chemistry teachers their students' find useful. The students were expected to choose from four options and give reasons for their choice. Students' responses to the items and the reasons for their choice informed the level of feedback that they found useful.

Focus group discussions between students and the researcher were also used to collect data. The chemistry teachers were asked to select three high - achieving students and three low- achieving students in their class for the discussions. This is because high-achieving students can be distinguished from low achievers by their use of feedback from their teachers and peers. While high-achieving students actively seek and use feedback, low-achieving students do not (Gamlem & Smith, 2013; Havnes et al., 2012). The criteria that were used to select both groups of students were their performance in the previous and current semester, their contribution in class and their attendance in school. There were two set of focus group discussions in each school, one for the high achievers and another for the low achievers. The discussions were audio recorded and transcribed verbatim.

All the Chemistry lessons that were observed were audio recorded and manually transcribed word for word for analysis. Students' tests, assignments and practical work in their exercise books were inspected and analysed for additional information on Chemistry teachers' feedback to their students after marking their work. Field notes were also used during observations to collect data. It comprised the observation date and time, a description of activities and other information related to the observations such as interruptions during class. The field notes were also used to record some of the Chemistry teachers' feedback to students during the lessons and their comments to students after marking their work. The transcribed data from the audio recordings was complemented with the researchers' field notes in order to compile a comprehensive data of the classroom observations. The researchers' field notes also served as a source of information for reliability checks. The observations were focused mainly on classroom dialogue between Chemistry teachers and their students, specifically on the feedback that Chemistry teachers provided to their students.

Validity

The instruments were shown to the researcher's team of supervisors for inspection and review to help check for content and face validity. A colleague PhD student who is also a chemistry teacher reviewed the instruments. These were field tested by the researcher at school D (a pseudonym). The results of the field testing, the supervisors and my colleague's comments enabled further modifications to be made to obtain the final instruments used for the study.

The study covered the entire second semester of the 2018/2019 academic year. The minimum number of visits to each school was two times a week and the maximum number was three times a week. After the second week most of the students got used to the presence of the researcher. I did not take part in any classroom discussion throughout the data collection period. This ensured that there was no manipulation of the classroom dialogue to increase the validity of the study.

The problem of data overload was reduced by analysing data especially the questionnaires after students have responded to it. For instance, nine students in school C whose responses to items in the open-ended student questionnaire - General was not clear were interviewed informally for clarification. The main objective of the focus group discussions was to answer research question 5 however it was also used to confirm students' earlier responses to items in the questionnaires. These respondent validation techniques also helped increase the validity of the study. The transcription of the recorded lessons took a while but was complemented with the field notes to give a comprehensive picture of the classroom dialogue for analysis. The use of multiple data collection methods like observations, audio recording of Chemistry lessons, use of questionnaires, focus group discussions and inspection of students marked work was a means of triangulation to increase validity.

Pilot testing

All the instruments were field tested in school D (a pseudonym), which is at the Ga South Municipality and shares a boundary with the Central Region. In 2017, there were 57 students sat for the WASSCE, with 31 of them representing 54%, having A1 – C6 in Chemistry. Therefore, it is an average performing school according to the categorisation used for the study. School D has three classes offering elective chemistry. Table 10 shows the average mark in chemistry for each class.

Table 10: Average Class Mark in Chemistry for all Classes offering Elective Chemistry in School D

Class	Average % Mark in Chemistry
2AG	36.02
2ScA	58.92
2ScB	42.78

End of first semester examination, School D (2019)

Form 2ScA had the highest average score of 58.92% for the previous term and therefore was selected for the pilot testing. During a two-week period in which chemistry lessons were observed and audio recorded, the instruments were administered to all the 39 students in the class.

Reliability

Reliability in qualitative research "can be regarded as a fit between what researchers' record as data and what actually occurs in the natural setting that is being researched" (Cohen et al., 2007, p. 149). To improve reliability, as much as possible verbatim accounts of participants' comments were used. The use of field notes during observations to also helped improve reliability as it was a means of comparing with transcribed data from the audio recordings in order to compile a comprehensive data of the classroom dialogue and focus group discussions.

Staying in the field for the whole semester as well as the use of a small audio recorder in the teachers' pocket during lessons minimized reactivity effects; where participants may change their behaviour if they know they are being observed, this helped improve reliability. A problem that affects the validity and reliability of qualitative research is anecdotalism. This is when the researcher selects a few well-chosen examples for making inferences (Silverman, 2013). This was minimized by analysing data comprehensively based on the research questions.

Cronbach's alpha reliability coefficients were determined for students' responses to the questionnaires titled perception and feedback levels. The reliability coefficient for the questionnaire titled perception was .76 and that for the questionnaire titled feedback level was .71.

Data Collection Procedures

The researcher visited the Greater Accra Regional Education Office and had discussions with the officer responsible for statistics. Based on the discussions, a letter of introduction from the Head of the Department of Science Education was sent to the Greater Accra Regional Director of Education. The WASSCE results in elective chemistry in 2017 for all schools in Greater Accra were released to the researcher.

The researcher then visited the three selected SHS and had discussions with the heads of the SHS. An introductory letter from the Head of the Department of Science Education was then sent to the Heads of the SHS. A week after the letter of introduction was sent; the Heads of the SHS introduced the researcher to the Assistant Heads and the Heads of Science Department. The Chemistry results of all classes in the schools offering elective Chemistry for the previous term was made available to the researcher, who analysed the results and calculated the average percentage mark for each class. The best performing class in Chemistry in each school was selected for the study. The Head of Science Department introduced the researcher to the Chemistry teachers of the selected classes and asked if they will be willing to take part in the study. They all agreed to take part in the study. The researcher then assured them of anonymity and confidentiality.

Data collection took place during the second semester of the 2018/2019 academic year. It started on the 14th of March 2019 and continued till the 25th of June 2019 when most of the schools had started the end of semester examinations. Twenty-five lessons including three practical sessions were observed, audio recorded and transcribed verbatim for analysis. The total duration of the observed lessons was forty hours. Some of the lessons took two hours, whilst others were for an hour.

In all the schools, the researcher was introduced to the class as a friend of the Chemistry teacher who is there to observe the lessons. The students were encouraged to be themselves. The Chemistry Teachers kept the recording device in their pocket whilst teaching. The use of a small audio recorder in the teachers pocket as well as staying in the field for the whole semester was to reduce reactivity effects; where participants may change their behaviour if they know they are being observed as well as minimize observer bias. After the second week most of the students got used to the presence of the researcher. My presence as a researcher in these classrooms was non-invasive, as I did not have any control over the issues of choice of topic, when and how to teach.

The Chemistry lessons in school A covered the topics acids, bases and salts, buffer solutions, redox reactions and electrolytic cells. In school B, the topics chemical kinetics and chemical equilibrium were covered, whilst in school C the topics chemical equilibrium, solubility and nuclear chemistry were covered. In school A, eight assignments, two practical works and a class test was inspected and analysed. In school B, ten assignments, and one class test was inspected whilst in school C, six assignments, one class test, and one practical work was inspected and analysed. The first questionnaire titled student questionnaire-General was administered in school A on the 22nd of May 2019. The last focus group discussion took place at school B on the 25th of June 2019. The audio recorded Chemistry lessons were assigned code numbers, for example, B/L/18/3, means lesson observed at school B on the 18th of March 2019.

Ethical issues

All ethical procedures governing qualitative research such as informed consent, confidentiality, anonymity, non-traceability, treating participants with respect, not causing any harm to participants (Cohen et al., 2007; Fraenkel &Wallen, 2009; Gravetter & Forzano, 2006; Silverman, 2013) were adhered to in the study. For instance, to ensure anonymity and non-traceability the gender of the Heads of the SHS were not disclosed. The Greater Accra Regional Education Office was assured of confidentiality of the information given the researcher. The Heads of the participating SHS, Assistant Heads and the Heads of Science Department were assured of anonymity and confidentiality and treated with respect. Participating Chemistry teachers and students of the selected classes were also assured of anonymity and confidentiality and treated with respect. Whenever students filled questionnaires as well as during the focus group discussions, they were assured that only the researcher will have access to their responses therefore they expressed themselves freely especially during the focus group discussions.

Data Processing and Analysis

Data was analysed based on the research questions. "A .... method of organizing the analysis is by research question. This is a very useful way of organizing data, as it draws together all the relevant data for the exact issue of concern to the researcher and preserves the coherence of the material" (Cohen et al., 2007, p. 468).

Research question 1

What level of feedback is prominent in Chemistry teachers' feedback practices in SHS classrooms? Two approaches were used to answer this question. Twenty-five lessons including three practical sessions with a total duration of forty hours which had been observed were audio recorded and transcribed verbatim for analysis. This was to find out the levels of feedback in the classroom dialogue. Secondly, students' assignments, practical work and class tests were inspected and analysed.

A three-part dialogue has been found to be widespread in classrooms. It begins when the teacher initiates the dialogue usually by means of a question. The student responds to the question and the teacher evaluates the student's response. This pattern of communication is described as Initiation-Response-Evaluation (IRE). This three-part conversation has been found to be widespread in classrooms. It is the most common form of discourse between teachers and their students in the classroom. Another form of this discourse takes place when instead of evaluating the student's response; the teacher gives the student feedback or explains the student's answer. This pattern is described as Initiation-Response-Feedback (IRF). The IRF form of discourse can also occur in a series of exchanges as an I-R-F-R-F chain where the elaborative feedback (F) from the teacher is followed by a further response (R) from the student and so on (Bansal, 2018; Chin, 2006; Mortimer & Scott, 2000 & 2003).

The unit of analysis is the teacher – student dialogue in the chemistry lessons in the classroom. This was analysed using the IRF pattern of dialogue.

Because the unit of analysis for the classroom dialogue was based on the IRF pattern, dialogues that did not follow the IRF pattern were excluded from the analysis. For example, questions that were not answered by students or self-answered by the teacher were not included. This was analysed by coding it, using feedback levels adopted from Hattie (2009 & 2012) and Hattie and Timperley (2007) feedback model. The researcher replaced the examples in the model with examples in Chemistry. Table 11 shows the coding scheme for the feedback levels adopted from Hattie and Timperley (2007); Hattie (2009 & 2012) feedback model.

Table 11: Coding Scheme for the Feedback Levels

Main Category	Definition	Example
Task - Level (FT)	When a student is informed if an answer is correct or incorrect without explaining why or giving suggestions on how to deal with incorrect answers. Asking for more of the same information. When a student is given information on his/her performance; that is grades expressed as a letter, number or fraction.	"It is correct". "Your answer is wrong". "90%". "A". "15/20".
Process - Level (FP)	When a student is given the reason why an answer is correct or incorrect and steps to carry out revision of work done.	"Your calculation of the rate constant is wrong because you did not consider the order of the reactants".

Table 11 Continued

	It includes comments about methods used to solve problems or identify mistakes.	"You omitted the title, scale and the units of the graph."
	It also includes comments that will enable the student to recognise how ideas are linked to each other in a topic.	"Indicate the state of the species and their mole ratios."
Self - Regulatory Level (FR)	It is reminders to students about strategies they can use to improve upon their own work without relying on the teacher for help.	"What is the effect of a change in temperature on the position of equilibrium?" Why do you think your answer was wrong?" "Explain your answer."
	It is usually in the form of analytical or reflective questions that guide the student in self-assessment.	"What interpretation can you make from the graph?"
Self - Level (FS)	Remarks that are directed to the student mainly to give encouragement. It is usually non-specific praise.	"Clap for him". "Excellent". "Good" "Neat work". "Thank you".
Other comments (OC)	Comments that are ambiguous or unrelated to the task	"Seen". "Sit up".

Hattie and Timperley (2007); Hattie (2009 & 2012) feedback model.

The same coding scheme was used for students' marked work. This was done for each school and finally combined to answer the question.

Research question 2

What is the students' perception of the usefulness of feedback that they receive from their Chemistry teachers? Two instruments were used to collect data to answer this question; one of the instruments was titled student Questionnaire-

Perception. It comprised of four two-tier items, students were required to select an option for each item and provide reasons for the option selected. Each item was a statement, the students were expected to choose from four options, that is, whether they completely disagreed, disagreed, agreed, or completely agreed to the statement and give reasons for their choice. The other instrument used was student questionnaire titled General. This was an open-ended questionnaire with 6 items. Items 1 and 2 were to find out students' perception of the usefulness of feedback that they received from their teachers. The data were analysed using descriptive statistics and verbatim quotes of students' responses to answer the question.

Research question 3

Which level of feedback from Chemistry teachers do their students find useful? Two instruments were used to collect data to answer this question; one of the instruments was titled student Questionnaire-Feedback levels. It comprised of four two-tier items, students were required to select an option for each item and provide reasons for the option selected. Each item was a statement on one of the feedback levels, the students were expected to choose from four options, that is, whether they found the statement not useful, fairly useful, useful or very useful when studying and give reasons for their choice. The instrument was analysed using descriptive statistics and verbatim quotes of students' responses. The other instrument was item numbers 3 and 4 on the questionnaire titled General. Students' responses to item numbers 3 and 4 were categorised into the various feedback levels. For instance, a response like; 'He is quick to praise you even when you are not completely correct' is categorized as self-level feedback whilst a response like;

'He explains to you why you were wrong whilst making corrections on the board' is process level feedback. Also, a response such as 'He guides us on how to do research and study on our own' is self-regulatory level feedback. These were then tallied to find which level of feedback students' find useful.

Research question 4

How do students use feedback from their Chemistry teachers? Students' responses to item numbers 5 and 6 on the questionnaire titled General guided in soliciting information on how students use feedback. Thematic content analyses of the responses students gave on these open-ended items were used to answer this research question.

Research question 5

Why do high-achieving students seek feedback, whilst low-achieving students do not? This question was answered using thematic content analysis of the focus group discussions of high achievers and low achievers in each class in the 3 schools. The students were selected with the help of their teachers based on their grade for the previous term and their average grade for the current term. Their contribution in class and their attendance in school were also considered by their Chemistry teachers in their selection. The high achievers had average grades above 74%, whilst the low achievers had average grades of 40% and below.

Chapter Summary

This study was about senior high school Chemistry teachers' feedback practices and how their students perceive and use them. The research design chosen for the study was the case study approach. Public SHS in the Greater Accra Region were put into 3 groups based on their WASSCE results in Chemistry and a school selected from each group for the study. Only Form 2 students and their Chemistry teachers were the participants for the study. In each school the best performing class in Chemistry for the first semester of the 2018/2019 academic year and their Chemistry teacher were selected for the study. Data was collected during the second semester of the 2018/2019 academic year and continued till most of the schools started the end of semester examinations. The researcher was the main instrument for the case study design. Some limitations of the study are case study research is subjective and therefore difficult to replicate. Generalizations are also limited in scope; therefore, the results are limited to the 3 schools that were purposively selected for the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter, the results of the study are presented and discussed to answer the five research questions.

Level of feedback prominent in Chemistry teachers' feedback practices

Research question 1 sought to find out the level of feedback that is prominent in Chemistry teachers' feedback practices in some SHS classrooms. Two approaches were used to answer this question. Firstly, twenty-five lessons including three practical sessions with a total duration of 40 hours which had been observed were audio recorded and transcribed verbatim for analysis. This was to find out the levels of feedback in the classroom dialogue. This was analysed by coding it using feedback levels adopted from Hattie (2009 & 2012) and Hattie and Timperley (2007) feedback model. However, the researcher replaced the examples in the model with examples in Chemistry. The unit of analysis was the dialogue between the teacher and his students during the Chemistry lessons. This dialogue was then analysed using the IRF form of discourse (Chin, 2006; Mortimer & Scott, 2000 & 2003). To present and analyse data to answer this research question, the lessons observed for the three teachers used in this study are reported separately for easy understanding.

Observation results for Bismarck, the Chemistry teacher at school A

Bismarck was observed in eight different lessons of which seven of the lessons were theory based while one was practical. The classroom dialogue was audio recorded and the feedback levels determined. The first lesson observed for Bismarck was on the topic 'Lewis concept of Acids and Bases'. Table 12 shows analysed classroom dialogue from a lesson observed at school A on the 24th of April 2019.

Table 12: Analysed Classroom Dialogue (Assigned Code Number A/L/24/4)

Speaker	Utterance(s)	Move	Feedback level
Teacher	How does Lewis define his acid and base........Bettina has some information so let's hear her.	I	
Student	An acid is a substance which accepts lone pair electrons to..........	R	
Teacher	She said an acid is a substance which accepts lone pairs of electrons. Thank you very much.	F	F S
Teacher	I will now get the base because they move hand- in- hand so if one is accepting then one is what?	I	
Students	Donating.	R	
Teacher	Donating. Okay.	F	F T
Teacher	The Lewis structure for the nitrogen? Yes, Armstrong, come and help us.	I	
Student	(Solves question on the board)	R	
Teacher	So, this is Lewis structure for nitrogen. But do we agree?	F - I	F T
Students	Yes.	R	
Teacher	Yeah, I think I will go with this.	F	F T
Teacher	Would it be an acid or a base?	I	
Students	An acid.	R	
Teacher	Yes, it will obviously be an acid still because we do not have lone pairs of electrons here.	F	F P
Teacher	Now, looking at the three definitions.........which one is the best?	I	
Student	Lewis.	R	
Teacher	Why? Yes, Timothy.	F	F R
Student	It's Lewis because, it doesn't have to be in an aqueous solution..........	R	
Teacher	So, in case you don't have aqueous solution you can still define it as.............	F	F T
Teacher	Determine if it's acid, basic or neutral. Someone should come to the board ... yes, Maame Afua.	I	
Student	(Solves question on the board) Sir, it is acidic.	R	
Teacher	Right, thank you very much. In fact, clap for her.	F	F S

Classroom observation, School A, April 2019

Key: **I**: Initiation; **R**: Response; **F**: Feedback; **F-I**: Feedback and Initiation; **FT**: Task Level Feedback; **FP**: Process Level Feedback; **FR**: Self- Regulatory Level Feedback; **FS**: Self- Level Feedback

A careful analysis of Bismarck's interaction with the students, as seen in Table 12, points to the fact that the most dominant feedback level used in the classroom dialogue was task level feedback followed by self-level feedback. Process level feedback and self-regulatory level feedback were the least utilized.

The second lesson observed for Bismarck was on the topic 'Strong and weak acids and bases'. Table 13 shows analysed classroom dialogue from a lesson observed at school A on the 26th of April 2019.

Table 13: Analysed Classroom Dialogue (Assigned Code Number A/L/26/4)

Speaker	Utterance(s)	Move	Feedback level
Teacher	Calculate the pH of a solution whose H^+ ions concentration is......... we want someone to come to the board........Dzifa	I	
Student	(answers on the board)	R	
Teacher	Right. Thank you very much.	F	F S
Teacher	But there is something we can use to describe the strong bases............yes, Armstrong?	I	
Student	Hydroxides of group one and two metals.	R	
Teacher	Yes............. of course, except beryllium.	F	F P
Teacher	We don't have the concentration of the H^+ ions straight away, so how will you get it.................Felix?	I	
Student	(answers on the board)	R	
Teacher	Thank you, Felix. Do we agree?	F - I	F S
Students	No.	R	
Teacher	Yes, Maame Akua come and help us.	F - I	F T
Student	(answers on the board)	R	
Teacher	Thank you very much. But is she right?	F - I	F S
Students	Yes sir.	R	
Teacher	Can you explain your first steps again…?	F	F R
Student	The question didn't directly state the hydrogen concentration so...................	R	
Teacher	Ok thank you very much. In fact, let's clap for her for a very good presentation here.	F	F S
Teacher	Calculate the pOH and the pH of that solution. Albert can you help us?	I	
Student	(answers on the board)	R	
Teacher	Clap for her for her excellent work. Clap for her.	F	F S
Teacher	A lot of people were asking, is this 2 supposed to be here?	I	
Student	Yes.	R	
Teacher	Yes, because you need to balance it, if the 2 is not there then the equation is not balanced.	F	F P
Teacher	So, question one, the first part… Albert do you want to…	I	
Student	(answers on the board)	R	
Teacher	Right. Thank you very much. Do we agree with this approach?	F - I	F S
Students	Yes.	R	
Teacher	Ok.	F	F T

Classroom observation, School A, April 2019

A detailed look at Table 13 indicates that the most dominant feedback level used in this dialogue was self-level feedback, process and task level feedback were used only twice while self-regulatory level feedback was the least utilized.

The third lesson observed for Bismarck was on the topic 'Buffer solutions'. Table 14 Shows analysed classroom dialogue from a lesson observed at school A on the 8th of May 2019.

Table 14: Analysed Classroom Dialogue (Assigned Code Number A/L/8/5)

Speaker	Utterance	Move	Feedback level
Teacher	So, when you hear of buffer, what comes to mind?	I	
Student	A solution which doesn't change its pH easily…	R	
Teacher	Ok that's buffer solution.	F	F T
Teacher	What is the pH of blood?	I	
Students	7.4	R	
Teacher	Yes, okay............even if you put an acidic food in your system, the pH doesn't change.	F	F P
Teacher	Assuming the blood is unable to resist pH, what will occur within your system?	I	
Student	Sir let us say it keeps on changing................	R	
Teacher	Yes, very good, clap for him.	F	F S

Classroom observation, School A, May 2019

The classroom dialogue during this lesson was mainly one – sided with Bismarck explaining the concept and giving the students notes. Bismarck answered most of the questions he asked consequently the greater part of the classroom dialogue did not follow the IRF pattern of discourse. Three feedback levels were obtained, one each on task level, process level and self-level.

The forth lesson observed for Bismarck was on the topic 'Redox reactions'. Table 15 shows analysed classroom dialogue from a lesson observed at school A on the 10th of May 2019.

Table 15: Analysed Classroom Dialogue (Assigned Code Number A/L/10/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	We want to determine the oxidation states of the underlined species. The first one, $KMnO_4$? Please come to the board......	I	
Student	(solves question on the board)	R	
Teacher	…okay, thank you. The next one? … (calls Jessica)	F - I	F S
Student	(solves question on the board)	R	
Teacher	… so please the plus (+) should be there.	F	F P
Teacher	So, this is Mg. if I add oxygen to it, what am I going to have?	I	
Students	MgO	R	
Teacher	So, can I say that this reaction is oxidation?	F - I	F T
Students	Yes.	R	
Teacher	Yes, it is oxidation because oxygen been added to a chemical specie, so it has gained oxygen.	F	F P
Teacher	So now we have Mg + O_2, and then we do the balancing. (calls a student to answer)	I	
Student	(Solves question on the board)	R	
Teacher	No, we are not dealing with equilibrium so over here, there is no need to bring it.	F	F P
Teacher	I have Zn^{2+}. Now I add two electrons to it. What do I get?	I	
Students	Zn	R	
Teacher	Okay.	F	F T
Teacher	We don't have this equation there so… Armstrong, you want to… okay.	I	
Student	(Solves question on the board)	R	
Teacher	So, he used the oxidation state. Like he said, H is moving on from zero to plus one (+1). That is oxidation.	F	F P
Teacher	The reaction B is it redox or not redox?	I	
Students	Not redox.	R	
Teacher	It's undergoing reduction. It's only one part, which is reduction. What about the C? It's also not redox?	F - I	F P
Students	Yes.	R	
Teacher	Why? Yes, Dzifa.	F	F R
Student	Sir because when you check for the oxidation state, they both have equal numbers....	R	
Teacher	Yes, in fact clap for her.	F	F S
Teacher	Yes, who will help us? Is there a redox reaction or not? Yes, (calls a student)	I	
Student	(Answers question)	R	
Teacher	Okay, thank you very much, clap for her.	F	F S

Classroom observation, School A, May 2019

An examination of Table 15 indicates that the most dominant feedback level used by Bismarck in this lesson was process level feedback, followed by self-level feedback, then task level feedback while self-regulatory level feedback was the least utilized.

The fifth lesson observed for Bismarck was on the topic 'Oxidizing and reducing agents in redox reactions'. Table 16 shows analysed classroom dialogue from a lesson observed at school A on the 17th of May 2019.

Table 16: Analysed Classroom Dialogue (Assigned Code Number A/L/17/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	PbO to Pb^{2+}, is it oxidation or reduction?	I	
Students	Reduction.	R	
Teacher	So, which agent is it going to be?	F - I	F T
Students	Oxidizing agent.	R	
Teacher	Okay.	F	F T
Teacher	… anyway, who's got a good definition? Let's see, Banini.	I	
Student	It is the species…. whiles undergoing oxidation………	R	
Teacher	Yes, I think we all got something.	F	F T
Teacher	These oxidizing agents have a lot of oxygen, now, the reducing agents, what will they have inside them?	I	
Students	Hydrogen.	R	
Teacher	Yes. In most of the cases, you could use the hydrogen to………	F	F P
Teacher	What is the oxidation state of sulphur here?	I	
Students	plus 4(+4)	R	
Teacher	Okay, so +4 to?	F - I	F T
Students	Zero	R	
Teacher	And then minus 2 to?	F - I	F T
Students	Zero.	R	
Teacher	Okay, so this one is undergoing reduction, and that one is undergoing what?	F - I	F P
Students	Oxidation.	R	
Teacher	Yes, why did we ignore the water? Timothy	F - I	F R
Student	Sir, the water is the product of the reaction…	R	
Teacher	Yes, the water is not undergoing any change………we are looking for the ones that are undergoing changes	F	F P
Teacher	What about the second one?…… Sn^{2+} is the reducing agent. And this one is the	I	
Students	Oxidizing agent.	R	
Teacher	Okay, so we can identify them.	F	F T
Teacher	If you can see, the ion here, is it oxidation or reduction?	I	
Students	Oxidation	R	
Teacher	And this one is the?	F - I	F T
Students	Reduction.	R	
Teacher	So, oxidation, and then the reduction.	F	F T

Table 16: Continued

Teacher	Okay, so how do you balance the Cr? Yes Isaac	I	
Student	Sir, add 2 to the reactants side	R	
Teacher	So, I'm going to add 2 to this side? Or which side?	F - I	F T
Students	Sir, the products side	R	
Teacher	Okay.	F	F T

Classroom observation, School A, May 2019

In this lesson, as indicated on the table, the most dominant feedback level used was task level feedback followed by process level feedback. The least applied feedback level was self-regulatory level feedback while self- level feedback was not used in this lesson.

The next lesson observed at school A was on the 22nd of May 2019, the topic was 'Balancing of redox reactions in acidic and basic media'. Just as happened in the third lesson, the classroom dialogue during this lesson was mainly one – sided with Bismarck explaining the concept and giving the students notes. Bismarck answered most of the questions he asked consequently the greater part of the classroom dialogue did not follow the IRF pattern of discourse. The only feedback level detected, was process level feedback as shown on Table 17.

Table 17: Analysed Classroom Dialogue (Assigned Code Number A/L/22/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	This OH^- and that OH^-, how come they did not cancel out? Can someone help us?	I	
Student	Sir, per the directive you gave, you said that the H+ ions and the OH- ions will rather react but...........	R	
Teacher	Yes, this $14H^+$ reacted with this one so there is no way they cancel out........	F	F P

Classroom observation, School A, May 2019

The seventh lesson observed for Bismarck was on the topic 'Electrolytic cell'. In this lesson, after Bismarck had explained the concept, students drew diagrams and copied notes. Accordingly, the greater part of the classroom dialogue did not follow the IRF pattern of discourse. Table 18 shows analysed classroom dialogue from a lesson observed at school A on the 31st of May 2019.

Table 18: Analysed Classroom Dialogue (Assigned Code Number A/L/31/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	So, let someone come to the board and help us.	I	
Student	(Solves question on the board)	R	
Teacher	Thank you very much.	F	F S
Teacher	…the number of moles? It is what?	I	
Student	Three.	R	
Teacher	Yes, how did you get the three?	F - I	F T
Student	The charge on aluminium.	R	
Teacher	The charge on aluminium, so it is in this form and it is going to be deposited in that form.	F	F P

Classroom observation, School A, May 2019

A close look at Table 18 shows that three feedback levels were obtained, one each on task level, process level and self-level.

The last lesson observed at school A was on the 7th of June 2019. It was a practical lesson and the topic was 'Back titration'. Bismarck copied the question on the board while the two laboratory assistants supplied the students with the solutions for the titrations. When the students completed the titrations, Bismarck went round signing by their titre values. Bismarck explained to me that this was to ensure that the students do not alter their titre values when they submit their practical books after calculations. Table 19 shows analysed classroom dialogue after the practical lesson.

Table 19: Analysed Classroom Dialogue (Assigned Code Number A/L/7/6)

Speaker	Utterance(s)	Move	Feedback level
Teacher	B is a solution obtained by.............so, B is the?	I	
Students	Acid.	R	
Teacher	So, B is the acid.	F	F T
Teacher	So, this is going into the?	I	
Students	Burette.	R	
Teacher	And then of course, we are going to pipette this.	F	F T
Teacher	The first question, this one how do we do this?	I	
Students	Mole ratio.	R	
Teacher	Yes, so we use the mole ratio and we are using the second equation, okay.	F	F T
Teacher	The question two, amount of HCl consumed when it reacted with the rock, yes, Lisbon?	I	
Student	Sir, I think you will first find the concentration....	R	
Teacher	Okay, so we are going to find the moles before reacting with the rock sample.	F	F T

Classroom observation, School A, June 2019

Table 19 shows that only one feedback level was used in the classroom dialogue after the practical lesson, that is, task level feedback.

The different feedback levels obtained after observing Bismarck in the classroom was put together in Figure 5.

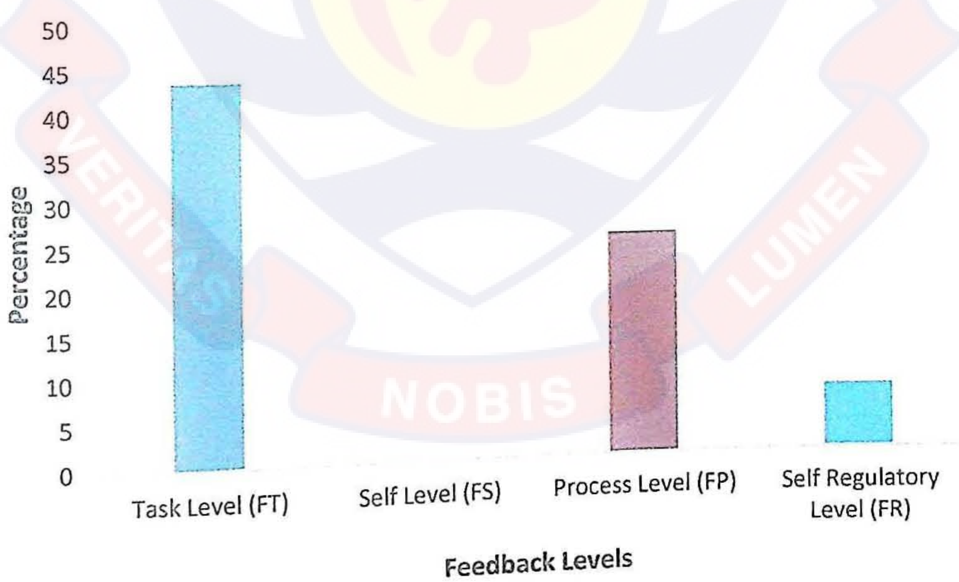

Figure 5: Analysed classroom dialogue showing Bismarck's feedback practices.

Observation results for Frederick, the Chemistry teacher at school B

Frederick was observed in eight different lessons and the feedback levels determined. The first lesson observed for Frederick was a discussion on the previous term's examination questions. Table 20 shows analysed classroom dialogue from a lesson observed at school B on the 18th of March 2019.

Table 20: Analysed Classroom Dialogue (Assigned Code Number B/L/18/3)

Speaker	Utterance(s)	Move	Feedback level
Teacher	What type of hybridisation occurs in diamond?	I	
Student	Sir, sp^3	R	
Teacher	sp^3, Okay.	F	F T
Teacher	What kind of hybridisation occurs in graphite?	I	
Student	sp^2	R	
Teacher	sp^2	F	F T
Teacher	Who can give us an alternative solution to this?	I	
Student	Sir, you use M x c x v	R	
Teacher	So, alternatively, m, mass is equal to what?	F	F T
Students	molar mass times concentration times volume.	R	
Teacher	That is an alternative method okay, this one is straight forward.	F	F T
Teacher	You spoke earlier? Yes, natural radioactivity.	I	
Student	Sir, it is the natural spontaneous disintegration of atomic nuclide into.........	R	
Teacher	You're defining natural radioactivity and 'natural' comes in.....can you take away the 'natural'?	F	F P
Student	It is the spontaneous disintegration of atomic nuclide into smaller nuclides..........	R	
Teacher	Okay, what are the radiations that can be emitted? Sarfo	F - I	F T
Student	Gamma rays.	R	
Teacher	Okay	F	F T

Classroom observation, School B, March 2019

A scrutiny of Table 20 shows that the dominant feedback level used was task level feedback. Process level feedback was used only once while there was no self-regulatory level feedback and self- level feedback in this lesson.

The second lesson observed for Frederick was on the topic 'Chemical reaction and the mole'. Table 21 shows analysed classroom dialogue from a lesson observed at school B on the 28th of March 2019.

Table 21: Analysed Classroom Dialogue (Assigned Code Number B/L/28/3)

	Speaker	Move	Feedback level
Teacher	What does the molar volume mean?	I	
Student	One mole of the gaseous substance …	R	
Teacher	Yes, who can polish it better for us? Yes, that's a good try, that's good, it's not bad.	F	F S
Student	One mole of the gaseous substance, has a volume of 22.4 dm^3.	R	
Teacher	One mole of that gas occupies a volume equal to 22.4dm^3, okay.	F	F T
Teacher	So, what is the equation that will help us to achieve this? Yes, Prince	I	
Student	Amount of substance ….	R	
Teacher	Very good……… so, Elizabeth what will be the transposed formula there for volume of carbon dioxide gas?	F - I	F S
Student	Amount of substance times the molar volume.	R	
Teacher	Very good.	F	F S
Teacher	So, you are saying to produce H_2 right? Okay and then Al_2NO_3 do you agree with Precious?	I	
Students	No.	R	
Teacher	They don't agree with you, it means there's a challenge somewhere. Okay David what's the challenge?	F - I	F T
Student	Sir, it's supposed to be $Al(NO_3)_3$	R	
Teacher	Precious, have you seen your mistake? So, you must make use of the oxidation state of the species.	F	F P
Teacher	Who can help us balance it? Okay, Michael	I	
Student	(Solves on the board)	R	
Teacher	So, it means that the equation is now balanced.	F	F T
Teacher	Okay, so, the relative moles of the hydrogen gas are what?	I	
Student	Sir, 3 times 0.4 over 2	R	
Teacher	So, your change of subject, important.	F	F P
Teacher	So, mass of hydrogen. How do we put it?	I	
Student	So, the mass is amount of substance times the molar mass, so you find the molar mass.	R	
Teacher	Very good.	F	F S
Teacher	What are the types of entities present in chemical substances?	I	
Student	molecules, atoms	R	

Table 21 continued

Teacher	And the other thing? Yes	F	F T
Student	Sir, ions.	R	
Teacher	Okay, so we have atoms, molecules and then ions.	F	F T

Classroom observation, School B, March 2019

An inspection of Table 21 shows that the dominant feedback level used was task level followed by process level and then self- level feedback. There was no feedback on self-regulatory level in this dialogue.

The third lesson observed for Frederick was on the topic 'Rate of Chemical reactions'. Table 22 shows analysed classroom dialogue from a lesson observed at school B on the 15th of April 2019.

Table 22: Analysed Classroom Dialogue (Assigned Code Number B/L/15/4)

Speaker	Utterance(s)	Move	Feedback level
Teacher	What is rate of reaction?	I	
Student	Rate of reaction is the change in the concentration of the product and reactant.	R	
Teacher	rate of reaction is the change of the concentration of the product or reactant per unit time. And so, it means that we measure the concentration of a reaction with respect to time. Isn't it?	F - I	FT
Students	yes	R	
Teacher	Good. Now what else did we look at under rate of reaction?	F - I	F S
Student	Factors that affect rate of reaction.	R	
Teacher	Alright. .... What are some of the factors?	F - I	F T
Student	Temperature	R	
Teacher	Temperature. Mhmm.	F - I	F T
Student	Catalyst	R	
Teacher	Catalyst. Mhmm. What else?	F - I	F T
Student	Concentration, pressure.	R	
Teacher	Pressure. So, pressure refers to what? .... But we talk about pressure when we are referring to, yes?	F - I	F T
Student	Volume	R	
Teacher	Volume. Ok	F	F T
Student	Gases	R	
Teacher	Gases. Ok… so pressure applies to gases. Ok… right , then err...........the last one	F - I	F T
Student	Nature of the substance.	R	
Teacher	Nature of the substance. Good.	F	F S

Table 22 continued

Teacher	Ok……. so, for a reaction like this A+B → C+D for example, ………… How do we write the rate law? What symbol, what letter is used to write the rate?	I	
Student	R	R	
Teacher	Capital R. good. ……….. so, R is equal to? We are trying to write the rate law.	F	FS
Teacher	So, she says the rate is equal to the constant………………… now what is the k over there?	I	
Student	The rate constant.	R	
Teacher	The rate constant. Alright. Now what about the x?	F - I	F T
Student	Order of reactant.	R	
Teacher	Order of reactant. Is that all?	F	FT
Teacher	The order of reaction with respect to reactant A. Ok……. so now that I have giving you x, you should be able to give me y. What does y represent?	I	
Students	Order of reaction with respect to reactant B	R	
Teacher	Order of reaction with respect to what… reactant B. Alright.	F	F T
Teacher	Ok… now as the reaction proceeds, you know the concentration of A will reduce to give us B. ………we said rate is what? The disappearance of the	I	
Student	Reactant.	R	
Teacher	The reactant, and then the formation of what?	F- I	F T
Student	Product	R	
Teacher	The product per time. So as the A is disappearing, B is been formed.	F	F P
Teacher	Why are we negating the change in concentration of A?	I	
Student	When the reactants are reacting, they are giving out like exothermic reaction.	R	
Teacher	We are not talking about exothermic or endothermic reaction. Why do we negate the change in concentration of A?	F - I	F T
Student	Because there is a decrease in the concentration of the reactants.	R	
Teacher	Good. There is a decrease in concentration of the reactants ok…… the reactant is reducing to give us the product.	F	F S
Teacher	Ok… so when you increase the concentration of A by 2, what happens to rate of reaction? ……………………….. rate also increases by what?	I	
Students	2	R	
Teacher	2. so you see that the rate also doubles. Isn't it?	F - I	F T
Students	yes	R	
Teacher	Ok……………..so it means that X is what?	F - I	F T
Student	1	R	
Teacher	1. Ok… right.	F	F T
Teacher	It increases by a factor of 9. ………………………… to what power of 3 should the concentration be raised for us to get that rate of 9?	I	
Student	2	R	
Teacher	Right.	F	F T

Table 22 continued

Teacher	What will be the overall order for that reaction?	I	
Student	3	R	
Teacher	Alright.	F	F T

Classroom observation, School B, April 2019

Just like the previous lesson, Table 22 shows that the dominant feedback level used was task level. This was followed by self- level feedback and then process level feedback. Similarly, there was no feedback on self-regulatory level in this dialogue.

The fourth lesson observed for Frederick was on the topic 'Chemical equilibrium'. Table 23 shows analysed classroom dialogue from a lesson observed at school B on the 23rd of May 2019.

Table 23: Analysed Classroom Dialogue (Assigned Code Number B/L/23/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	If we have just one reactant which is breaking to give us a product, what word do we use for that? .... Yes, Francis	I	
Student	Reactivity.	R	
Teacher	Reactivity? Are you sure? Ben	F	F T
Teacher	There are so many types of reactions: we can have neutralisation reactions and what other reaction?	I	
Student	Combustion reaction.	R	
Teacher	Okay, combustion reaction.................and many other types of reactions.	F	F T
Teacher	Where the reaction is complete, that is the reactants react completely to give us a product. Can you give me an example of such a reaction?	I	
Student	Burning wood into ashes.	R	
Teacher	Good, burning wood into ashes.	F	F S
Student	Boiling egg.	R	
Teacher	Boiling egg, okay. So, burning wood into ashes, can we get the wood back?	F - I	F T
Students	No	R	
Teacher	Okay, so such a reaction is a complete reaction where the reactant is giving us a product.	F	F T
Teacher	Liquid water being heated to give us water in the gaseous form isn't it?	I	
Students	Yes	R	
Teacher	The gaseous water can be cooled isn't it?	F	F T
Teacher	What type of reaction is happening there? So, we have evaporation and then what?	I	
Students	Condensation	R	
Teacher	Evaporation and condensation. So, evaporation and condensation can be said to be a reversible reaction isn't it?	F - I	F T

Table 23 continued

Students	Yes		
Teacher	Good	R	
Teacher	First, let's look at irreversible reaction.	F	F S
	What is irreversible reaction?	I	
Student	Irreversible reaction is a type of reaction in which the reactants react completely to form the products without the products forming the reactants	R	
Teacher	Okay, where the products cannot be reversed to get the reactants .... so, what is a reversible reaction? Yes Francis?	F - I	F T
Student	It is a reaction whose reactants can be formed from the product.	R	
Teacher	Or we say that the reactants give us a product and the product also react to give us back what?	F - I	F T
Students	The reactants.	R	
Teacher	The reactants. Good. (draws a graph on the board)	F	F S
Teacher	How would you define or explain chemical equilibrium?	I	
Student	It's when the rate of the forward reaction is the same as that of the backward reaction.	R	
Teacher	Okay. Or?	F - I	FT
Student	The rate at which the reversible reaction remains constant.	R	
Teacher	I'm saying in terms of concentration	F	FT
Student	When the concentration of the products is equal to the concentration of the reactant.	R	
Teacher	Okay. Or we say that when the concentration of the reactants and that of the products remains	F - I	FT
Student	Constant.	R	
Teacher	Constant, good.	F	FS
Teacher	Now when you have equilibrium established, ... we say that what, rate of forward reaction is equal to what?	I	
Students	Rate of backward reaction	R	
Teacher	Right.	F	F T
Teacher	.... now how would you define equilibrium constant, k using the relation we have on the board?	I	
Student	Sir, it is a constant which is proportionality in equilibrium.	R	
Teacher	Mmm, I want you to use the relation on the board. Yes .... Benjamin?	F- I	F P
Student	Sir, equilibrium constant is the ratio of the concentration or pressure of the product of a reactant to	R	
Teacher	Product of a reactant what? Of a reactant.............?	F- I	F T
Student	Reaction.	R	
Teacher	Now, the word you are using, 'product', you should be careful. ....Now, you can see that the reaction that we have at the top is the reaction's what?	F- I	F T
Student	Product.	R	
Teacher	Product............... there is a product of the reaction's product. Do you see that?	F- I	F T
Students	Yes.	R	
Teacher	A product of the reaction's product. So, if you are defining be careful. I want you to start again.	F- I	F T

Table 23 continued

Student	So, equilibrium constant is the ratio of the concentration or pressure of the product of the product of a reaction to.........	R	
Teacher	the product of a reaction's product to…	F	F P
Student	to the product of the reaction's reactants	R	
Teacher	the product of the concentration or…?	I	
Student	pressure of the reaction's reactants.	R	
Teacher	Good. Clap for him.	F	F S
Teacher	Now, but I want him to repeat it again.	I	
Student	Equilibrium constant is the ratio of the concentration or pressure of the product of a reaction's product to the product of the concentration or pressure of the reaction's reactant	R	
Teacher	Good.	F	F S
Student	Sir, can you say to the power… with respect to its stoichiometry coefficient?	R	
Teacher	Good. ....all raise to their appropriate number of what? Or stoichiometric coefficient or number of moles okay, right. That's good.	F	F S
Teacher	(writes equation on the board) so, Kc is equal to, concentration of	I	
Students	PCl	R	
Teacher	PCl_3,what the number of moles, one isn't it?	F- I	F P
Students	Yes.	R	
Teacher	So, it's to the power one, concentration of Cl_2 (g) also to the power one over?	F- I	F T
Students	PCl	R	
Teacher	Concentration of PCl_5. Derive the unit for the equilibrium constant.	F- I	F P

Classroom observation, School B, May 2019

An examination of Table 23 point out that the dominant feedback level used was task level. This was followed by self-level feedback and then process level feedback.

The fifth lesson observed for Frederick was on the topic 'Chemical equilibrium'. Table 24 shows analysed classroom dialogue from a lesson observed at school B on the 27th of May 2019.

Table 24: Analysed Classroom Dialogue (Assigned Code Number B/L/27/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	… so, if you have the 'k' far greater than one, what does it mean?	I	
Student	It means it is not stable.	R	
Teacher	Not stable? What is not stable?	F	F T
Student	It means that the products are far greater than the reactants.	R	
Teacher	It means that concentration of the product is higher than the reactant.	F	F T
Teacher	Now, what about if you have 'k' far less than one? So, it means that the reactants are what?	I	
Students	Greater than the products.	R	
Teacher	Good. So, the concentration of the reactants is greater than what?	F - I	F S
Students	The products.	R	
Teacher	Okay. So, it means that the reaction lies to the left and favours the reactants.	F	F P
Teacher	Who can give me the ideal gas expression or the equation?	I	
Student	Sir, PV is equal to nRT	R	
Teacher	PV is equal to nRT, okay.	F	F T

Classroom observation, School B, May 2019

This lesson was also dominated by task level feedback as indicated on Table 24 process level feedback and self-level feedback were used equally, only once each.

The sixth lesson observed for Frederick was on the topic 'Factors affecting an equilibrium system'. Table 25 shows analysed classroom dialogue from a lesson observed at school B on the 30th of May 2019.

Table 25: Analysed Classroom Dialogue (Assigned Code Number B/L/30/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	………. what will happen to the system according to Le Chatelier's principle, if the concentration of a reactant is increased what do you think will happen to a system? Yes Francis	I	
Student	Sir, the concentration………. the reaction will favour the production of more of the products so the equilibrium will shift to the right.	R	
Teacher	Why, why does it happen so?	F - I	F R

Table 25 continued

Student	Sir, because the reactants are more than the products so in order to balance that the number of products should also increase for them to be stable.		
Teacher	Okay.	R	
Teacher	(teacher copies another question on the board) What would be the effect on the equilibrium position as well as the equilibrium constant, Kc, when more of hydrogen is added to the reaction vessel in the following equilibrium?	F	F T
Student	The equilibrium position would shift to the right.	I	
Teacher	Okay. Why?	R	
Student	This is because the amount of reactants has increased so its greater than that of the products and according to Le Chatelier's principle, the reaction will counterattack that by increasing the amount of products.	F - I	F R
		R	
Teacher	Okay. So, what will happen to the equilibrium position?	F- I	F T
Student	It will shift to the right.	R	
Teacher	Okay. Do you agree with him?	F - I	F T
Students	Yes.	R	
Teacher	Alright.	F	F T
Teacher	If we have increased hydrogen, then what should happen to it? ....they must quickly react to give us a product, Okay. So, it means that the reaction would be favoured in what	I	
Student	The forward reaction.	R	
Teacher	In the forward reaction means that the products must be formed quickly so that we can have a balance.	F	F P
Teacher	What happens to Kc?	I	
Student	Kc will decrease.	R	
Teacher	Why? Explain.	F - I	F R
Student	Sir, more of the H_2 is being added so the concentration of the reactants is increased....so decrease in concentration of reactants will decrease the Kc.	R	
Teacher	but if concentration of the reactants is increased............... it means that a product too is formed, so, what do you think will happen to the Kc?	F - I	F T
Student	I think Kc will increase. This is because since there is a decrease in the reactants to form more products......	R	
Teacher	Not to form more products, to form a product which will cause the system to go back to equilibrium.	F	F P
Student	So, it won't change?	R	
Teacher	It won't change. There will be no change in Kc. The reactant that is used up is forming the product to re-establish equilibrium, okay.	F	F T
Teacher	So, a decrease in the concentration of hydrogen will cause a decrease in the concentration of nitrogen. Do you agree?	I	
Students	Yes.	R	
Teacher	Why? Class prefect can you answer that question?	F - I	F R
Student	Sir, I think since hydrogen is reacting with nitrogen to form the product, they are being consumed so there is a decrease in both.	R	
Teacher	Did you hear that? .... Ben please repeat.	F	F T
Student	Since hydrogen is reacting with nitrogen at the reactant side, it will give us a product .... and cause a decrease in their concentrations.	R	

Table 25 continued

Teacher	Okay, alright.	F	F T
Teacher	Now, a change in temperature............... what is an exothermic reaction?	I	
Student	It is a reaction that releases heat energy to the environment.	R	
Teacher	It gives out energy or heat to the surrounding, okay. So endothermic is what?	F - I	F T
Student	The opposite.	R	
Teacher	The opposite, so heat is taken into the system, okay.	F	F T
Teacher	If a reaction is an exothermic reaction.................. heat is part of the product. Is that right?	I	
Students	Yes sir.	R	
Teacher	Okay	F	F T
Teacher	(copies question on the board) We see that this particular reaction, is it exothermic or endothermic?	I	
Students	Endothermic reaction.	R	
Teacher	It's an endothermic reaction. Because we have what?	F- I	F T
Students	A positive delta H.	R	
Teacher	Okay. So, what will be the effect of an increase in temperature?	F- I	F T
Student	Sir, it will favour the production of the products.	R	
Teacher	Please explain	F- I	F R
Student	Sir since it's an endothermic reaction, it means that the enthalpy of the products was less than that of the reactants, so it has to gain heat in order to stabilize.	R	
Teacher	Heat is added to the system......... explain the effect of an increase in temperature?	F- I	F R
Student	It will lead to a decrease in the concentration of PCl_5.	R	
Teacher	A decrease, why?	F- I	F R
Student	Sir it's because the forward reaction is an endothermic reaction so the more heat is added, it will favour the forward direction so more of the reactants will form more products.	R	
Teacher	Okay, that's the forward reaction, since it is that direction that can proceed to use the added heat.	F	F P

Classroom observation, School B, May 2019

Table 25 shows the dialogue was dominated by task level feedback. This was followed by self-regulatory level feedback and then process level feedback. There was no self- level feedback in this dialogue.

The seventh lesson observed for Frederick was on the topic 'Factors affecting equilibrium position: concentration'. Table 26 shows analysed classroom dialogue from a lesson observed at school B on the 3rd of June 2019.

Table 26: Analysed Classroom Dialogue (Assigned Code Number B/L/3/6)

Speaker	Utterance(s)	Move	Feedback level
Teacher	(copies equation on the board) If for example, we increase the concentration of hydrogen, what will happen?	I	
Student	It will shift to the right.	R	
Teacher	What does it mean that it will shift to the right?	F	F R
Student	Sir, when the concentration of the reactant is increased the equilibrium position will shift to the right, that's more of the reactants will form products.	R	
Teacher	Okay............ it means that it must react, those reactants must react quickly to give us a product so that there can be a balance isn't it?	F - I	F T
Students	Yes.	R	
Teacher	Good...............we are saying that if we increase hydrogen it means that more of the ammonia will be produced. If more of the ammonia will be produced, then it means that the nitrogen must also decrease isn't it?	F - I	F S
Students	Yes.	R	
Teacher	Alright, if there was equilibrium and we increase the concentration of a product, like ammonia, what will happen?	F - I	F T
Student	The equilibrium position will shift to the left.	R	
Teacher	Right. So, we are saying that on the other increasing the concentration of the products shifts the equilibrium position to the left.	F	F T
Teacher	Consider the synthesis of ammonia from nitrogen and hydrogen to release energy, that's an exothermic system............... if heat is added to the system then there, would be a shift in the direction that consumes energy. That is to the left. Are you getting it?	I	
Students	Yes sir.	R	
Teacher	Good. Now note, this decreases the concentration of what?	F - I	F S
Students	Ammonia.	R	
Teacher	And increases the concentration of what, nitrogen and?	F - I	F T
Students	and hydrogen.	R	
Teacher	Hydrogen, right.	F	F T
Teacher	When you see a positive delta H, you should know that this is what?	I	
Students	An endothermic reaction.	R	
Teacher	An endothermic system..............if we increase the energy of the system, we put in heat what do you think will happen? The equilibrium position will shift to what?	F - I	F T
Students	It will shift to the right.	R	
Teacher	Shifting to the right, that means what? What happens to the concentration of for example, calcium carbonate?	F - I	F R
Student	Sir the concentration of calcium carbonate on the left-hand side will decrease.	R	
Teacher	Whiles concentration of products what?	F - I	F T
Students	Increase.	R	

Table 26 continued

Teacher	Okay, so we are saying that we use Le Chatelier's principle to explain the effect of temperature change on a system at equilibrium.	F	F T

Classroom observation, School B, June 2019

This lesson was also dominated by task level feedback. Self-regulatory level and self-level feedback were used equally, while there was no feedback on process level.

The last lesson observed at school B was on the 6th of June 2019. It was on the topic 'Factors affecting equilibrium position: pressure'. Table 27 shows analysed classroom dialogue from this lesson.

Table 27: Analysed Classroom Dialogue (Assigned Code Number B/L/6/6)

Speaker	Utterance(s)	Move	Feedback level
Teacher	(dictates question) Explain what effect an increase in temperature would have on the equilibrium concentration of PCl_5	I	
Student	The concentration of PCl_5 will decrease.	R	
Teacher	So, give us the reason, the reason is more important to us.	F - I	F R
Student	............it shows that it is an endothermic reaction, hence, more of the reactants would be used, decreasing the concentration of PCl_5.	R	
Teacher	That's correct, okay. So, what would be the effect on the concentration of PCl_3 or the chlorine gas?	F	F T
Teacher	......who remembers the Boyle's law, or the mathematical expression of the Boyle's law?	I	
Student	Boyle's law states that when you take mass of a gas a constant temperature… sir…	R	
Teacher	You want to help her?	F	F T
Student	… if I take mass of a gas at a constant temperature, the volume is inversely proportional to the pressure.	R	
Teacher	So, volume is inversely proportional to........or pressure is inversely proportional to volume, okay.	F	F T
Teacher	What about Avogadro's law..........in equilibrium if pressure is increased, what does it mean in terms of the volume?	I	
Student	Volume is decreased.	R	
Teacher	Volume is decreased.	F	F T
Teacher	But remember volume is directly proportional to number of moles so if volume decreases, it means that number of moles must also decrease. Do you agree?	I	

Table 27: Continued

Students	Yes.	R	
Teacher	So, we are saying that when the pressure of an equilibrium is increased the equilibrium shifts to the direction which proceeds the decrease in the number of moles. Do you agree with that?	F - I	F T
Students	Yes.	R	
Teacher	Okay.	F	F T
Teacher	So, look at this question.............who can tell us what would happen to the concentration of oxygen, if pressure is lowered?	I	
Student	Sir, if pressure is lowered, the equilibrium shifts to the backward reaction where the number of moles is more.	R	
Teacher	Okay.	F	F T

Classroom observation, School B, June 2019

This lesson was likewise dominated by task level feedback followed by self-regulatory level feedback. There was no feedback on process level and self- level feedback. The different feedback levels obtained after observing Frederick in the classroom was put together in Figure 6.

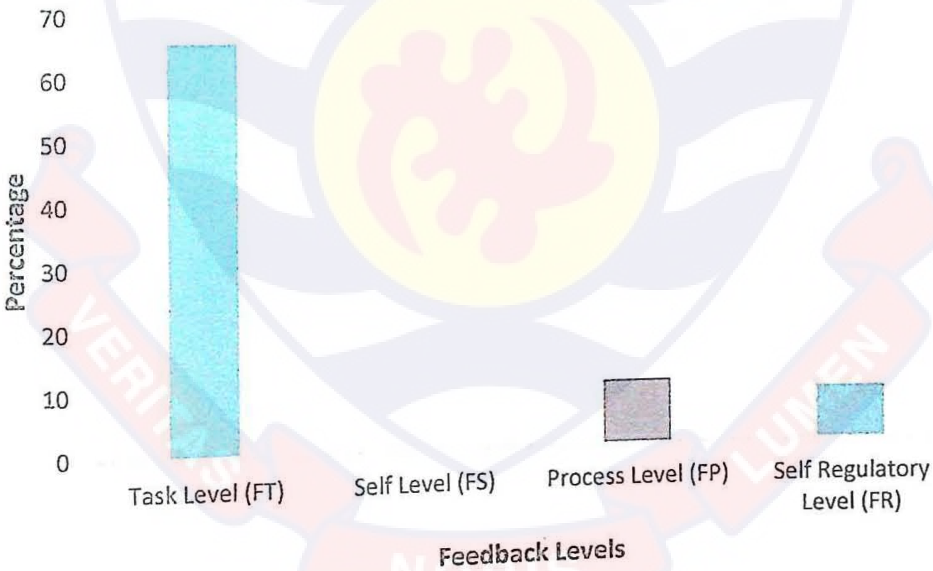

Figure 6: Analysed Classroom Dialogue showing Fredrick's Feedback practices.

Observation results for Prince, the Chemistry teacher at school C

Prince was observed in nine different lessons, seven of which was theory based while two were practical based. The first lesson observed for Prince was on the topic 'Chemical equilibrium'. Table 28 shows analysed classroom dialogue from a lesson observed at school C on the 30th of April 2019.

Table 28: Analysed Classroom Dialogue (Assigned Code Number C/L/30/4)

Speaker	Utterance(s)	Move	Feedback level
Teacher	What is rate, rate of a reaction?	I	
Student	Rate of a reaction is the change in the position of the reactants on the right or left side.	R	
Teacher	So, we are looking at change in concentration of the reactants or products, and when we talk of equilibrium, what comes to mind?	F – I	F P
Student	Balance.	R	
Teacher	Balance................they are reversible reactions.	F	F T
Teacher	Which of the reactions can we develop a rate equation from?	I	
Student	Sir, rate determining step.	R	
Teacher	From rate determining step, right.	F	F T
Teacher	How do you write the equilibrium expression for the reaction?... Kc for the reaction?	I	
Student	(answers on the board)	R	
Teacher	Clap for her.	F	F S
Teacher	Equilibrium constant in terms of concentration, who will write the first one for us?	I	
Student	(answers on the board)	R	
Teacher	Alright, the second one.	F	F T
Student	(answers on the board)	R	
Teacher	Alright, okay.	F	F T
Teacher	..........you should be able to tell us the definition, yes, anybody who can help us?	I	
Student	…product over reactant.	R	
Teacher	Product over reactant, no, Mary, can you help?	F - I	F T
Student	It is the ratio of the concentration of the products to the concentration of the…	R	
Teacher	Anybody else who can help us? Yes, Priscilla.	F	F T
Student	It is the ratio of the concentration or the partial pressure of the products............of their mole coefficient.	R	
Teacher	Ok.	F	F T
Teacher	What is the relationship between concentration and partial pressure?	I	
Student	[P = n/vRT]	R	
Teacher	Okay how do we do the substitution? Generating relationships between Kc and kP. Yes, anybody?	F - I	F T
Student	(answers on the board)	R	
Teacher	Can somebody else help us? Godfred, you want to help?	F	F T
Student	(answers on the board)	R	
Teacher	Can we clap for him?	F	F S
Teacher	(continues solving question) … so what is the unit?	I	
Students	newtons per meter square	R	
Teacher	Okay.	F	F T

Classroom observation, School C, April 2019

A scrutiny of Prince's interaction with the students, as seen in Table 28, points to the fact that the most dominant feedback level used in the classroom dialogue was task level feedback followed by self-level feedback while process level feedback was the least utilized. In this lesson, self-regulatory level feedback was not applied.

The second lesson observed for Prince was on the topic 'Factors affecting equilibrium position and Le Chatelier's principle'. Table 29 shows analysed classroom dialogue from a lesson observed at school C on the 7th of May 2019.

Table 29: Analysed Classroom Dialogue (Assigned Code Number C/L/7/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	Who will write the first equation for us?	I	
Student	(writes equation on the board)	R	
Teacher	Can we get the last equation? Yes, quickly…	F - I	F T
Student	(writes equation)	R	
Teacher	Can we write the ionic equation for the equation that you have written? Yes, Bismarck	F - I	F T
Student	(writes equation on the board)	R	
Teacher	Now, you were told that a silver cyanide ion was formed so that is our interest.	F	F T
Teacher	How do we find the concentration of silver ions, yes?	I	
Student	(writes on the board)	R	
Teacher	Explain to us.	F	F R
Student	I said this value was given, that's 1.0×10^{21}, this one was not given………..	R	
Teacher	So, what values are there, what values give…	F	F T
Teacher	Equilibrium expression in terms of Kp for this equation, what will be the equilibrium expression for this?	I	
Student	Sir, please let me write it (writes on the board)	R	
Teacher	So, can we correct it?	F	F P
Teacher	So, let us move to Le Chatelier's principle, and what does its state?	I	
Student	It states that when a stress is imposed on a system in equilibrium, the equilibrium position shifts………	R	
Teacher	Alright. So, we have system, normally equilibrium systems are closed systems so…………	F	F T
Teacher	We increase the concentration of a reactant, what will happen?	I	
Student	Sir, the equilibrium position will shift to the left.	R	
Teacher	Alright, explain.	F	F R

Table 29 continued

Student	Sir, when the equilibrium is shifted to the right, it will decrease the concentration of the reactants.	R	
Teacher	Can someone else give us another explanation?	F	F T
Student	When you increase the concentration, the equilibrium shifts to the left, more of the products.........	R	
Teacher	So, the principle states that when we increase a stress in a system, equilibrium will have to shift to the position in order to reduce the stress…	F	F T
Teacher	So, when you increase pressure of the system what happens?	I	
Student	Sir, the equilibrium will shift to where there is a smaller number of moles.	R	
Teacher	Why is that so?	F	F R
Student	Sir, so that the pressure in the system…	R	
Teacher	The pressure in the system, no not really. There is a direct relationship between pressure and number of moles.	F	F P
Teacher	Temperature? Yes	I	
Student	Sir, please when temperature is increased the equilibrium position will shift to the endothermic direction.	R	
Teacher	Can you explain?	F	F R
Student	Yes. So, when we increase the temperature then the equilibrium has to move to the endothermic side so that the heat would be removed in the system.	R	
Teacher	Alright.	F	F T

Classroom observation, School C, May 2019

An examination of Table 29 indicates that the dominant feedback level used in the classroom dialogue was task level feedback followed by self-regulatory level feedback while process level feedback was the least employed. Self-level feedback was not applied.

The third lesson observed for Prince was a continuation of the topic 'Factors affecting equilibrium position and Le Chatelier's principle'. Table 30 shows analysed classroom dialogue from a lesson observed at school C on the 14th of May 2019.

Table 30: Analysed Classroom Dialogue (Assigned Code Number C/L/14/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	Alright, state Le Chatelier's principle..............okay, Patrick.	I	
Student	The principle states that when a system is stressed the equilibrium shifts to a position whereby...	R	
Teacher	So, your answer ends at 'whereby', anybody else?	F - I	F T
Student	Sir, it states that when stress is introduced into a system of equilibrium, the equilibrium shifts in a way which turns to cancel out the effect of the stress.	R	
Teacher	Okay. What are the two main factors that can affect the equilibrium position in a chemical reaction between gases?	F - I	F T
Student	Sir, temperature and pressure.	R	
Teacher	So, these are the two main factors...........what is a dynamic equilibrium?	F - I	F T
Student	Sir, it is a reversible reaction in a closed system.	R	
Teacher	That is quite short. Any other definition?	F - I	F T
Student	Dynamic equilibrium is a reversible reaction in which the rate of the forward reaction is...	R	
Teacher	Is it complete?	F	F P
Teacher	Anybody else?	I	
Student	Dynamic equilibrium is a reversible reaction in which forward reaction is equal to backward reaction.	R	
Teacher	So....... forward reaction is equal to backward reaction in terms of rate, but the equilibrium also takes place in a closed system.	F	F T
Teacher	So, who will help us with a balanced equation for the reaction? Thelma.	I	
Student	(writes equation on the board)	R	
Teacher	Alright. So, write the expression for Kp.	F - I	F T
Student	(writes the expression for Kp)	R	
Teacher	Alight, we said it was an exothermic reaction.............if we have an increase in pressure and temperature, what will be the equilibrium position? Gideon.	F - I	F T
Student	Sir, when pressure is increased equilibrium position will move to the right.	R	
Teacher	Anybody else? Marigold.	F - I	F T
Student	Sir, when pressure is increased equilibrium position will move to the left.	R	
Teacher	Will move to the left? Can you explain that for us?	F	F R
Student	Sir, the pressure, it corresponds to the number of moles.............but here, the number of moles of the reactants is less so it will shift to the left.	R	
Teacher	Mmm? Any other explanation?	F	F R
Student	If you look at it, the direction that has a decrease in mole is the backward reaction which means that equilibrium has to shift to that direction to decrease the pressure.	R	

Table 30 continued

Teacher	Alright, equilibrium position shifts to the left. Increase in temperature?		
Student	Sir, when temperature and pressure increase, the equilibrium position shifts to the left.	F - I	F T
Teacher	Equilibrium position shifts to the left when we increase temperature. Explain?	R	
Student	Sir, the forward reaction is exothermic...........the equilibrium has to move to a direction that will proceed with the absorption of heat.	F	F R
		R	
Teacher	So, that's why it moves to the left. Alright.	F	F T
Student	Sir, decrease in the pressure?	R	
Teacher	You still don't understand? Can someone explain the 'pressure' for him?	F	F R
Student	When there is a decrease in pressure.................so the equilibrium shifts to the left.	R	
Teacher	Alright.	F	F T
Teacher	So, this is calcium carbonate.........we are going to add the same amount of acid, the same concentration, what did you observe?	I	
Student	Sir, there is a reaction here but no reaction here.	R	
Teacher	How do you know there is a reaction here and no reaction there? The one with the increased surface area came out fast as compared to this.	F	F P
Teacher	So, the colour of this has changed right? What time?	I	
Student (time keeper)	One minute, thirty seconds.	R	
Teacher	This one is still like that; it doesn't mean it will not change but will take a longer time for it to change. Any question?	F	F P
Student	Sir, the concentration........?	R	
Teacher	Yes, they were of the same concentration. I increased the temperature so this one reacted faster as compared to the other.	F	F T

Classroom observation, School C, May 2019

As indicated on Table 30, the feedback levels applied by the teacher is comparable to what was used in the previous lesson. It was dominated by task level feedback followed by self-regulatory level feedback while process level feedback was the least made use of. Prince did not apply self-level feedback in this dialogue.

The fourth lesson observed for Prince was on the topic 'Nuclear Chemistry and Radioactivity'. Table 31 shows analysed classroom dialogue from a lesson observed at school C on the 31st of May 2019.

Table 31: Analysed Classroom Dialogue (Assigned Code Number C/L/31/5)

Speaker	Utterance(s)	Move	Feedback level
Teacher	What is half-life?	I	
Student	Half-life is the time taken for radioactive nuclei to decay to half its original amount.	R	
Teacher	Its original amount? Alright, any other definition?	F – I	F T
Student	Half-life is the time taken for half the initial quantity of a radioactive element to decay.	R	
Teacher	In the previous class, somebody said it is 'half the mass of a nuclide when half of the mass of the nuclide decays', that is incorrect, right?	F	F T
Teacher	What is rate of decay or activity? Anybody? Yes, Godfred.	I	
Student	It is the change in nuclide of the radioactive element undergoing decay divided by change in time.	R	
Teacher	(repeats student's answer) not too well...... Any other?	F	F T
Student	The rate of decay of a radioactive......is directly proportional to the number of number of atoms of the nuclide present in the sample.	R	
Teacher	So, in simple terms, the amount of the radioactive nuclide that decays within a specific amount of time, just like rate of change of displacement..........	F	F P

Classroom observation, School C, May 2019

This lesson was also dominated by task level feedback followed by process level feedback. Prince did not employ self-level and self-regulatory level feedback in this dialogue.

The fifth lesson observed for Prince was a practical lesson on the topic 'Determination of the solubility of $Ca(OH)_2$'. After dictating the question, Prince put the students in groups of six students per group. Dialogue for this practical lesson did not follow the IRF format. The students simply followed the instructions given in the question and took turns to filter, titrate and measure the temperature.

The sixth lesson observed for Prince was on the topic 'Solubility curves'. Table 32 shows analysed classroom dialogue from a lesson observed at school C on the 7th of June 2019.

Table 32: Analysed Classroom Dialogue (Assigned Code Number C/L/7/6)

Speaker	Utterance(s)	Move	Feedback level
Teacher	We will look at where you made the errors so that we will correct them, is that okay?	I	
Students	Yes.	R	
Teacher	…for any graph, you are expected to have the title. Is that okay? You were supposed to plot mass of carbon dioxide against time. So, you have mass, and the unit is gram, is that okay?	F – I	F P
Students	Yes sir.	R	
Teacher	So, either you use mass and the unit is 'gram', and then we have time, t and the unit is in minutes, right?	F	F P
Student	Yes.	R	
Teacher	Good. Those of you, who did not bring any title, take note. And then your scale, it's important.	F	S
Teacher	Now after plotting your points, you had a curve of this nature, is that not so?	F I	F P
Students	Yes.	R	
Teacher	To find instantaneous rate of reaction in grams per minute at four minutes.... ....most of you did it but you did not use the line you drew.	F	F P
Student	Sir, can we extend the line to touch the 'y'?	R	
Teacher	Yes, you can, it doesn't really change anything. If you draw your tangent well..........the slope of the tangent will give you the same values.	F	F P
Teacher	What most of you did was to come and pick the value here and then you divided this by the 44, which is not correct. Is that okay?	I	
Students	Yes sir.	R	
Teacher	The value I expected you to use is this one because that is the instantaneous rate..........so check and make the necessary corrections.	F	F P
Teacher	Saturated region on the solubility graph? When we talk of saturated, what does it mean?	I	
Student	Sir, it means it cannot dissolve any solute at a given temperature.	R	
Teacher	… so, what interpretation can we make from the graph? What can we say?	F	F R
Student	Sir, when it is on the curve, it is saturated. When it is above the curve, it is saturated but when it is below the curve, it is unsaturated.	R	
Teacher	For sample 'A', can we determine any saturation point?	F	F R
Student	(goes to the board to show answer)	R	
Teacher	…the thing is already soluble, so there is no point of saturation, okay.	F	F P

Classroom observation, School C, June 2019

Analysis of the dialogue in this lesson reveals that it is dominated by process level feedback followed by self-regulatory level feedback. Prince did not make use of task level feedback and self-level feedback in this lesson.

The seventh lesson observed for Prince was on the topic 'Solubility rules'. Table 33 shows analysed classroom dialogue from a lesson observed at school C on the 10^{th} of June 2019.

Table 33: Analysed Classroom Dialogue (Assigned Code Number C/L/10/6)

Speaker	Utterance(s)	Move	Feedback level
Teacher	Now, calcium hydroxide, is it soluble or insoluble? We worked with it the other time. What did you observe?	I	
Student	It's slightly soluble.	R	
Teacher	So, calcium hydroxide is slightly soluble in water.	F	F T
Teacher	If you have a precipitate will it be an aqueous solution? What will it be?	I	
Student	Solid.	R	
Teacher	It would be a solid............based on the reaction, we can tell that aluminium hydroxide is insoluble.	F	F T
Teacher	When you mix a potassium phosphate and a calcium nitrate solution, what happens? Anybody?	I	
Student	(goes to the board) the calcium nitrate will…	R	
Teacher	… can you explain?	F	F R
Student	So, this in solution will give this, then calcium nitrate in solution will give you this........so, the calcium reacts with this... … all phosphates are insoluble.	R	
Teacher	Alright, so can we clap for him?	F	F S
Teacher	Now, phosphates of alkali metals are soluble. Is that okay?	I	
Students	Yes.	R	
Teacher	Good. The nitrates are all soluble. So, in solution the calcium phosphate precipitates out, and potassium nitrate which is soluble remains in solution.	F	F S

Classroom observation, School C, June 2019

Two feedback levels dominated this lesson equally, these were task level feedback and self-level feedback. The least utilised feedback level was self-regulatory level. Prince did not make use of process level feedback in this lesson.

The eight lesson observed for Prince was also on the topic 'Solubility'. Prince put the students into groups and gave them questions on the topic to solve. A member of each group was then called to present the results on behalf of the group. Table 34 shows analysed classroom dialogue from a lesson observed at school C on the 11th of June 2019.

Table 34: Analysed Classroom Dialogue (Assigned Code Number C/L/11/6)

Speaker	Utterance(s)	Move	Feedback level
Teacher	Do we agree with the presentation on the board?	I	
Student	Sir, the concentration of the	R	
Teacher	So, what was he supposed to write? Alright, so correct that for him.	F	F P
Teacher	Move on to the second one.	I	
Student	So, for this one, the lead carbonate is going to precipitate and this one is still going to be in the aqueous solution. Then when you come here, we all know that…	R	
Teacher	Alright so can we clap for them?	F	F S
Teacher	What was he supposed to find? Is it the molarity or the…? Was it the concentration?	I	
Students	Molarity.	R	
Teacher	So, is that correct?	F	F T
Students	Yes.	R	
Teacher	Alright.	F	F T
Teacher	Alright, the last question, explain to us why…	I	
Student	So, we have sodium iodide, sodium bromide, sodium.......... so, chloride has a smaller size hence has a…	R	
Teacher	I expected you to use the lattice energy values.	F	F P

Classroom observation, School C, June 2019

Two feedback levels dominated this lesson equally, these were task level feedback and process level feedback. The least utilised feedback level was self-level. Prince did not make use of self-regulatory level feedback in this lesson.

The last lesson observed at school C was on the 14th of June 2019. It was a practical lesson on the topic 'Solubility and crystallisation'. Just like most practical lessons, dialogue did not follow the IRF format. Only one feedback was applied, that is task level feedback as shown on Table 35.

Table 35: Analysed Classroom Dialogue (Assigned Code Number C/L/14/6)

Speaker	Utterance(s)	Move	Feedback level
Teacher	So, we are going to mix sodium nitrate and potassium chloride, and we will end up with sodium chloride and	I	
Students	Potassium nitrate.	R	
Teacher	Okay. So, the intention is to prepare potassium nitrate.	F	F T

Classroom observation, School C, June 2019

The different feedback levels obtained after observing Prince in the classroom was put together in Figure 7.

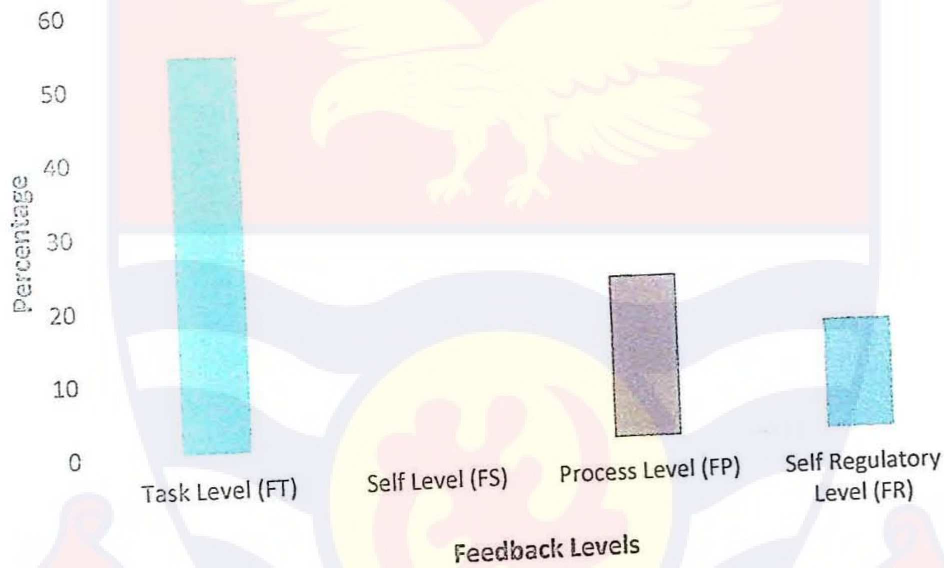

Figure 7: Analysed Classroom Dialogue showing Prince's Feedback Practices.

The feedback practices of all the three teachers observed was put together. Figure 8 shows analysed classroom dialogue for all the lessons observed indicating the Chemistry teachers' feedback practices.

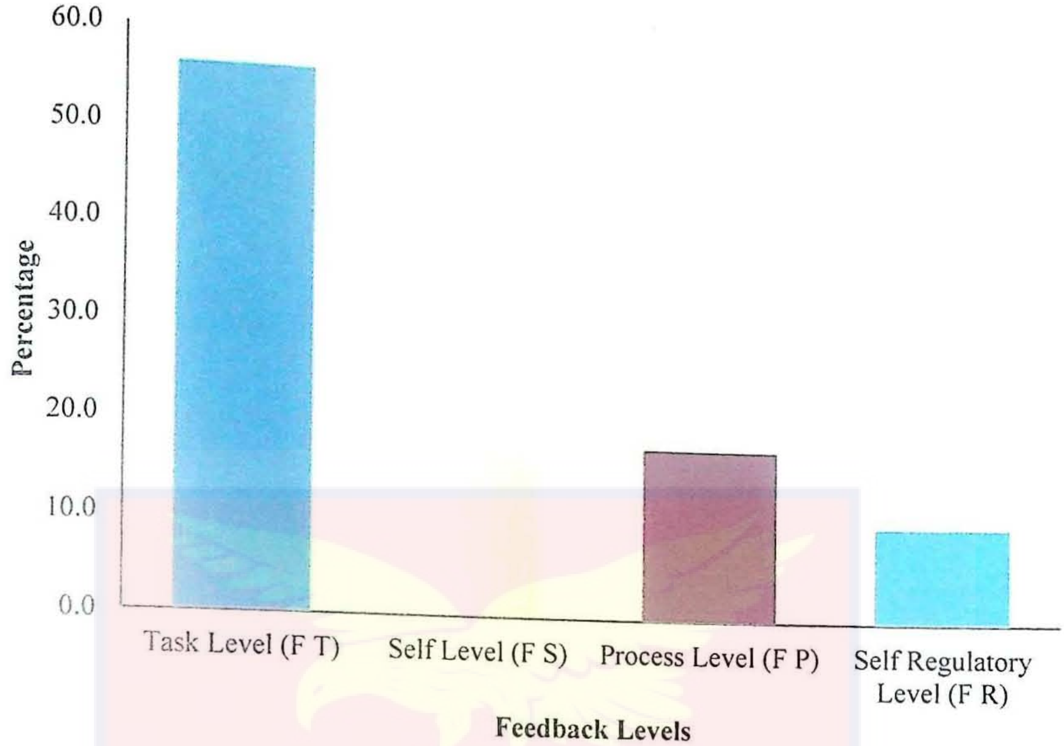

Figure 8: Analysed classroom dialogue all lessons observed showing the Chemistry teachers' feedback practices.

Figure 8 shows that in the classroom the most prominent feedback level that Chemistry teachers' give their students is task level feedback which is 56 %, followed by process level feedback which is 18 %, self-level feedback is 16 % and lastly self-regulatory level feedback which is 10 %.

The second approach that was used to answer research question 1 was an inspection and analysis of students' assignments, practical work, and class test to find out the levels of feedback that Chemistry teachers' give their students after marking their work. A total of 23 assignments, 3 practical workbooks, and 3 class tests were inspected and analysed using the coding scheme adopted from Hattie (2009 & 2012); Hattie and Timperley (2007), feedback model.

Figure 9 shows the results of the analysis of students' assignments, practical work and class tests indicating Chemistry teachers' feedback practices to their students' after marking their work.

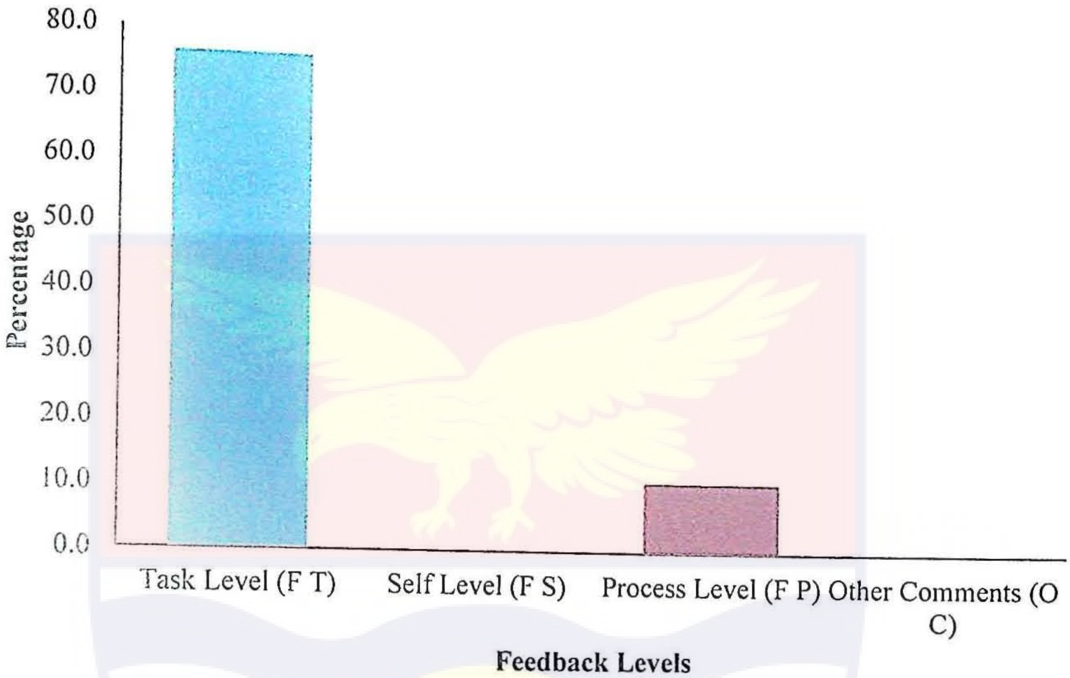

Figure 9: Analysis of students' assignments, practical work and class tests showing Chemistry teachers' feedback practices after marking students' work.

Figure 9 shows that the most prominent feedback level that Chemistry Teachers' give their students after marking their work is task level feedback which is 76 %, followed by process level feedback which is 11 %, other comments like 'seen' or 'work hard' is 7%. Self-level feedback which is 6 % is last. The feedback that Chemistry teachers' give to their students after marking their work does not include the self-regulatory level. Figures 8 and 9 indicate that the level of feedback predominating Chemistry teachers' feedback practices in the classroom and on students' marked work is task level feedback. Figures 10 and 11 show some examples of the comments that Chemistry teachers' give to their students after marking their work.

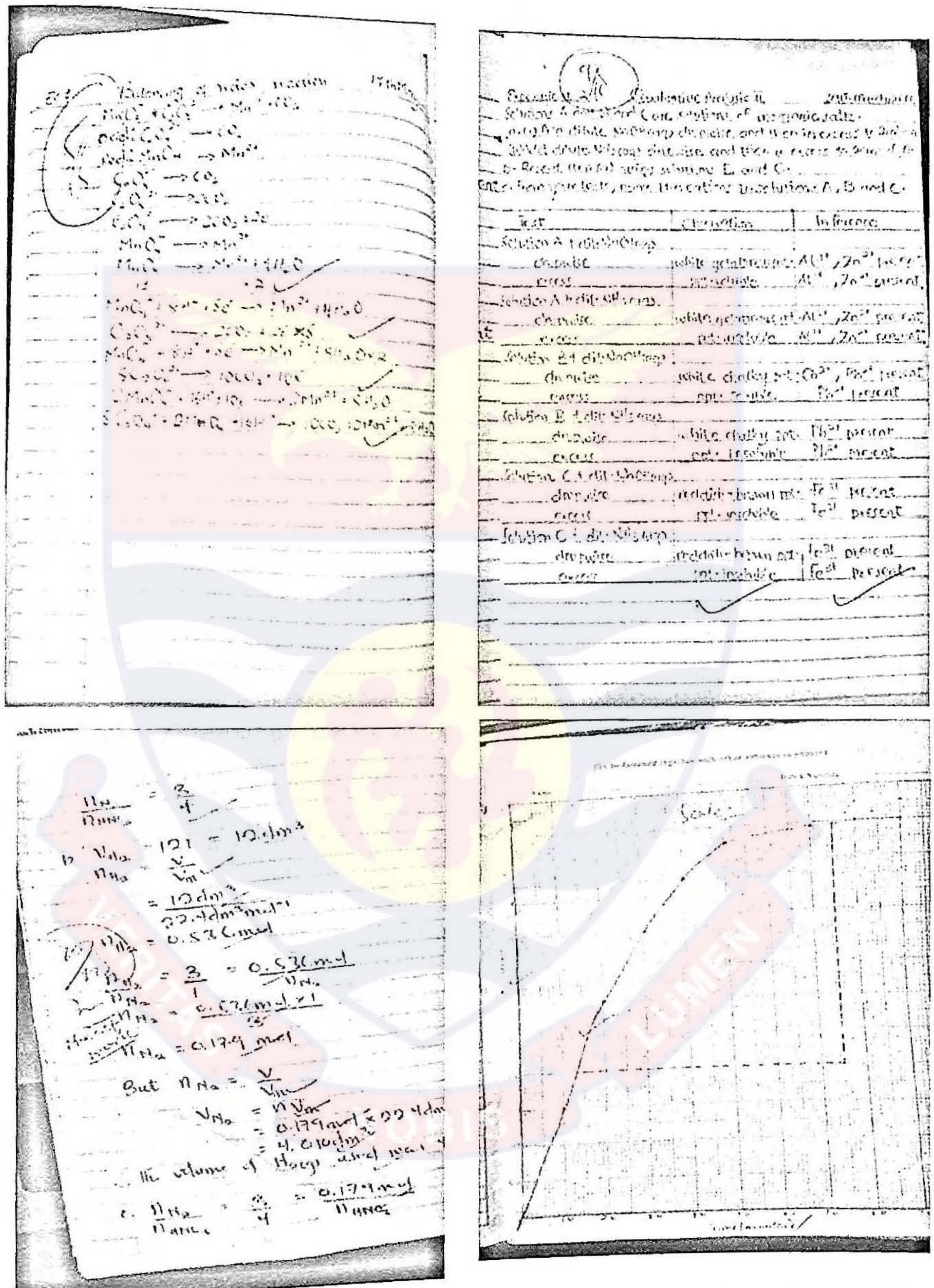

Figure 10: Feedback that Chemistry teachers' give to their students after marking their work.

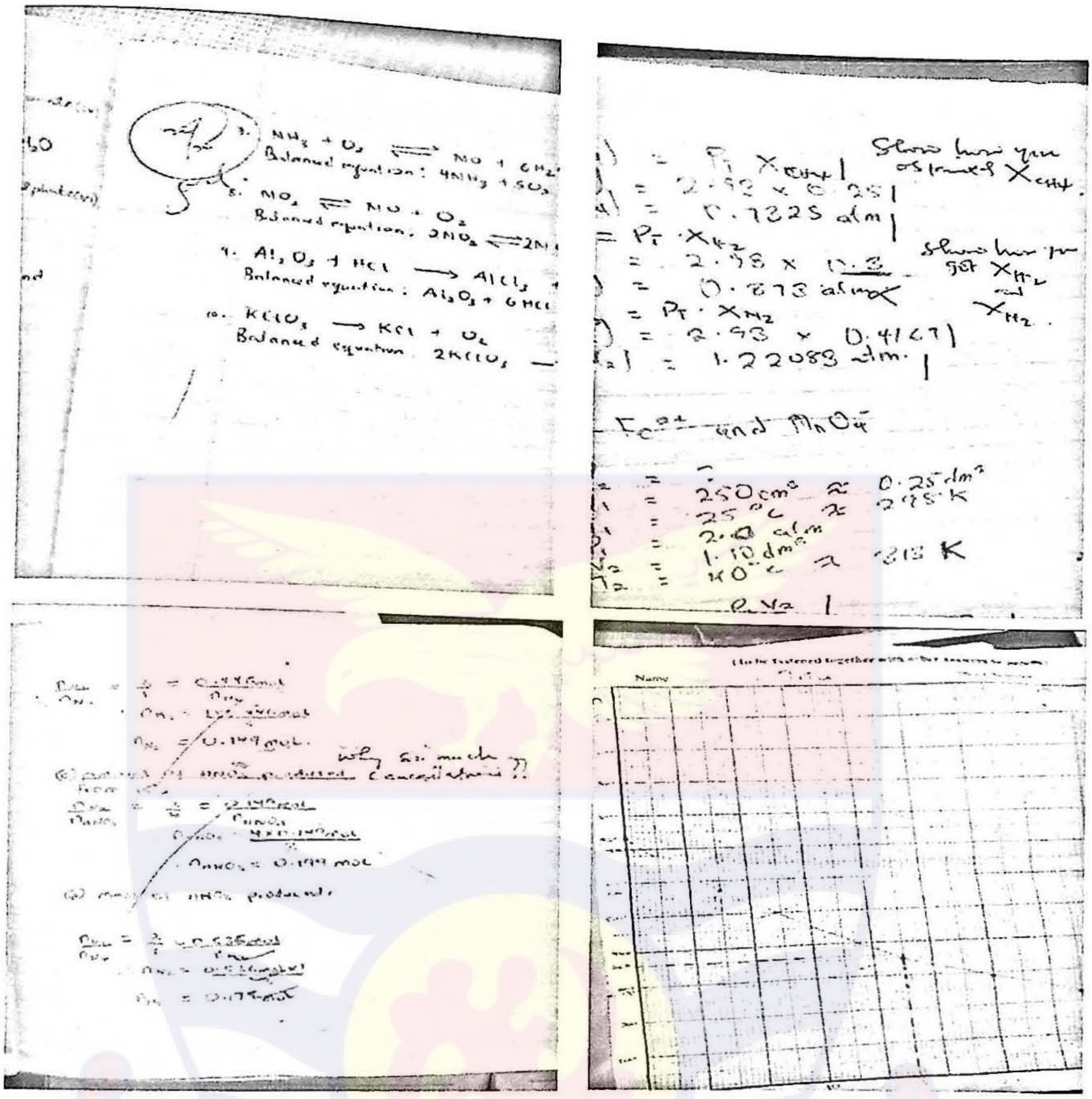

Figure 11: Feedback that Chemistry teachers' give to their students after marking their work.

Discussion on Level of feedback prominent in Chemistry teachers' feedback practices

Research question 1 sought to find out the level of feedback that is prominent in Chemistry teachers' feedback practices in SHS. Figures 8 and 9 show that task level feedback predominates Chemistry teachers' feedback practices. Feedback should progress from task to processing to self-regulation whilst the self-level is the least effective form of feedback for enhancing achievement (Hattie, 2009 & 2012; Hattie & Timperley, 2007). Though Hattie and others assert that self-level feedback is the least effective to enhance achievement, the study shows that self-level feedback is useful and motivate student to work hard to improve learning.

> **Rita**: 'It boosts my confidence and urges me to study harder so that I can always get an encouraging comment from my teacher'.
>
> **Ama**: 'It makes me feel good about my work'.
>
> **Eddie**: 'I feel happy and encouraged to read ahead of the class and answer more questions in class'.

From the quotes above, though Ama's feeling of 'good' about her work do not give indication that leads up to progress. However, Rita and Eddie show clearly that their feeling of 'good, happy, confident and encouraged' goaded them to engage in practices that led to progress and achievement. The study also shows predominance of task level feedback which is 56 % in Figure 8 and 76% in Figure 9 while process level feedback follows with 18 % in Figure 8 and 11% in Figure 9. The self-regulatory feedback was absent in assignments, tests, and practical exercises. This shows that teacher feedback is mainly task level and hardly progresses to more effective feedback practices.

When Chemistry teachers give their students assignments, tests, or practical work their primary goal after marking is to grade it for continuous assessment. In discussions with Bismarck, the Chemistry teacher at school A, he expounded that the school administration expects the teachers to provide a number of marks for the continuous assessment of the students. This may explain the high percentage of task level feedback in Figure 9. In teacher-centred lessons, teachers tend to ask more knowledge-based questions. It is usually information-seeking recall questions that require predetermined short answers. The purpose in such traditional lessons is to evaluate what students know. The teacher then corrects those that are wrong (Chin, 2006; Kaya, 2014; Zohar, Schwartzer & Tamir, 1998). This could be a reason why task level feedback predominates Chemistry teachers' feedback practices in the classroom. Pressure on teachers to improve results of students in externally-set examinations appears to focus teaching on rote recall and memorisation. Consequently, not much attention is paid to the kinds of higher-order thinking involved in formative assessment (Wiliam et al., 2004). This could be another reason why task level feedback is high whilst process level and self-regulatory level feedback are low in Chemistry teachers' feedback practices in the classroom. These findings collaborate Koomson (2019) which shows that science process skills acquired by senior high school chemistry students are mainly basic science process skills which is dominated by recalling of scientific facts. Since process level and self-regulatory level feedback are low, students are not adequately prepared to relate ideas which lead to low acquisition of skills like inferring, predicting, evaluations and experimentation (Koomson, 2019). The implication for teaching is that teachers should plan to progress their feedback practices from task to self-regulatory level via process level rather than emphasising on task level feedback which usually fails not only to progress learning effectively but also to acquire higher level skills like inferring, predicting, evaluating and experimentation.

Feedback practices of two Chemistry teachers teaching the same topic

During the study, two teachers in two different schools taught the same topic at different times. Even though not part of the research questions, the researcher decided to compare the feedback practices of two teachers teaching the same topic. This is because in qualitative research including case study, there is lack of predetermined constraints on outcomes and openness to whatever emerges during the study (Silverman, 2013). The names of teachers and schools are pseudonyms. Fredrick, the Chemistry teacher in school B used five periods with a total duration of 5 hours to teach Chemical Equilibrium. He started teaching on the 23rd of May 2019 and continued till the 6th of June 2019. The lessons were assigned code numbers B/L/23/5, B/L/27/5, B/L/30/5, B/L/3/6 and B/L/6/6. Figure 12 shows the feedback practice of Fredrick when he taught Chemical Equilibrium.

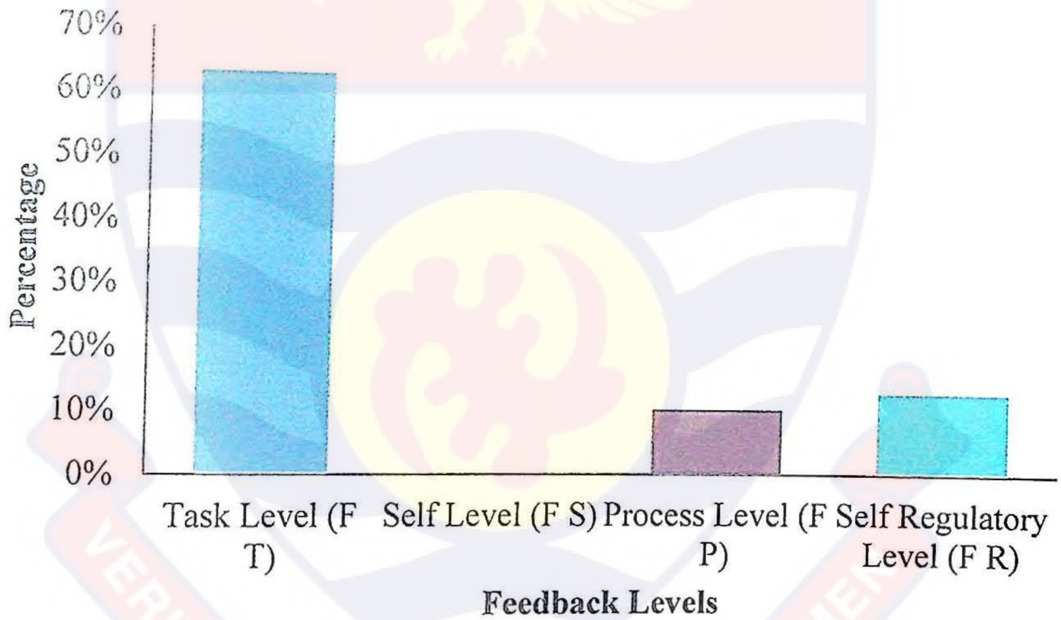

Figure 12: Feedback practice of Fredrick when he taught Chemical Equilibrium.

Figure 12 shows that when Fredrick taught chemical equilibrium, the most dominant feedback practice was task level feedback which was 63%. Self-regulatory level and Self level feedback were all 13% whilst process level feedback was 11%

Prince, the Chemistry teacher in school C used three periods with a total duration of 6 hours to teach Chemical Equilibrium. He started teaching on the 30th of April 2019 and continued till the 14th of May 2019. The lessons were assigned code numbers C/L/30/4, C/L/7/5 and C/L/14/5. Figure 13 shows the feedback practice of Prince when he taught Chemical Equilibrium.

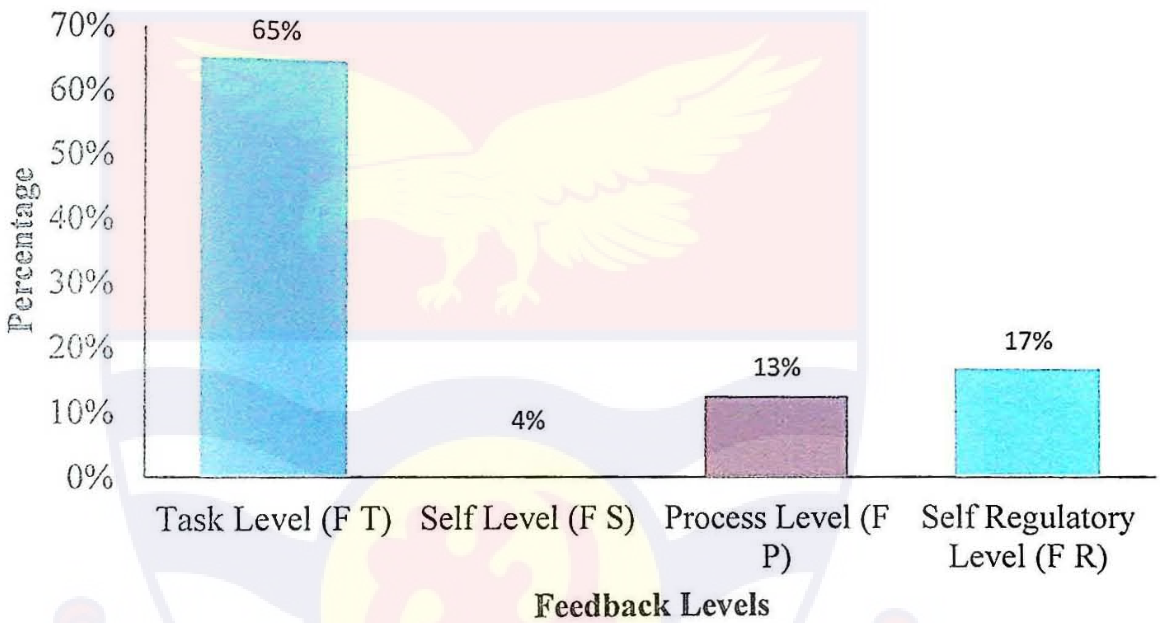

Figure 13: Feedback practice of Prince when he taught Chemical equilibrium.

Figure 13 shows that when Prince taught chemical equilibrium, the most dominant feedback practice was task level feedback which was 65%. Self-regulatory level feedback was 17%, process level feedback was 13% and self-level feedback was 4%.

The feedback practices of the two teachers were put together in Figure 14.

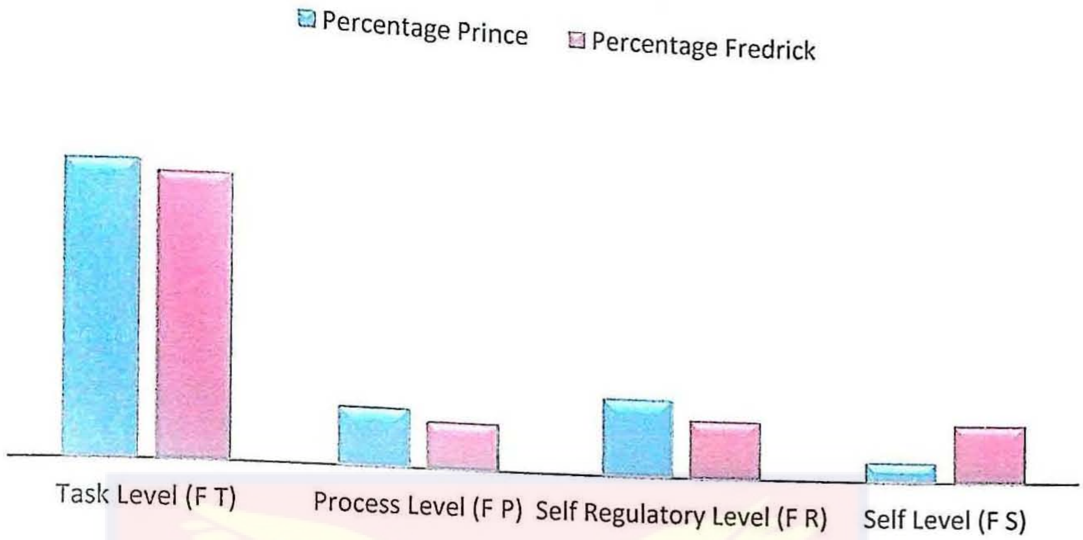

Figure 14: Feedback practices of Prince and Fredrick when they taught Chemical equilibrium.

Chemical equilibrium is a topic that requires a lot of process and self-regulatory level feedback especially when it comes to the application of Le Chatelier's principle to explain the change in equilibrium conditions such as temperature and concentration on the equilibrium position and the equilibrium constant. This requires teachers asking questions that demand inferring and explaining. That is reflective and probing questions which is mostly self-regulatory level feedback. However, from Figure 14, the two Chemistry teachers' feedback to their students it is still dominated by task level feedback. This indicates that for a topic which requires students to develop skills like predicting and inferring; the two Chemistry teachers asked information-seeking recall questions, requiring task level feedback where they indicate if an answer is correct or wrong without explaining why. In terms of percentages, Prince who gave his students a relatively higher percentage self-regulatory level feedback of 17% seems to have performed better than Fredrick who gave his students 13%.

Students' perception of usefulness of feedback

Research question 2 sought to find out the students' perception of the usefulness of feedback that they receive from their Chemistry teachers. Two instruments were used to collect data to answer this question. One of the instruments was titled student questionnaire – Perception, comprising four two-tier items, respondents selected an option to each item and provided reasons for the option selected. Each item was a statement, the respondents were expected to choose from four options and give reasons for their choice. The first statement was; corrections or comments (feedback) from my Chemistry teacher about my work (in class or exercise book) help me to see where I can improve on the work. The respondents were to choose whether they completely disagreed, disagreed, agreed, or completely agreed and give reasons for their choice. Figure 15 shows students' responses to the statement.

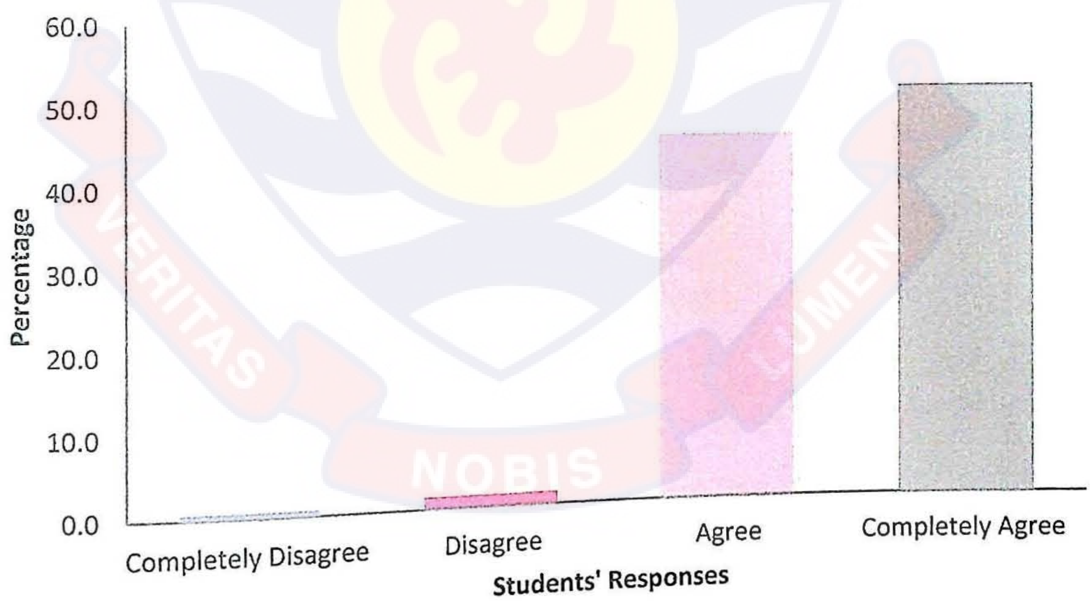

Figure 15: Students' responses to the statement; corrections or comments from my Chemistry teacher about my work help me to see where I can improve on the work.

One student out of the 118 respondents representing 0.8 percent completely disagreed with the statement. Two students representing 1.7% disagreed with the statement. Fifty-four students representing 45.8% agreed with the statement, whilst sixty-one students representing 51.7% of the respondents completely agreed with the statement. This indicates that majority of the students, 97.5% either completely agreed or agreed with the statement that corrections or comments from their Chemistry teacher helped them to see where they can improve.

Students who completely agreed or agreed with the statement gave reasons for their choice. The names of the students are pseudonyms. These were some of the reasons given by the students:

> **Edwin**: 'When my Chemistry teacher corrects or comments about my work in class or exercise book, I get to know where I am not performing, then take measures to improve on that'.

> **Patrick**: 'My teacher helps me to identify the parts am finding difficult to study'.

> **George**: 'Comments about my work from my Chemistry teacher help me to locate the section I am deficient in thus giving me the signals to improve in that section'.

> **Ben**: 'Correction helps me to improve upon my studies as writing the right answer by yourself in an exercise book helps you to remember anytime you are asked a similar question'.

> **Frank**: 'I find these corrections helpful in many ways. E.g. How to present calculation questions the right way as required'.

> **John**: 'For example we did an assignment in a graph book and I refused to write the scale. He deducted marks from me, so it has made me not to forget anything during exercises or homework'.

> **Albert**: 'Correction given me by my chemistry teacher after work or exercise helps me the next time; I encounter the same type of questions'.

Victor: 'This is because sometimes I may think that I have learnt but a slight twist in the question proves me wrong. So, his correction helps me know where I can improve'.

Melody: 'It makes me know my mistakes .... since I have known my mistakes, I will not repeat them again'.

Daniel: '....... helps me to identify my mistakes and also encourage me in order to work harder so I will not repeat similar mistakes'.

Mohammed: '......helps me to see where I can improve especially during my personal studies. Comments such as 'reason or cause not clearly shown' help me to know the appropriate words to use to explain myself. His corrections also help me to know where I went wrong'.

Armstrong: 'An example is today when we're having practical session on back titration, my colour change was not appropriate, and he informed me to reduce the number of drops of the indicator and it was helpful'.

Annaliese: 'Yes I agree because it allows me to understand the topics well and learn from my mistakes. But it sometimes makes me not feel smart especially when I fail a test'.

Mary: 'I discover my weakness in certain topics due to the comments my Chemistry teacher makes about my work'.

Estella: 'Sometimes, I think I have really learnt a specific chemistry topic but some questions he gives us to solve show me that I have to either revise the topic or solve more questions'.

Naomi: 'When my Chemistry teacher corrects me about my work, it gives me the courage to try the work again which in turn help me improve in that particular topic'.

Nancy: 'Corrections /comments from my Chemistry teacher about my work helps me to identify my strengths as well as my weaknesses, hence provide more room for improvement'.

The common reason that students who completely agreed or agreed to the statement, gave was corrections or comments from their Chemistry teacher helped them identify their mistakes and not repeat it. The students, who completely disagreed or disagreed with the statement, gave the following reasons for their choice: **Yaa**: 'Sometimes I still find problems'.

> **Phina**: 'Honestly, I do not see any comments or feedbacks in my exercise book after any exercise because I usually get 10 out of 10 or get all the questions correct'.

> **Nicholas**: 'Since we are training for WASSCE we need to improve in all areas not for only a specific one (topic)'.

The second statement was; suggestions or guidelines (feedback) from my Chemistry teacher about how to solve similar or difficult questions (in class or exercise book) help me to see where I can improve. The respondents were given the same options as in the first statement and asked to give a reason for their choice. Figure 16 shows students' responses to the statement.

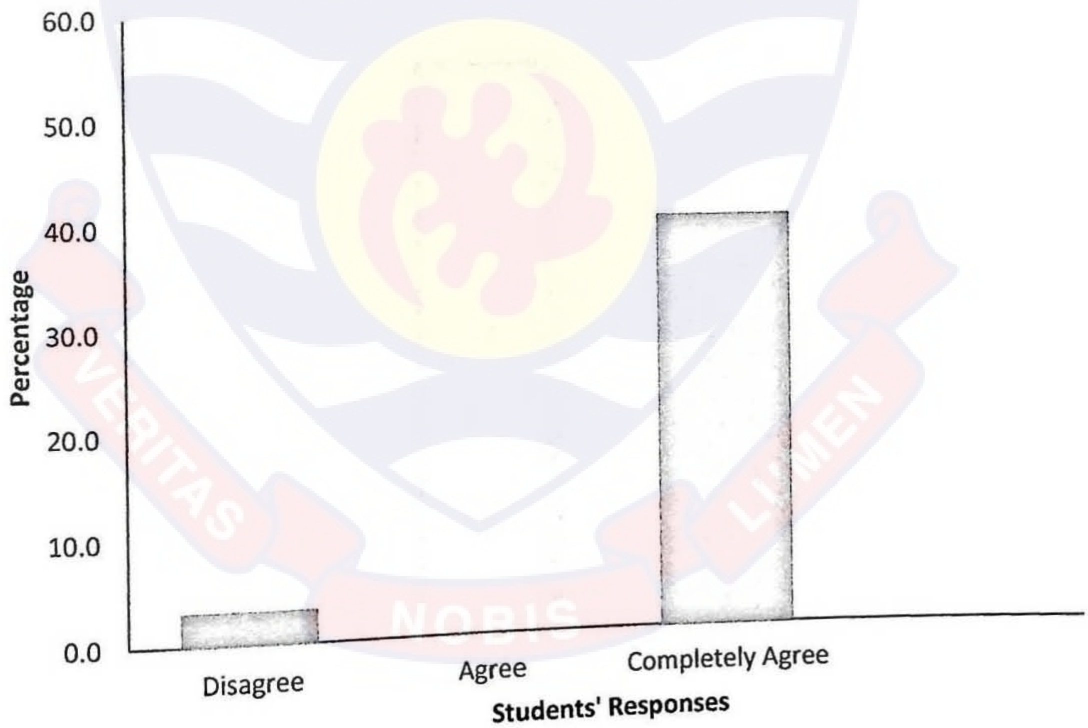

Figure 16: Students' responses to the statement; suggestions or guidelines from my Chemistry teacher about how to solve questions help me to see where I can improve.

None of the students completely disagreed with the statement. Four students representing 3.4% of the respondents disagreed with the statement. Sixty-six students representing 55.9% of the respondents agreed with the statement whilst forty-eight students representing 40.7% completely agreed with the statement. This indicates that majority of the students, 96.6% either completely agreed or agreed with the statement that suggestions or guidelines from their Chemistry teacher about how to solve questions helped them to see where they can improve.

Students, who completely agreed or agreed with the statement, gave the following reasons for their choice:

> **Godfred**: 'When I am given questions to solve of which I do not know the procedures or simple understanding of the question, I find it difficult at that time but when my chemistry teacher gives me guidelines, I follow the guidelines given to solve questions that come my way'.

> **Nathaniel**: 'This is because, anytime I find a difficult question or similar question about a particular work, I try remembering an approach my teacher used in solving it. For example, before he solves a question, he writes down the parameters given and out of that know what to do next'.

> **Benjamin**: 'Guidelines from my teacher about how to solve similar questions helped me to improve on an aspect of a particular topic. For example, my teacher taught me mole concept in class, and I went to him to solve one difficult question. He helped me by guiding me solve it of which I understood it best'.

> **Patrick**: 'It shows me where I can improve so that I do not have difficulty in solving such questions again'.

> **Stefan**: '…When am guided, I improve on techniques of solving chemistry questions'.

> **Bright**: 'Suggestions from my Chemistry teacher when answering questions exposes me to my weakness and where to improve upon'.

> **Stephanie**: 'I think I have done the right thing, but his guidelines and his suggestion enable me to see my mistake'.

Lawrencia: '…because it helps me to solve more questions'.

Francis: 'I once answered a question, but my answer was incomplete and so my teacher then revealed to me areas I did not cover during my study'.

Eleazar: 'Alternative methods to solving difficult problems from my Chemistry teacher have enlightened me on my approach to chemistry questions'.

Vanessa: 'His guidelines help me to understand questions whether difficult or not'.

Phyllis: '… enlighten me on how to go about solving similar and more difficult questions, as well as areas I need to work on'.

The common reason that students who completely agreed or agreed to the statement, gave was, guidelines and suggestions from their Chemistry teacher enabled them to see their mistakes, not repeat it and helped them to solve more questions.

Students, who disagreed with the statement, gave the following reasons for their choice:

Vera: 'I disagree because he doesn't give us class exercise on every topic, so I won't be able to see that I have understood or not'.

Mercy: 'This is because it doesn't really work for me. The fact that I know how to solve certain questions doesn't mean my improvement in other aspects is assured or shows me my weaknesses'.

The third item on the questionnaire was the statement; corrections or comments (feedback) from my Chemistry teacher about my work show me how much I have studied. The respondents were given the same options as in the previous statements and asked to give a reason for their choice. Figure 17 shows students' responses to the statement.

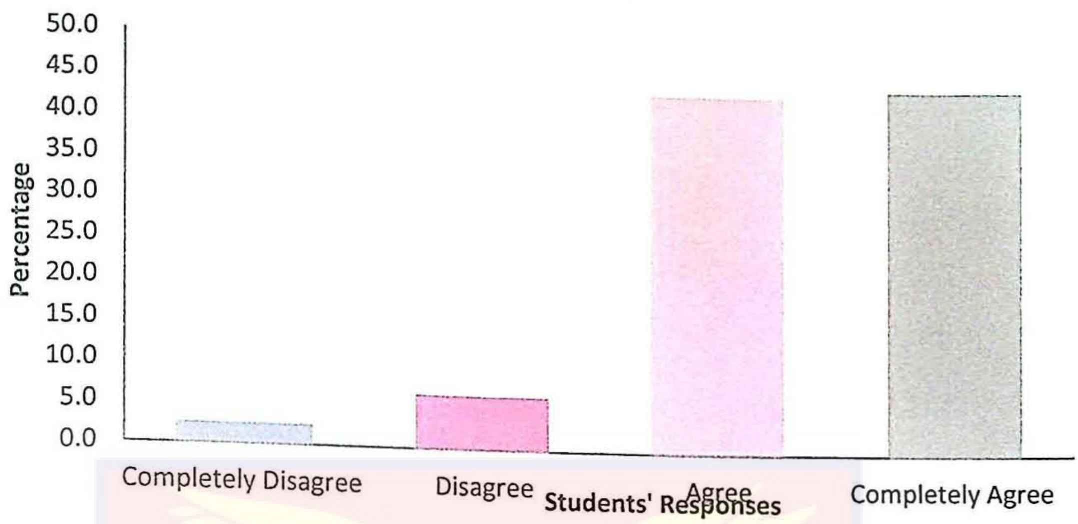

Figure 17: Students' responses to the statement; corrections or comments from my Chemistry teacher about my work show me how much I have studied.

Three students representing 2.5% completely disagreed, whilst eight students representing 6.8 % disagreed. Fifty-four students representing 45.8% completely agreed whilst fifty-three students representing 44.9 % agreed. This indicates that majority of the students, 90.7% either completely agreed or agreed with the statement that corrections or comments from their Chemistry teacher about their work show how much they have studied.

Students, who completely agreed or agreed with the statement, gave the following reasons for their choice:

> **Derrick:** '…when my chemistry teacher does corrections with me, and still I don't understand, it makes me know that I'm not studying'.

> **Francis:** 'If he agrees with my answer, then I know that I have studied quite well. If he does not, then I know I have to study harder'.

> **Richmond:** '…Example when I am given excellent or very good at the end of an exercise. It is going to show me that I am learning and will need to work harder'.

> **Betty:** 'When my chemistry teacher asks any question and I answer, the way in which he comments shows me how much I have studied. For example, well said, very good, excellent etc'.

Naa: 'This is really true; sometimes the questions he set really question my learning'.

Akua: 'Because if a question is given and I do well, I know that I have studied and also if I don't study and work is given, it shows me that I didn't study'.

Bright: 'Comments from my Chemistry teacher on my question answering shows me how much I have studied so far'.

Benedict: 'When exercises are given it shows me how much I have learnt'.

Kweku: 'Sometimes we think we have learned to the fullest, but only a question will let you know that you need to do more than expected'.

Francis: 'One way or the other, it shows me how I have studied. But not always. Sometimes not all that I have learnt comes, so I can't conclude that it really shows how much I have studied. But I agree partially'.

Kwabena: 'When he corrects me too much, it gives me the impression that I haven't studied enough'.

Allen: 'When the results for a test come out and I see my performance, it shows me how much I have studied'.

Larry: 'An example is that one time he asked the class to define redox reaction and I knew it because I learnt before time, and on a different time he asked us to define electrolysis, I had no idea what it was so I think he asking questions and giving us feedback enable me know how much I have studied'.

Theophilus: 'This is because when he brings a test and you perform well, you know you are good enough with the topic but when you are unable, you realise that you need more preparation'.

Mary: 'This is because sometimes my score in certain tests conducted by my teacher on topics learnt show that I have studied scantly'.

Edwin: '... If I have studied well, I will be able to solve questions correctly and if I have not studied well it will show'.

Estella: 'At times, corrections from the teacher either make me feel like I have a lot more to study or I have studied enough to write the exams'.

Students, who completely disagreed or disagreed with the statement, gave the following reasons for their choice:

Phyllis: 'Corrections or comments from my chemistry teacher show me how and where I can improve, but they don't determine or show how little or how much I have studied. I may have studied really hard but could have missed a couple of things'.

Michael: 'Sometimes, when he teaches and we don't understand, and he gives work, we have to copy so that when he is recording, we would get good marks and help us to pass in our exams'.

Emma: 'I disagree because comment is not done always during lessons'.

Benjamin: 'The correction rather helps me improve upon my studies but does not show me how much I have studied'.

Godfred: '…… do not show me how much I have studied but rather when I am being tested on sample questions'.

Joseph: 'I completely disagree because if the teacher gives work and I answer and get 100% and he write 'very good keep it up' and later I find a difficult question and am unable to solve it the teachers comment will not appear here to make me know how much I have studied'.

Mohammed: 'Getting one or two questions right or wrong does not show me how much I have studied. One can answer a question wrongly due to several reasons, which may not be because the person has not studied. For example, being unable to correctly balance chemical equations does not mean one has not studied that topic'.

Isaac: 'You might have studied something ahead of the class which might necessarily not be known to the teacher. Therefore, his comments do not necessarily show me how much I have studied'.

The fourth item on the questionnaire was the statement; when solving questions, suggestions, or guidelines (feedback) from my Chemistry teacher show me if I am better prepared. The respondents were given the same options as in the previous statements and asked to give a reason for their choice. Figure 18 shows students' responses to the statement.

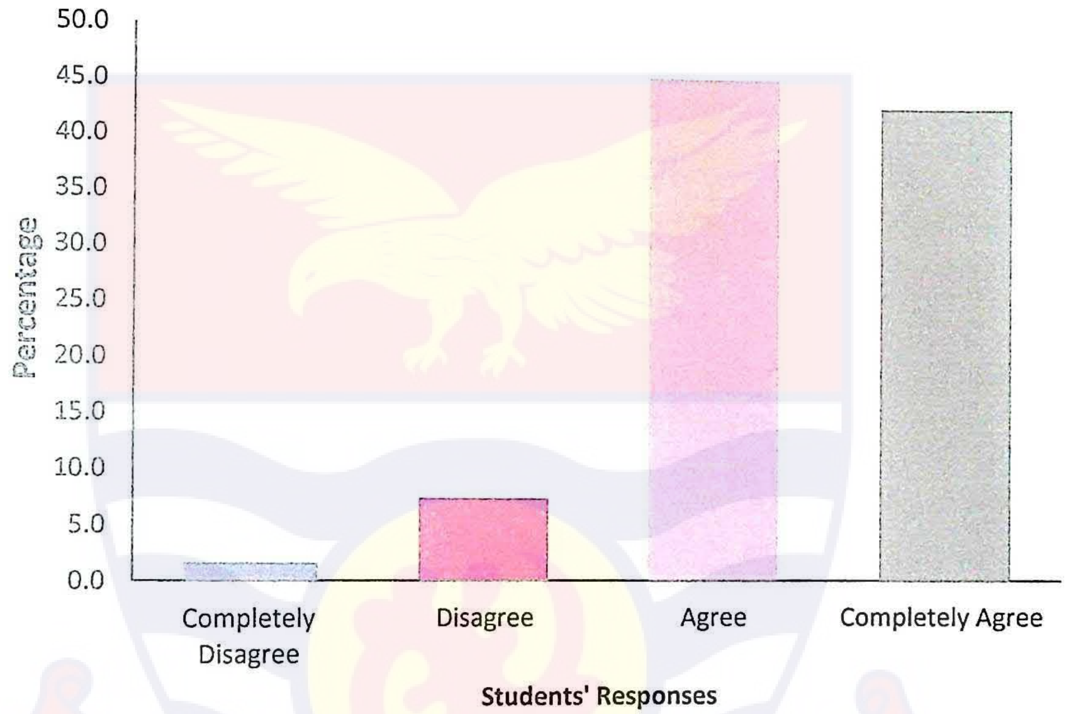

Figure 18: Students' responses to the statement; when solving questions, suggestions or guidelines from my Chemistry teacher show me if I am better prepared.

Two students representing 1.7% of the respondents completely disagreed, whilst nine students representing 7.6% disagreed. Fifty-two students representing 44.1% completely agreed whilst fifty-five students representing 46.6% of the respondents agreed with the statement. This indicates that majority of the students, 90.7% either completely agreed or agreed with the statement that when solving questions, suggestions, or guidelines (feedback) from their Chemistry teacher show that they are better prepared. The reasons that students gave for their choice were similar to what they gave for the third statement.

Students, who completely agreed or agreed with the statement, gave the following reasons for their choice:

> **Godfred**: 'Yes because when I am corrected, I learn from my mistakes and follow the guidelines which makes me well-prepared in solving other questions'.

> **Aaron**: '…It shows how well prepared I am when I am given exercise irrespective of getting the work correct or wrong'.

> **Andy**: 'Sometimes you are solving a particular question and you get stuck, but when the teacher approaches and gives you little guidelines, then you are able to do the work perfectly'.

> **Vincent**: '… makes me know how prepared I am. In case where he gives questions and am able or unable to solve it. It shows my stand'.

> **Julius**: 'Work that he puts on the board challenges me. When I am not well prepared, I get low marks'.

> **Stephanie**: 'When solving questions especially I like his suggestions, it teaches me whether I'm better prepared for examination or I'm joking with my studies'.

> **Priscilla**: '… This is because he can ask some questions in class and then I realise that I didn't prepare fully'.

> **Elizabeth**: 'When he gives a question for me to solve, the way I will solve the questions makes me know how prepared I am, his facial expression and also his comment will let me know that I am making some mistakes or getting it right'.

> **Francis**: 'After he marks my work, the compliments he gives help me to know how prepared I am as well as the scores'.

> **David**: 'When solving questions, guidelines from my chemistry teacher shows me if I'm better prepared or not because if he solves and still I don't understand then I get serious and go to my friend or someone for better understanding'.

> **Sarah**: '……. anytime he comes to class and ask me to answer a question, if I answer it, then it shows that am better prepared'.

> **Allen**: "For instance, if I am solving a question and he keeps on correcting my mistakes while solving, it helps me know that I am not well prepared that I need to learn more'.

> **Kwabena**: 'When I try applying what my teacher has said about solving questions and I find it difficult; I know I am not better prepared. When I find it easy applying it, I know I am well prepared'.

> **Henrietta**: 'Once a while, he decides to ask us questions on what we have previously done as a form of revision and this helps me to notice if I'm well prepared or not'.

Students, who completely disagreed or disagreed with the statement, gave the following reasons for their choice:

> **Dennis**: 'It is not the suggestions from my teacher that shows how well prepared I'm. The preparation depends on me. Although his guidelines build me up'.

> **Alex**: 'This is because I feel that sometimes he doesn't give us challenging questions to solve so we only solve easy questions and his feedback to that is good. When I solve challenging questions for preparation, I realise that I don't really understand'.

> **Larry**: 'When he gives us questions to solve on the board, whether you are on the right track or not he does not alert you. When you are done before he tells you it is wrong. So, it can be that I was well prepared, but I missed a step or there was a miscalculation somewhere'.

> **Joe**: '……because if the teacher gives me guidelines when solving questions, it does not show me If I am better prepared because even if he gives me guidelines and I do not practice, I might forget and will make it difficult for me to solve'.

Anna: 'I would prefer to solve questions on my own and afterwards show them to my teacher rather than being taught while solving questions. This would help me know if I'm better prepared'.

Student responses to all the statements were put together and the frequencies and percentages of the various options determined. Figure 19 shows the total number of times respondents chose the various options for all four statements.

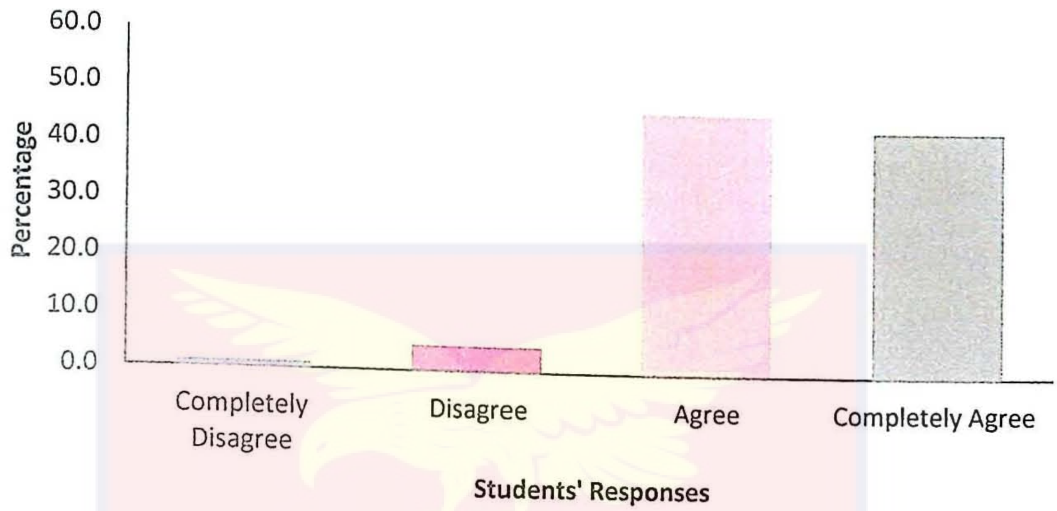

Figure 19: Students' responses to all statements on their perception of the usefulness of feedback that they receive from their Chemistry teacher.

The number of times that respondents chose completely disagree for all four statements was six representing 1.3% of the total responses, whilst that for disagree was twenty-three representing 4.9% of the total responses. Respondents chose completely agree two hundred and fifteen times representing 45.6% whilst respondents chose agree, two hundred and twenty-eight times representing 48.3%. This indicates that majority of the respondents, 93.9% either completely agree or agree with the statements. Therefore, they perceive feedback from their Chemistry teacher as useful. Whilst a minority of the respondents, 6.2% either completely disagree or disagree with the statements. Therefore, they perceive feedback from their Chemistry teacher as not useful.

The other instrument used was student questionnaire titled-General. This was an open-ended questionnaire with 6 items. Items 1 and 2 were to find out students' perception of the usefulness of feedback that they receive from their teachers.

Item 1 was stated as, please give example(s) of corrections/comments about your work; or suggestions/guidelines on how to solve questions (feedback) from your Chemistry teacher recently. Did you find it helpful?

These were some of the responses given by the students:

Benedict: 'He corrected someone on the definition of hybridization and Graham's law which really, really helped me'.

Akua: 'He gives us exercise and then discusses with us on how we solve the questions then corrects us. It is very helpful'.

Thelma: 'He made a comment about how pressure and temperature can affect the equilibrium position of a chemical reaction and it has made it easier to answer other questions on equilibrium reactions'.

Nicholas: 'Our teacher gives us work to try and gives us some time to solve, he goes around (student to student) correcting the wrong solution which in turn put us on track all the time'.

Godfred: 'When we have been tested and they have been marked, he comes to class and correct us about our mistakes. He solves it for us, or we all solve it together by expressing ideas'.

Julius: 'When we were treating rates of chemical reactions…. and he came to look at my work, he showed me how the work could be solved the simplest way and I was able to solve any question under that topic'.

Jeremiah: 'When we are solving questions, he comes around to check what we are doing whether it's right or wrong. He teaches us when it's wrong and explains it further for us to understand'.

Justina: 'He made one of my colleagues correct me when I answered a question wrongly'.

Mohammed: 'When a question is asked, and a student answers it wrongly, he would ask another student to correct him/her. If the other student is right, he would confirm it for us'.

Estella: 'He corrected me on the drawing of the titration table and since then I always do the right thing'.

Mary: 'My teacher once penalized me for cancelling a recorded data in a table from my experiment and told me never to do it again. I found it really helpful because I do not make such mistakes anymore'.

Betty: 'I answered a question on the definition of Lewis acid, and he said thank you. It was helpful because I was encouraged to answer more questions in class since, since I don't answer a lot in class'.

Annaliese: 'When he tells the class to clap for me, it encourages me more and helps in my understanding'.

Ann: 'Good Job' he says. I find it very helpful; I tend to feel good about myself and make me happy that I know the way to go about the question'.

Ama: 'So this term was the first time I went to the board to solve a question on Acids, Bases and Salts since Form 1(I usually don't go to the board because of fear) but he encouraged me and made the class clap for me when I was done though the method I used wasn't what he expected or wanted. Yes, it was helpful'.

Kofi: 'My friend solved a question wrongly on the board, and my teacher corrected him. This helped me during my studies to avoid making that mistake'.

Chris: 'What you've done is right, but you should always make sure you indicate the charge. Without the change you may be marked down. I found that really helpful'.

Akosua did not find feedback from her Chemistry teacher helpful all the time and gave the reason as; *'Not all the time, sometimes when he is explaining a point he does not go into details'.*

Item number 2 was stated as do you find corrections /comments /suggestions/ guidelines (feedback) from your chemistry teacher useful for your work and studies? Please explain.

These were some of the responses given by the students:

Priscilla: 'Yes, because sometimes the assignment he gives us introduce me to different questions which I have never met before. So, when he corrects me on my mistakes, I find it helpful'.

Aaron: 'Yes, this is because during studies, which is learning on my own, I solve questions on the topic we have been taught and I find it very easy in solving due to his guidelines.

George: 'I really find it very useful because he once made us ask our friends questions and after that your other friend will also ask his question, I think when we continue with this it will open our minds and we will receive more information from our friends'.

Andrews: '… It also sometimes put you in the right path especially when performing experiment'.

Justina: 'When I answered a question in class and my teacher told me well done, I found it useful. The reason I found it useful is that it encourages me to do more. For instance, for me to answer questions in class and do the assignments given to me'.

Jones: 'He gives clues to solving questions and other approaches to solving those questions which technically makes working or answering questions easier'.

Abdul: 'Yes, it's very useful. He gives us simple guidelines in solving complex chemistry calculations. Also, I find it difficult to understand when reading directly from my textbooks, but his notes help me a lot'.

Edinam: 'Yes, this is because during my studies, I normally reflect on some of the comments he makes and some suggestions to guide me as I study'.

Dzifa: 'Yes because it reduces the mistakes you make and improve your thinking ability'.

Vanessa: 'Yes. It makes me understand things (complex) that are in the textbooks books better'.

Estella: 'Yes I do because certain comments he gives make me understand something I might have read several times from the textbook already but didn't understand'.

Some of the students did not find feedback from their Chemistry teacher useful and gave the following reasons:

Mary: 'Not always. Because I sometimes find it difficult to understand what he is talking about'.

Nicholas: 'From my point of view He should take time on certain topics because all fingers are not equal, thus some may understand but the others will not'.

Vera: 'No, because when he comes to class, he doesn't talk loudly so I find it difficult to hear him'.

Students' responses to items 1 and 2 are an indication that most of them perceive feedback from their Chemistry teachers' as useful whilst a few perceive feedback from their Chemistry teachers' as not useful.

Discussion on Students' perception of the usefulness of feedback that they receive from their teachers

Research question 2 sought to find out the students' perception of the usefulness of feedback that they receive from their teachers. When students were asked to rank the statement that teacher feedback helped them to see where they can improve on their work, 97.5% either agreed or completely agreed (Figure 15). When they were asked whether teacher feedback helped them to see where they can improve when solving questions, 96.6% either agreed or completely agreed (Figure 16). The proportion of students that either agreed or completely agreed to statements that teacher feedback helped them to know how much they had studied and if they were better prepared solving questions were 90.7% (Figure 17) and 90.7% (Figure 18) respectively. Figure 19 shows that most of the respondents, 93.9% perceive feedback from their Chemistry teacher as useful. The findings that most of the students find teacher feedback useful implies that majority of students have the tendency to make use of formative assessment to improve learning. This assertion is concurred by Harks et al. (2014), when they stated that perception of feedback's usefulness should promote students' actual use of the information it provides. Likewise, according to Van der Schaaf et al. (2013), students' perceptions will affect the way they act in response to teacher feedback. It follows therefore that students' perception that teacher feedback is useful would enable them to use feedback information to correct erroneous knowledge components leading to a consequent improvement in their achievement. The study demonstrated that students consider feedback useful and use feedback information to improve only when there is some level of understanding. For instance, Michael, a student who stated that feedback is not useful depicts instance(s) where students without understanding concepts taught look for other means to pass exams rather than seeing feedback as an opportunity to improve and progress in learning.

> 'Sometimes, when he teaches and we don't understand, and he gives work, we have to copy so that when he is recording we would get good marks and help us to pass in our exams' (**Michael, Chemistry student**).

The finding that when learners do not understand concepts taught feedback is not helpful collaborates Hattie (2012) that feedback comes second, after instruction and is effective if there is surface knowledge or initial instruction. This revelation suggests that teaching approach whereby teachers usually expose students to solving past questions may not necessarily lead to progress in learning. In this approach to learning, students are assessed and given feedback in the form of correct answers when students are not exposed thoroughly to the underlying concepts. In this case, feedback is not given on solid foundation. When feedback is provided in a vacuum, its effectiveness is limited. In other words, feedback can only build on something and has no effect in a void. For feedback to have an effect, there must be a learning context to which it is addressed and is of little use when there is no initial learning or surface information. When learners are at the acquisition phase, it is better for a teacher to provide elaborations through instruction than to provide feedback on poorly understood concepts (Hattie, 2009; Hattie & Timperley, 2007).

However, the study also reveals that students like Michael's inability to use feedback information to improve learning do not only anchor on lack of understanding but also hinges on their perception of usefulness of feedback. Contrary to students like Michael, students like Allen, believe in the usefulness of feedback and state that '*When the results for a test come out and I see my performance, it shows me how much I have studied*'. Students who believe that feedback is useful utilise feedback information either to motivate one's self or to give assurance and also to identify weakness in order to strategize for improvement. Theophilus epitomises such students.

> This is because when he brings a test and you perform well, you know you are good enough with the topic but when you are unable, you realise that you need more preparation' (**Theophilus, Chemistry student**)

Students like Theophilus confirms Bourke (2016) that in the view of students, assessment in the form of tests gives them information about how much they have learned. The discussion has shown that students who perceive feedback as not useful are unlikely to use feedback information to progress in learning. On the other hand, students who see feedback information as useful are more likely to utilise such information to improve learning. This finding also affirms Storch (2010) that learners' attitudes towards the feedback affects not only whether and how learners respond to the feedback provided, but ultimately whether there is long term learning.

Level of feedback from Chemistry teachers that students find useful

Research question 3 sought to find out which level of feedback from Chemistry teachers that students find useful. Two instruments were used to answer this question. Firstly, students were given a questionnaire titled feedback levels, comprising of four two- tier items. Each item was a statement on one of the feedback levels and the respondents were expected to choose from four options and give reasons for their choice. The first item was stated as, when my chemistry teacher says my answer is correct or wrong. This is a statement on task level feedback. The respondents were to choose whether they found the statement not useful, fairly useful, useful or very useful when studying. Figure 20 shows students' responses to the statement on task level feedback.

One student out of the 118 respondents representing 0.8 percent of the respondents did not find task level feedback useful when studying. Nineteen students representing 16.1% chose the option that task level feedback was fairly useful when studying. Fifty-eight students representing 49.2% chose the option that task level feedback was useful when studying, whilst forty students representing 33.9% of the respondents chose the option that task level feedback was very useful when studying. This indicates that majority of the students, 83.1% chose the option that task level feedback either useful or very useful when studying.

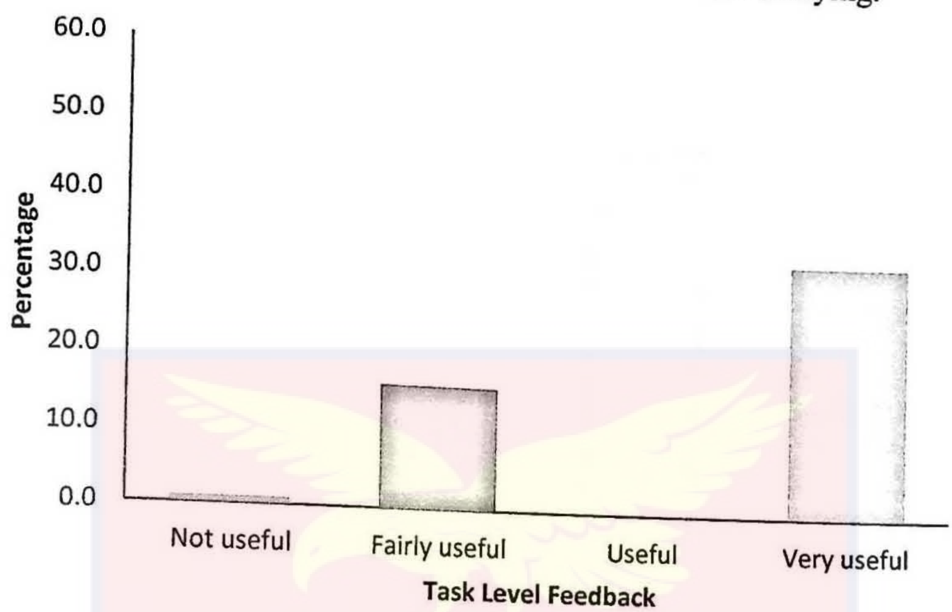

Figure 20: Students' responses to the statement on task level feedback.

Examples of some responses from students who chose the option that task level feedback is either useful or very useful when studying are as follows:

> **Gina**: 'When He tells me my answer is correct, it makes me happy that I understand what He is teaching. And when he says my answer is wrong, I learn more for me to understand what he is teaching'.
> **Nina**: 'I find it useful because after his correction I get to know the right answer'.
>
> **Tina**: 'It's very useful because when he says its correct it clears all doubt I have concerning the answer and if it's the other way it makes me eager to know the correct answer and how to go about it'.
>
> **Kwabena**: 'So when the teacher says it's not correct, then when solving similar questions, I adopt new methods in solving it'.
>
> **Patrick**: 'It is useful because, when my answer is correct, it tells me that I am improving but when it is wrong it encourages me to work or study more effectively'.
>
> **Mark**: 'This is because it makes me realise whether I am learning or not'.

Justina: 'I find it very useful when my Chemistry teacher says my answer is correct or wrong because I learn a lot out of it. For example, when I answer a question and I get it right he congratulates me, and it encourages me to learn more. Also, when I answer a question wrongly, it also helps me to do more'.

For the students who chose the option that task level feedback is either not useful or fairly useful when studying, examples of some of the reasons they gave for their choice are as follows:

Vivian: 'It's not useful because I don't usually understand his questions'.

Felix: 'It became fairly useful to me because that remark like you are wrong cannot help me in my studies when he does not assist me with my correction'.

Kofi: 'Fairly useful because telling me my answer is wrong in class among my mates will discourage me from learning or studying chemistry since I know whenever I try to answer a question it will be wrong'.

Anna: 'I would prefer him to say my answer is acceptable but not correct saying my answer is wrong may make me feel down'.
Audrey: 'For example, saying yes to an answer may not be of help as I may not know the reasons for agreeing to my answer'.

Akosua: 'I just get to know my method or approach to a particular question is incorrect but not how to get the right answer'.
The names of the students are pseudonyms.

The second item was stated as, when my chemistry teacher shows me how (steps to follow) to correct my mistakes. This is a statement on process level feedback. The respondents were to choose whether they found the statement not useful, fairly useful, useful or very useful when studying. Figure 21 shows students' responses to the statement on process level feedback.

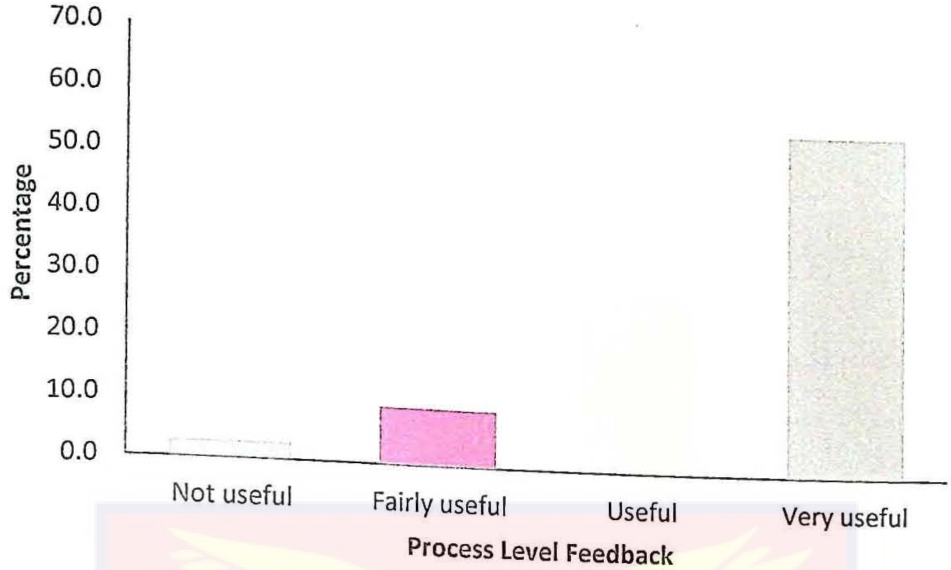

Figure 21: Students' responses to the statement on process level feedback.

Three students out of the 118 respondents representing 2.5 percent of the respondents did not find process level feedback useful when studying. Eleven students representing 9.3% chose the option that process level feedback was fairly useful when studying. Thirty-six students representing 30.5% chose the option that process level feedback was useful when studying, whilst sixty-eight students representing 57.6% of the respondents chose the option that process level feedback was very useful when studying. This indicates that majority of the students, 88.1% chose the option that process level feedback was either useful or very useful when studying.

Examples of some responses from students who chose the option that process level feedback was either useful or very useful when studying are as follows:

Ama: 'It helps me to understand the procedure better'.

Yaa: 'It is easier to keep corrected mistakes in memory'.

> **Elsie**: 'It prevents me from making similar mistakes when studying'.
>
> **Rex**: 'It gives me a better understanding why those answers are incorrect'.
>
> **Kojo**: 'It is very useful so that anytime I go wrong; I can correct my mistakes on my own when he is not available'.
>
> **Lucy**: 'I find it useful because when he is not around; I can follow his steps and study on my own'.
>
> **Georgina**: 'When my Chemistry teacher show me the steps to follow to correct my mistake it encourages me to learn more on my own than to wait for my Chemistry teacher to teach me.

For the students who chose the option that process level feedback is either not useful or fairly useful when studying, examples of some of the reasons they gave for their choice are as follows:

> **Gloria**: 'He doesn't correct my mistakes in detail. i. e. I don't understand his steps'.
>
> **Issac**: 'I sometimes understand his steps and sometimes I don't really get his corrections'.
> **Prince**: 'This is because the steps that he may show may or may not tally with the way I learn'.

The third item was stated as, when my chemistry teacher gives suggestions/ guidelines /strategies on how to solve questions (or study) on my own. This is a statement on self-regulation level feedback. The respondents were given the same options to choose from. Figure 22 shows students' responses to the statement on self-regulation level feedback.

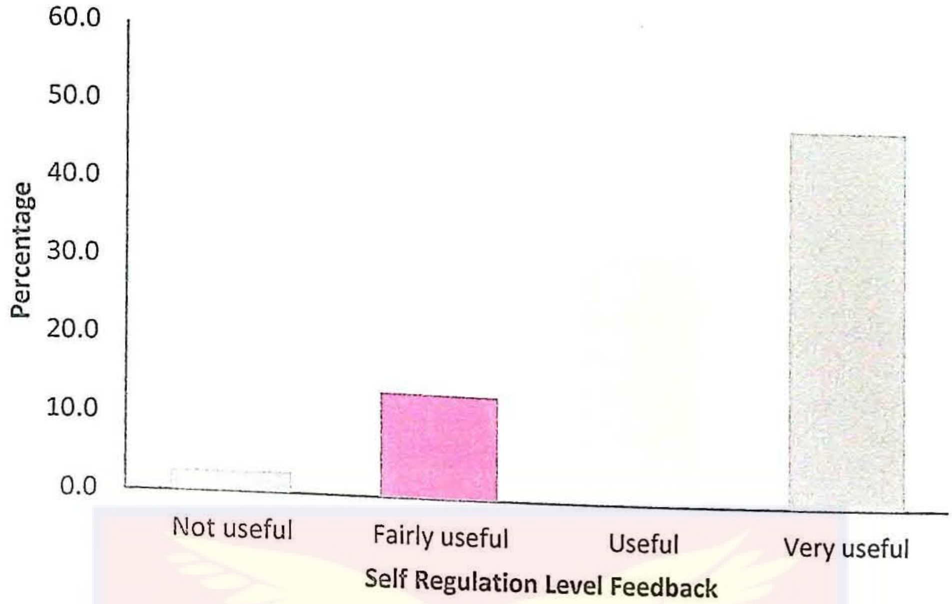

Figure 22: Students' responses to the statement on self-regulation level feedback.

Three students out of the 118 respondents representing 2.5 percent of the respondents did not find self-regulation level feedback useful when studying. Sixteen students representing 13.6% chose the option that self-regulation level feedback was fairly useful when studying. Thirty-nine students representing 33.1% chose the option that self-regulation level feedback was useful when studying, whilst sixty students representing 50.8% of the respondents chose the option that self-regulation level feedback was very useful when studying. This indicates that majority of the students, 83.9% chose the option that self-regulation level feedback was either useful or very useful when studying.

Examples of some responses from students who chose the option that self-regulation level feedback was either useful or very useful when studying are as follows:

Mabel: 'It makes me eager in solving questions.

> **Jane**: 'It helps me to avoid depending on teachers so that when there is no teacher, I can solve questions on my own'.
>
> **Frank**: 'It helps me to study on my own'.
>
> **Kwame**: 'When I was given questions on solubility curves the first time, I had no idea about how to do it. I struggled a lot but when he later came to class to give the class guidelines it helped a lot'.
>
> **Bernard**: 'It encourages us to learn very well on our own. It also promotes my understanding'.

For the students who chose the option that self-regulation level feedback is either not useful or fairly useful when studying, examples of some of the reasons they gave for their choice are as follows:

> **Michael**: 'Most strategies, my chemistry teacher gives on how to study on my own are just short ways to answer the problem. But I think it is quite not useful since it does not make me adopt to the appropriate steps.
>
> **Jerry**: 'Sometimes I don't even understand the guidelines he gives to solve a question on my own'.
>
> **Kofi**: 'His guidelines may help me in studying and also may not help me because I may not be okay with that way of studying'.
>
> **Esther**: 'I sometimes don't understand and have to go to a friend for further explanation'.

The fourth item was stated as, when my Chemistry teacher says well done (or very good) or lets the class clap for me. This is a statement on self-level feedback. The respondents were given the same options to choose from. Figure 23 shows students' responses to the statement on self- level feedback.

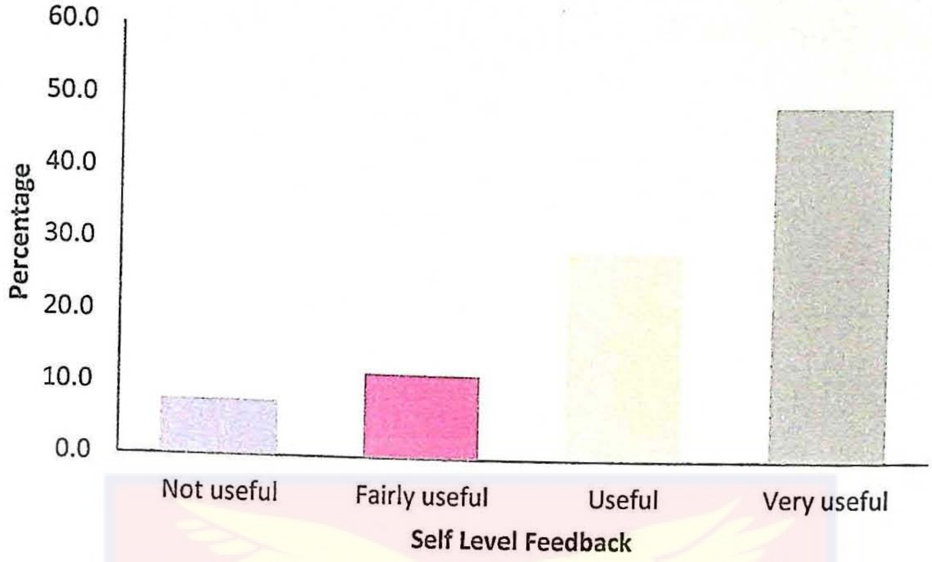

Figure 23: Students' responses to the statement on self- level feedback.

Nine students out of the 118 respondents representing 7.6 percent of the respondents did not find self-level feedback useful when studying. Fourteen students representing 11.9% chose the option that self-level feedback was fairly useful when studying. Thirty-five students representing 29.7% chose the option that self-level feedback was useful when studying, whilst sixty students representing 50.8% of the respondents chose the option that self-level feedback was very useful when studying. This indicates that majority of the students, 80.5% chose the option that self-level feedback was either useful or very useful when studying.

Examples of some responses from students who chose the option that self-level feedback was either useful or very useful when studying are as follows:

Solomon: 'It motivates me to do more'.

Rita: 'It boosts my confidence and urges me to study harder so that I can always get an encouraging comment from my teacher'.

Ama: 'It makes me feel good about my work'.

Eddie: 'I feel happy and encouraged to read ahead of the class and answer more questions in class'.

Tracy: 'It boosts my morale and makes me eager to learn more and makes me confident'.

For the students who chose the option that self-level feedback is either not useful or fairly useful when studying, examples of some of the reasons they gave for their choice are as follows:

Ibrahim: 'Some people see that as a motivation but for me, it rather makes me shy and as such may not answer a question the next time in class'.

Fred: 'Not useful because it makes me feel I am good, so it does not push me to learn more things'.

Efua: 'Sometimes when the class claps for me or he says well done, I become complacent thinking I'm done learning that topic even though I have a lot to revise'.

The percentage of students who chose the option useful and very useful for each of the four feedback levels were put together. Figure 24 shows the percentage of students who chose the option useful and very useful for each feedback level.

Figure 24 indicates that over 80% of the respondents find all feedback levels from their teachers useful. However, in terms of percentages, 88.1% find process level feedback useful, followed by 83.9% who find self-regulatory level feedback useful, then 83.1% who find task level feedback useful and lastly 80.5% who find self-level feedback useful.

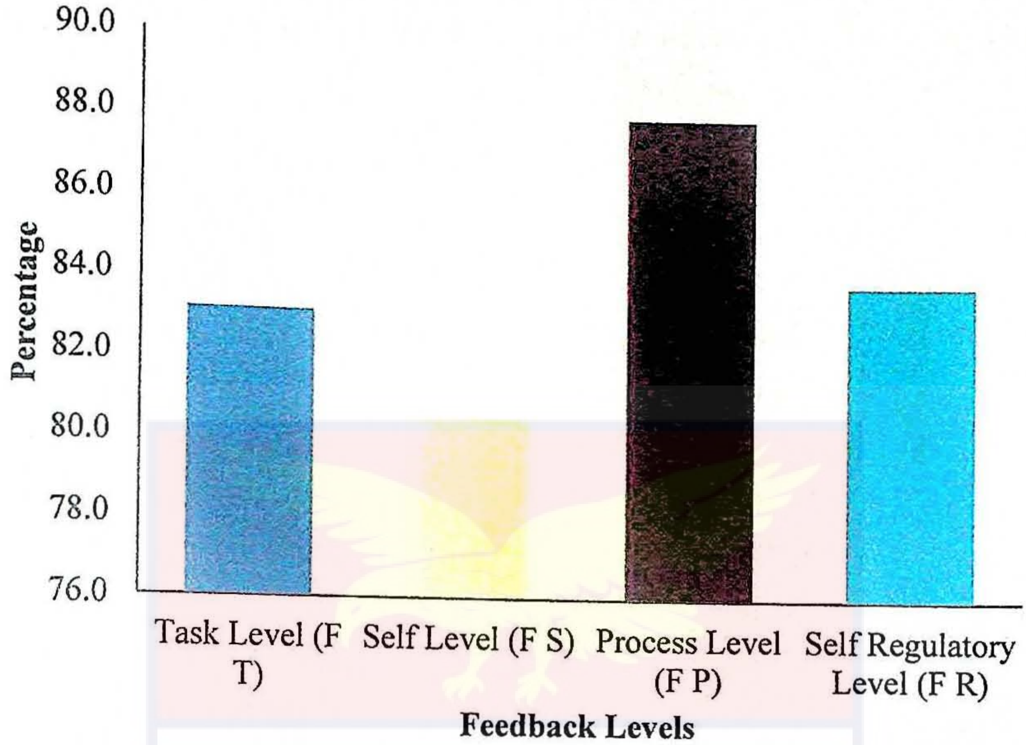

Figure 24: Percentage of students who chose useful and very useful for each feedback level.

The second instrument that was used to answer this question was item numbers 3 and 4 on the questionnaire titled-General.

Item 3 was stated as, what do you find very useful (appreciate/value) about corrections/ comments/suggestions (feedback) from your chemistry teacher on your work and why?

Item 4 was stated as, what do you find not useful (not valuable) about comments/suggestions (feedback) from your chemistry teacher on your work and why?

Students' responses to item numbers 3 and 4 were categorized into the various feedback levels. For instance, a response like; 'He is quick to praise you even when you are not completely correct' is categorised as self-level feedback whilst a response like; 'He explains to you why you were wrong whilst making corrections on the board' is process level feedback. These were then tallied to find which level of feedback students find useful. Figure 25 shows categorisation of students' responses to what they find useful about feedback from their Chemistry teacher and the reasons why.

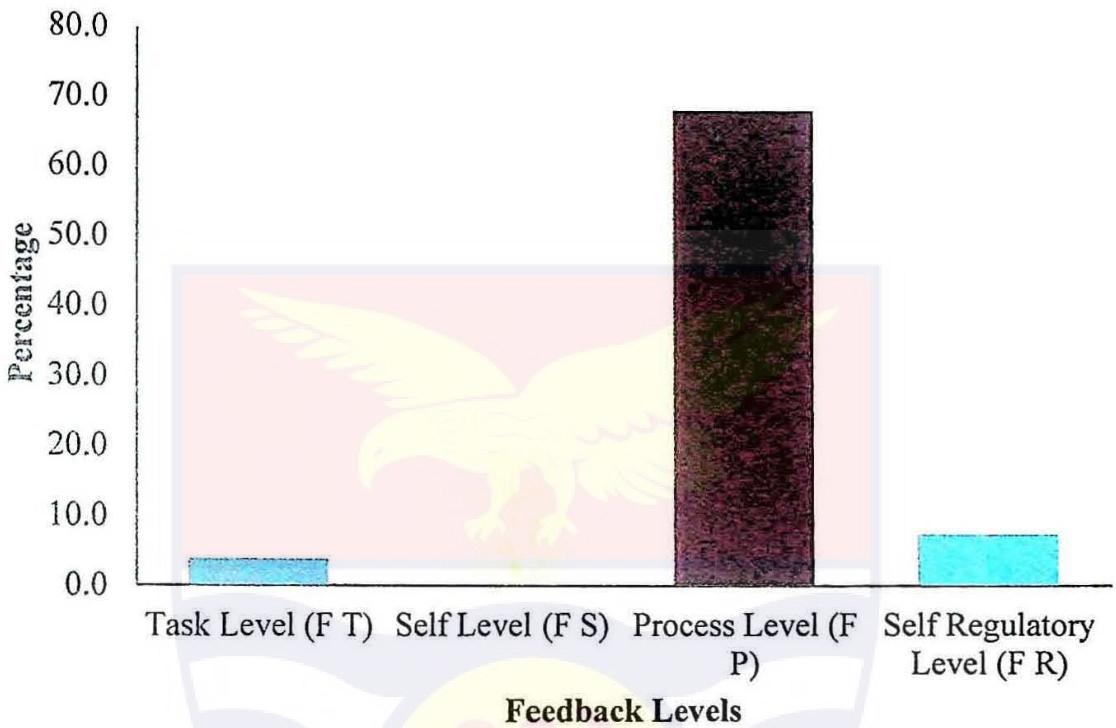

Figure 25: Categorisation of students' responses to what they find useful about feedback from their Chemistry teacher and the reasons why.

Most of the respondents, about 69.8% preferred process level feedback, followed by 18.9% who preferred self-level feedback, 7.5% of the respondents' preferred self-regulation level feedback and lastly 3.8% preferred task level feedback. Figures 24 and 25 indicate that even though students find all the feedback levels from their teachers useful, more students prefer process level feedback.

Discussion on Level of feedback from teachers that students find useful

Research question 3 sought to find out which level of feedback from teachers that students find useful. Figure 24 indicates that over 80% of the respondents find all feedback levels from their Chemistry teachers useful. However, in terms of percentages, 88.1% find process level feedback useful, followed by 83.9% who find self-regulatory level feedback useful, then 83.1% who find task level feedback useful and lastly 80.5% who find self-level feedback useful. Therefore, comparing percentages, 4.2% more of the respondents find process level feedback useful than self-regulatory level feedback, 5% more of the respondents find process level feedback useful than task level feedback whilst 7.6% more of the respondents find process level feedback useful than self-level feedback. From Figure 25, most of the respondents, that is, 69.8% preferred process level feedback, followed by 18.9% who preferred self-level feedback, 7.5% of the respondents' preferred self-regulation level feedback and lastly 3.8% preferred task level feedback.

For that reason, most of the respondents preferred process level feedback. One of the respondent's, Lucy who indicted that process level feedback is useful gave the following reason for her choice: 'I *find it useful because when he is not around I can follow his steps and study on my own*'. This is in line with the assertion by Hattie (2012) that process level feedback leads to self-regulation feedback. In other words, when teachers' feedback to students is process level it progresses to self-regulation by the students. Kofi a respondent, who indicated that task level feedback is fairly useful gave the following reason: '*Fairly useful because telling me my answer is wrong in class among my mates will discourage me from learning or studying chemistry since I know whenever I try to answer a question it will be wrong*'. This is confirmed by studies done by Adediwura and Ojediran (2010) that the feedback methods that teachers make use of can shape students' self-efficacy. Kofi's response also corroborates the assertion by Van der Schaaf et al. (2013) that the tone of feedback should not be too judgmental. The implication for teaching is that teachers have to be tactful with the feedback that they give to their students.

How students use feedback from their teachers

Research question 4 sought to find out how students use feedback from their teachers. Students' responses to item numbers 5 and 6 on the questionnaire titled-General were used to answer the question.

Item 5 was stated as how do you use comments/suggestions (feedback) from your Chemistry teacher for improving on your performance (or work)? Please give example(s).

Item 6 was stated as how do you use comments/suggestions (feedback) from your Chemistry teacher when studying? Please give example(s).

The responses of some of the students' on how they use feedback from their teachers are as follows:

> **Chris**: 'The feedback is normally information I can hardly find in textbooks, they also come as tips for quick calculations too'. 'I write suggestions from my teacher in my notebook and always compare it with what I have in the textbook to see which one is easier'.
>
> **Dennis**: 'I write his suggestions in my jotter and use it to prepare for examinations'.
>
> **Albert**: 'Comments made by teacher in class help me from repeating certain mistakes made by my mates and myself when studying'.
>
> **Asamoah**: 'When my Chemistry teacher corrects my mistakes, it serves as a reminder and allows me to learn from my mistakes'.
>
> **Kingsley**: 'The mistake that I did, and he corrected me I write in my jotter so when I am learning and in case, I forget I take my jotter and quickly cross-check'. 'His comments and suggestions help us to solve questions on our own and it makes it easier'.

Lilian: 'When solving questions during my private studies, I look at his worked examples as a guideline to study'.

Richard: 'When I test myself after learning on my own, I make sure that I avoid making mistakes that were corrected by my teacher'.

Eben: 'I make sure I write the comments at the back of my chemistry notebook so when I am studying, I go by his comments and suggestions, this helps me study well to improve upon my performance'.

Benny: 'When studying I use my exercise books and try to learn from my correction'.

Melvin: 'I use it by paying much attention to the correction he gives me so that I may not do the same thing during examinations. E.g studying of hybridization, I didn't understand but I got to understand when I was corrected in one of my exercises'.

Pat: 'Any answer he gives to a question, I write it in my notebook and refer to it when I am studying'.

The most common response of the students on how they use feedback from their teachers is that they write their teachers feedback in their jotter and use them when studying to prevent them from repeating mistakes. However, a student, Asantewa had a different response: '*I analyse the question or what am learning. Take my time to discuss the answer sometimes with my friends and also compare answers*'. Clearly, she prefers and uses peer feedback instead of that from the teacher.

Discussion on how students use feedback from their teachers

Research question 4 sought to find out how students use feedback from their teachers. Students' responses to item numbers 5 and 6 on the questionnaire titled-General in addition to other students' comments on feedback suggest at least four major ways of how students use feedback from their teachers. Firstly, students use feedback to synthesise easier strategy to improve performance.

> **Chris**: 'The feedback is normally information I can hardly find in textbooks, they also come as tips for quick calculations too'. 'I write suggestions from my teacher in my notebook and always compare it with what I have in the textbook to see which one is easier'.

Chris does not rely only on teacher feedback but analyse feedback with standard textbook(s) to plan easier learning approach to improve performance.

Secondly, students use feedback to analyse mistakes and apply comments provided to enhance student self-efficacy and motivation.

> **Melvin**: 'I use it by paying much attention to the correction he gives me so that I may not do the same thing during examinations. E.g studying of hybridization, I didn't understand but I got to understand when I was corrected in one of my exercises'.
>
> **Tracy**: 'It boosts my morale and makes me eager to learn more and makes me confident'.

Thirdly, students use feedback as scaffold. Students use teacher feedback to learn how to solve problems. They try questions or problems and when they have issues, they go back to study the feedback further and try to improve learning.

> **Lilian**: 'When solving questions during my private studies, I look at his worked examples as a guideline to study'.
>
> **Richard**: 'When I test myself after learning on my own, I make sure that I avoid making mistakes that were corrected by my teacher'.

As shown by Lilian and Richard, feedback serves as a model to solve problems and offers further support when students encounter challenge during their effort to work independently. Fourthly, students use feedback to help them to engage in self-evaluation of their ability and self-regulation of their learning behaviour. The teacher feedback serves as mirror which students use to reflect the level of learning as well as understanding. Becoming aware of the level of understanding, they then adjust their learning behaviour. Students' state of metacognition helps them to self-regulate and independently make effort to improve learning. The comments of Mabel, Jane, Frank and Bernard depict that students' use of teacher feedback leads to self-dependent learning

> **Mabel**: 'It makes me eager in solving questions'.
>
> **Jane**: 'It helps me to avoid depending on teachers so that when there is no teacher I can solve questions on my own'.
>
> **Frank**: 'It helps me to study on my own'.
> **Bernard**: 'It encourages us to learn very well on our own. It also promotes my understanding'.

Why high-achieving students seek feedback, whilst low-achieving students do not

Research question 5 sought to find out why high-achieving students seek feedback, whilst low-achieving students do not. This was answered by focus group discussions of high achievers and low achievers in each class in the three schools. The students were selected with the help of their teachers based on their grade for the previous term and their average grade for the current term. Their contribution in class and their attendance in school were also considered by their Chemistry teachers in their selection. The high achievers had average grades above 74%, whilst the low achievers had average grades of 40% and below. The first set of focus group discussions was at school A on the 10th of June 2019. It was in two groups; the first group was between the researcher and three high-achieving students. This was followed by the second group that was between the researcher and three low-achieving students. The names of all the students are pseudonyms. The discussion between the researcher and three high-achieving students is as follows:

> **Researcher**: Let me come to you Albert. How often do you receive these corrections, comments, suggestions, guidelines? How often do you receive it from your chemistry teacher?
>
> **Albert**: Okay, me, I don't normally answer questions in class but once in a while, I go and…
>
> **Researcher**: You don't normally answer questions in class?
>
> **Albert**: Yes. But the little times I do it, I get positive response maybe from the teacher or the class in general.
>
> **Researcher**: So how often, if you can give us an idea, because I want to know how often you receive those things from your chemistry teacher?
>
> **Albert**: Personally?
>
> **Researcher**: Yes, personally because you said you don't answer questions in class.
>
> **Albert**: But the last time I answered a question in class, it was correct, and I think the class clapped for me.
>
> **Researcher**: Okay, and the class clapped for you but does it mean that because you don't answer questions in class you don't… because sometimes as soon as he gives you guys work, I see him going round looking and making comments and suggestions, 'you should do it this way', I see it.
>
> **Albert**: Yes, he comes around to...........
>
> **Researcher**: Yes. And that's also comments or suggestions that he is giving you or statements he is making about your work whiles he is going around. That's why I'm asking that how often you receive those things.
>
> **Albert**: Okay, in that case, most of the time, I don't get some of them correct so I try, the person sitting next to me, to compare and sometimes he shows me the way to do it.

Researcher: I used the word 'how often' because I want to see if you could… because I know you have two chemistry periods a week, elective. That is what I have been observing. Two elective chemistry periods a week so how often? Is it every chemistry class; is it once in a week? That is what I want to know.

Albert: Okay, out of the two, I will say one.

Researcher: Once, once a week. When you are doing exercises you get comments from…

Albert: Yes.

Researcher: Okay, that is fine. Let me come to you then. Isaac.
Isaac: I will say almost every chemistry lesson; I get a guideline to solve a problem.

Researcher: Suggestions or comments from him?

Isaac: Yes, Sir.

Researcher: Does it mean you answer a lot of questions in class?

Isaac: No, I'm just like him. I don't answer questions in class due to the fact that, some of them, like this guy is a 'shark'. So, I don't like answering questions. But concerning the work, in case he gives us work, he comes around, 'do it this way, don't do it that way'. At times, I try to apply some principles from books then he will be like even though it's correct, you should have done it this way, this one is more comprehensive.

Researcher: So, does it mean then that your teacher comes around a lot when he gives you work in class? He comes around to specifically look at yours.

Isaac: No, not to look at mine but at times after marking, he be like… recently we had a practical session and I applied the principles I learnt from past questions and he was like even though its correct, 'this way would have been better'. So, from that, I've learnt something new.

Researcher: Okay, so the reason why asking… for instance the practical one, the one that you used a different method, and then he told you that another method could have been better, did he write it in the book or he called you and spoke to you?

Isaac: He didn't write in the book but after marking, that's when he would be like 'this would have been better' so he actually told me.

Researcher: It means that personally he told you.

Isaac: Yes.

Researcher: Was it in class or after class?

Isaac: After class. I think that was when I didn't bring my practical notebook, so I sent my jotter home, went to transfer it, and when I sent it for him to mark, that is when he told me.

Researcher: Okay, so he told you when you sent it to him.

Isaac: Yes.

Researcher: So, let me come to you. How often do you receive…?

Yaa: I usually answer questions.

Researcher: Yes, I have seen you answer questions a lot which is good.

Yaa: Okay, and sometimes too when he gives us work in class to solve, he comes around and if it isn't really right, usually the person sitting by you, he told us to compare. When you compare and you see that it's still not going well..............

Researcher: You compare with each other; you get information from your friends, so he advises you to do that?
Yaa: Yes.

Researcher: Okay, and then when you answer questions, he makes some comments, so you get that. Do you get that in every chemistry class, approximately?

Yaa: Before I will answer, sometimes I am not sure so I will be like sir I am trying, and then I will just say it. If it is not correct, he will tell me then he will ask another person to answer then I will pick from there.

Researcher: So, we are talking about how often? Those comments, corrections, and suggestions.

All the three Students: Okay, as maybe if we have a practical lesson, and we are supposed to solve, and we solve it and it is not correct, he tells us.

Researcher: But we will still come back to how often?

Yaa: Okay, it's not really a lot for me, but for others it might be…

Isaac: Yes, but not very often.

Researcher: If you say not often, how often?

Isaac: This semester, I don't quite remember but twice. Currently, I have two questions to ask him. I want to ask him today.

Researcher: So, you have gone to him twice, was it during classes or after classes?

Isaac: After class.

Researcher: So even after classes, you still have time to see him. So, can you tell us why it is only twice that you have gone to him this semester? Is it because you do not have problems when you are studying?

Isaac: Usually, I don't have the problem but maybe I'm solving a particular question and I get a challenge, I try to understand first. In case I try, and I don't understand, that's when I go to him.

Researcher: Okay, so if you try and you can understand, that's when you don't go to him?

Isaac: Yes, Sir.

Researcher: Let me come to you Albert, so how often do you go to your teacher? Maybe, guidelines, corrections, ideas strategies on your work or your studies?

Albert: I do not remember going to him.

Researcher: So, the whole of this semester you have not been to him at all?

Albert: Personally?

Researcher: Yes, that is what I mean.

Albert: Not really. I don't really have problems. Maybe, if I get something wrong, maybe because I have forgotten or I don't know how to solve it, I don't go to him to show me.

Researcher: I see. So, you do not really go to him, the whole of this semester, whiles Isaac has gone to him twice, Albert, you haven't gone to him at all?

Albert: Yes.

Researcher: So, what he does in class is fine?
Albert: Yes, I would like to but there isn't enough time.

Researcher: In terms of? Because Isaac goes after school.

Albert: I am also at the west so maybe........

Researcher: So, you do not have that time, what if you are solving a problem and you have a difficulty, what do you do since you do not go to him?

Albert: With my friends.........

Researcher: So, you brainstorm with your friends till you get the answer?

Albert: Sometimes, we do not get the answer.

Yaa: Sometimes you solve but you don't get the answer, so you get frustrated, tired and just leave it.

Researcher: So how often do you also go to him?

Yaa: Not often. Last time I went to him, it was after he showed us our test papers and there was this question I didn't understand, and I told him to explain.

Researcher: That is this term?

Yaa: Yes. I usually go to him when I get something wrong, so he explains why I got it wrong.

Researcher: So how often have you gone to him this term?

Yaa: Twice. But usually also in class after he finishes solving something then I ask him if maybe something I learnt is correct so that it will not seem as if I am going to him.

Researcher: So, it means you get most of your information in class.

Yaa: Yes.

Researcher: Okay so you don't really need to go that often, because you understand it in class. Am I summing it up well?

All the three Students: Yes.
Researcher: So, you understand it well. You don't have to go often and when you go sometimes it's either you've gotten something wrong or in your case, you went because there was a problem and you took the book back and he explained to you that what you did was wrong.

Isaac: Yes.

Researcher: Okay.
(Focus group discussion with three high-achieving students, School A, June 2019).

The discussions between the researcher and three low-achieving students at school A is as follows:

Researcher: What if the question that you want to solve is difficult? What do you do?

Abena: Okay, first I try with the steps, if I do not get it; I may go through with someone else.

Researcher: Some of your colleagues?

Abena: Yes. But if I still don't get it, I have to bring it back to the class and try… normally, I will ask him personally.

Researcher: You ask him personally?

Abena: Yes. I'm not really comfortable with asking questions in class so normally I tell someone to ask the question for me. Because the class, you know they are a lot and they make noise.

Researcher: So sometimes you ask somebody to ask the question for you. If the person is not able to ask it and you are still not clear, do you go to him?

Abena: Yes, that is when I go to him, but I actually have an extra classes teacher that I'm able to go to more often than my Chemistry teacher.

Researcher: The extra classes teacher teaches you chemistry?
Abena: Yes.

Researcher: Okay, let me come to you Ann. So, what do you also do with guidelines or suggestions on how to solve difficult questions or similar questions?

Ann: Usually, most of the questions have similarities no matter how difficult it is. If I don't get it, there are other students in my class that I can approach. When I don't get a better explanation from them, I can ask during the next lesson.

Researcher: I see you ask questions in class.

Ann: I ask him that this, I don't get it. Sometimes everybody else will get it but then I will not. I still want to insist to get it.

Researcher: What about the rest of your colleagues. Don't they make noise about it?

Ann: That? I don't care. I am the one going home with the grades not them so if…

Researcher: Okay let me come to you then, Abena. So, what do you also do with suggestions or guidelines about how to solve similar or difficult problems?

Abena: Like what they all said, I put it down and when it's difficult, I bring it to Sir then usually, he writes it on the board for everyone to solve it or he will solve it for us so that everyone would benefit from it.

Researcher: But you said when it is difficult you bring it to sir as in alone? You come to see him alone, I mean privately after school?

Abena: No, I tell him that this is the question I don't understand then usually, he writes it on the board.

Researcher: So, for the rest to.... Okay. Now let me ask you then Chris. How often do you receive comments or suggestions or guidelines from your chemistry teacher?

Chris: I won't say every time, but I won't say never too because it's in between. Because it's like we are many and he can't just look at everyone's own. Maybe when he is going through, the one that can catch his eye and he sees something wrong about it he tells you.

Researcher: So, for instance let me ask you, during this semester, how often have you had comments or corrections from your teacher, personally?

Chris: Like one-on- one?

Researcher: Yes. That's why I'm saying how often you have received that, because that one is personal. Even though it's the whole class, he is going around so what he is giving is a personal one.

Chris: I can't really count but it's a lot. Maybe six times.

Researcher: Now let me come to Abena. How often do you get those comments and corrections, like the question I asked him?

Abena: I will say maybe eight. I don't really count it, because usually I'm paying attention to my work and what he is saying.

Researcher: Okay, I am on you now Ann, how often do you get?

Ann: Approximately like 15.

Researcher: 15 times this term?

Ann: Yes. Because I think each time, we have an exercise, even when he doesn't stop at me, I call him because I want to be sure I'm on track.

Researcher: So how often do you call him?
Ann: If he is going around and he pass by me, then I call him.

Researcher: So do you also may be like he's made a comment or maybe you've answered a question or he has given you an exercise and your marks is low, do you go and see him after class sometimes?

Ann: Not necessarily after class, because mostly when we write test and the papers are marked and brought to us, we solve it together on the board. If you have any problem, you inform him. Sometimes also I go to him when I don't understand why this is wrong then he explains.

Researcher: So, you go to him, not necessarily after school but after the class.

Ann: Yes.

Researcher: What about you?

Chris: The same thing.

Researcher: But you said you do not ask questions at all. You let some people ask for you.

Chris: Yes, but if I still have a problem, then I ask him directly after class.

Researcher: Directly after the class? You follow him and ask him?

Chris: Yes.

Researcher: Abena, I will come back to you. You said that most times during exercise in class, he comes to you. About eight times this semester. Do you also go to him?

Abena: Yes, especially when it is practical, but not all the time.

Researcher: But most times during practical sessions. So why do you go to him?

Abena: To know if what I have done is correct because sometimes the questions, they will be like: it has to change from red to orange.

Researcher: What about you?

Chris: I ask my class colleagues.

Researcher: So, you mostly you ask your colleagues, those you think they understand then they explain to you. But when they explain to you, do you understand?

Chris: Yes.

(**Focus group discussion with three low-achieving students, School A, June 2019**).

The second set of focus group discussions was at school C on the 14th of June 2019. It was in two groups. The first group was between the researcher and 3 high-achieving students. This was followed by that between the researcher and 3 low-achieving students. The discussion between the researcher and three high-achieving students is as follows:

Researcher: What about suggestions or guidelines about how to solve similar or difficult questions? What about that? What do you do with it? Suggestions or guidelines.

Godfred: Okay when we are solving exercise in class, then I do it the wrong way, and he gives me guidelines: 'oh this is how we do this, this is how we do this' so maybe when solving a past question or any question at all, then I will remember, oh he said, 'we should do this, we should do this' so that I will apply it when solving the past questions.

Researcher: In giving you the guidelines, does he come to you personally or what he says to the whole class?

Godfred: To the whole class and when I also go to him personally.

Researcher: How often do you go to him personally?

Godfred: Once in a while.

Researcher: So, for instance, this term, how many times have you gone to him?

Godfred: This term, once, after a class.

Researcher: Okay, but apart from that you use the corrections that he gives in class.

Godfred: Yes, sir.

Researcher: So, let me come to you Mary. So how often do you receive corrections or comments or suggestions or guidelines, that's feedback, how often do you receive that?

Mary: Not often.

Researcher: Not often?

Mary: Yeah. I do not answer questions in class.

Researcher: It is because you don't answer questions in class. So, you do not receive feedback from your teacher, you don't receive it often?

Mary: Yes, please.

Researcher: What about if he gives exercises and he move around? Because sometimes I see him move around whiles you people are doing exercises….what about that time? Doesn't he come to you?

Mary: Yes, he comes and that is when I get comments or guidelines from him.

Researcher: Is there a reason why you don't answer questions in class?

Mary: Sir please in my class, if a teacher should ask a question and you give a wrong answer or something, they start to laugh at you.

Researcher: The main question is that, how often do you receive comments, suggestion or guidelines from your teacher?

Stefan: Anytime he gives us exercise and maybe in class, like what we did the last time, the group work. In a group, then one person presents it on the board so if there is any correction he makes it in our exercise books, then he writes it: "this that, this that" or general test, maybe in answering a question, if I don't answer it correct then he will say "oh this is how it is done"

Researcher: But what about if he gives exercises in class because Mary was saying sometimes when he gives exercise, and I have seen it. Sometimes when he gives exercise, he goes around making comments. What about that also?

Stefan: That one, I don't normally receive comments.

Researcher: You don't normally receive comments.

Researcher: What about you when he gives exercise and he is going around?

Godfred: Sometimes. I make small mistakes, give different answers, so he sees the mistake I have done, and he will tell me 'do this right'.

Researcher: Okay, so it means, can we then say that you get a lot of these comments and corrections and suggestions very often.

Stefan: Not that often. Sir like when he comes to class to teach only, you will not receive any comment but anytime he tests us that is when the comments…

Researcher: So, the comments normally come after your tests.

All the three Students: Yes.

Researcher: So, it means that whiles he is teaching sometimes he can ask somebody to come to the board and he gives you comments after that?

All the three Students: Yes.

Researcher: But the major ones are the ones that he gives you after exercises and after tests.

All the three Students: Yes.

Researcher: Do you also go to your chemistry teacher for corrections, comments, suggestions and guidelines on your work?

Mary: Yes.

Researcher: How often?

Mary: Not often, but this semester, when I went to him, it was for physics not chemistry.

Researcher: So, it means that when it comes to chemistry, this semester you have not really gone to him for any feedback apart from the one that he gives in class?

Mary: Yes.

Researcher: Do you also go to him for corrections? Apart from what happens in class.

Godfred: I have not gone to him, because if he teaches and he corrects all our mistakes, that's all I need to go and solve all the past questions.

Researcher: So, you are fine. What about you? Stefan

Stefan: That is just after the class when he is leaving then I try to …
Researcher: … so how often do you do that after the class? This semester, have you done that?

Stefan: Just once. That was at the beginning of the term and it was on acids, bases and salts.

Researcher: Okay, fine.

Researcher: Why do you sometimes go to him for feedback?

Godfred: So when you are in the class, there are many people so maybe............but when I go to him personally, as for that one, he can take his time and explain it to me so that I can understand it easily.

Researcher: Okay, so that is why you go to him.

Godfred: That is why.

Researcher: What about you Stefan?

Stefan: Sir this semester, I've not……. last semester, I think only once.

Researcher: And why did you go to him last semester only once?
Stefan: Because if it was in the class, like the question I was asking, it's pertaining to the topic but I wanted to ask a particular question which I think would not be helpful to the class so that one is personal.

Researcher: So, you go to him personally. So, it means that apart from the ones that when you are solving questions, it comes to… and he makes comments, you go to him personally so that he will help you to understand, because sometimes it's not appropriate to say it in class?

Stefan: Yes.

Researcher: Mary what about you?

Mary: (sighs). Sir, please you see in the class like this, we have people who have learned ahead so if you should ask a question that people have already learnt, they will see it to be some kind of, you don't learn or something so, I prefer to ask him one- on -one for explanation.

Researcher: Okay, so when you ask in class, they think that maybe you are drawing the class back?

Mary: Yes.

Researcher: Do they make noise when you ask?

Mary: Yes.

Researcher: Ah, okay. So, they make noise when you ask. That is sometimes a little intimidating.

Mary: Yes.

Researcher: So, then you prefer to see him privately? And I said that this term how often… most times when you go to him, it is on physics not chemistry?

Mary: Yes, please.

Researcher: So as for chemistry, you have not… so it means with chemistry, you are fine with the feedback you get in class.

Mary: Yes.

(Focus group discussion with three high-achieving students, School C, June 2019).

The discussions between the researcher and the low-achieving students at school C is as follows:

Researcher: How often do you go and show your work to him?

Georgina: Sometimes he will tell me the right thing but, he will not come around so when he writes on the board then............

Researcher: But what if you are still not very clear?

Georgina: I ask questions in the class.

Researcher: Okay, but how often do you go to him?

Georgina: I don't go to him except personally.

Researcher: What about you, Melody, how often do you go to him?

Melody: Sir, I don't go to him.

Researcher: So, Melody you are also saying the same?

Melody: Yes, Sir.

Researcher: How often does he come to you in class?

Melody: Sometimes he comes and checks whether what you are doing is right or wrong but not often.

Researcher: Okay, for instance, let us say the whole of this week, has he come to check?

Melody: Yes.

Researcher: He came to check yours this week? Michael

Michael: Yes

Researcher: How often?

Michael: Once.

Researcher: What about you Georgina?

Georgina: Yes, when we were doing the group discussion, he came to us.

Researcher: The group discussion, did he come to your group Melody?

Melody: He came there but, he did not come to me personally.

Researcher: And you?

Michael: Yes, he said what we were doing, we should do it one by one on our own then after that..............so, I was doing my own then he came.

Researcher: So, he came to you last week and this week.

All the three Students: Yes

Researcher: So, he comes often, and sometimes not often?

All the three Students: Yes.

Researcher: Now the point is how often you also ask questions in class.

Georgina: If I cannot ask a question then my other colleague asks.

Researcher: So, what if your other colleague does not ask?

Georgina: Then I ask myself.

Researcher: So, are you confident enough to ask in class if you do not understand?

Georgina: Yes.

Researcher: What about you? Michael

Michael: Sir as for me, I don't ask questions I class.

Researcher: Any reason?
Michael: Sometimes if I don't get it, I go to my friends so that they will teach me.

Researcher: But you do not ask?

Michael: Sir sometimes they ask so that I will know…

Researcher: One of your friends that I spoke to, Mary told me that she will not ask because in the class, sometimes they will intimidate you.

Michael: Yes.

Researcher: They will say that you are taking them back.

Michael: Yes, that one is true.

Georgina: As for me, I don't listen to them. If I don't understand but the class said what don't you understand, I don't listen to them.

Researcher: So, you ignore them and ask?

Georgina: Yes.

Researcher: Melody and Michael, how often then do you go to your teacher after the class assuming you do not understand, and you don't ask like Georgina?

Michael: I do not go. I ask my friends.

Researcher: …so you ask your friends to teach you

Michael: and I understand.

Researcher: What about you? You also do not go to the teacher, so, what do you do?

Melody: Ask my friends.

Researcher: So, it means you don't go, and you don't ask in class either.

Melody: Yes, Sir.

(Focus group discussion with three low-achieving students, School C, June 2019).

The third set of focus group discussions was at school B on the 25th of June 2019. This was also in two groups, first between the researcher and three high-achieving students followed by that between the researcher and the three low-achieving students. The discussion between the researcher and three high-achieving students is as follows:

> **Researcher**: Nana Yaa, let me ask you, do you sometimes go to your chemistry teacher for corrections or comments or even suggestions or guidelines? On your own, I mean apart from class, do you go to your teacher for corrections or comments?
>
> **Nana Yaa**: No.
>
> **Researcher**: Why? Are you okay with what happens in class?
>
> **Nana Yaa**: Yes.
>
> **Researcher**: Let me ask you then, Ben, do you sometimes go to your teacher for corrections or comments?
>
> **Benjamin**: I have been to sir about like twice or so. I was learning a particular topic I think states of matter then there were certain things about allotropy which I was not writing it right and I went to him then he explained to me.
>
> **Researcher**: So, you have been to him twice this term?
>
> **Benjamin**: Twice. I visited him once last semester and once this semester.
>
> **Researcher**: When you go and see him, is it after class, at break or after school?
>
> **Benjamin**: At break.
>
> **Researcher**: And the reason why you see him is that maybe you are not sure about something.

Benjamin: Maybe I don't want to confuse myself so…

Researcher: What about you Francis?

Francis: I don't.

Researcher: Why?

Francis: When I'm usually faced with a problem, I try and solve it on my own. If I don't understand it, I will check online, I will do everything within my means to get it so…

Researcher: What if you check online, you do everything, and you still don't get it?

Francis: Then I will ask my father.

Researcher: Your father? Is your father a teacher?

Francis: Yes, a science teacher.

Researcher: So that is why you do not go to your Chemistry teacher for corrections or comments?

Francis: Yes.

Researcher: Nana Yaa, you do not go to him at all even if you do not understand something.

Nana Yaa: I go to the 'net'.

Researcher: What about you Ben?

Benjamin: I have an extra classes teacher.

Researcher: So, you are comfortable with the extra classes teacher.

Benjamin: Yes.

Researcher: How often also do you receive corrections or comments, or suggestions or guidelines from your teacher?

Francis: For me, he normally corrects me.

Researcher: How often? Is it every class, every two classes, is it every three classes?

Francis: This term all the topics we have done, he has corrected me on most of the mistakes I made.

Researcher: Is it when you answered questions in class or when he gives you class exercise?

Francis: When I answer question in class. Maybe, I omit something then he will correct me that 'you've left out this or that'.

Researcher: Do you answer questions in class every time?

Francis: Yes, I always try and answer questions.

Researcher: Of course, I have noticed that. So, it means that most times, almost every class.

Francis: Yes, Sir.

Researcher: When he gives you assignments and you don't get the right answer............

Francis: We will do corrections.

Nana Yaa: Maybe Francis had it correct, then I will go for his book, look at where I made the mistakes and do the corrections.

Researcher: So, it means that if I know that Francis had that part correct, then I go to him

Nana Yaa: Then make corrections.

Researcher: So basically, you depend on your friends to do the corrections.

All the three Students: Yes.

(Focus group discussion with three high-achieving students, School B, June 2019)

The discussions between the researcher and three low-achieving students in school B is as follows:

Researcher: So, you normally depend on your friends for…to be sure about if it's correct?

Magdalene: Yes.

Researcher: After your friends have spoken to you, do you go back to the teacher during class or after class?

Magdalene: After class, sometimes, we have time for library, those times, our leisure times.

Researcher: How often do you also go to your teacher for these explanations or corrections?

Firdaus: As for me I don't go to him.

Researcher: Why? Is there a reason?

Firdaus: My friends, I go to the person that understands. Sometimes we stay in class after closing and study. Francis will put us together and teach us.

Researcher: So, it means you benefit more from your friend than your teacher.

Firdaus: Yes.

Researcher: Do you agree with him?

Kenneth: Yes, I agree.

Researcher: So, you prefer your friends, all of you prefer your friends.

All the three Students: Yes.

Researcher: If you do not understand, you do not ask the question in class?

Kenneth: Sometimes I ask.

Researcher: I see. So basically, your difficulty then is understanding.

All the three Students: Yes.

Researcher: Because you do not understand then you cannot answer any question. So whatever comment he makes after that is not helpful unless your friends help you after school.

All the three Students: Yes.

Researcher: That is, it. Am I capturing what you are saying?

All the three Students: Yes.

Researcher: Sometimes do you let your friends ask the questions for you? Because some students said that if they do not understand they let their friends ask for them.

Magdalene: Yes, sometimes someone feels shy to stand up and talk in the class so he will ask his friend that 'oh ask sir that this or that'.

Firdaus: Sir, maybe too our friends are also part of it because if you want to answer a question and then they see you to be a bad student… if you stand up to answer, they will start to laugh at you.

All the three Students: They would say that what you are coming to say is wrong so sit down.

Researcher: They intimidate you.

All the three Students: Yes.

Researcher: When your Chemistry teacher gives you work and he goes around inspecting, does he come near you?

All the three Students: Yes.

Researcher: If he comes around and you are making mistakes, does he correct you?

All the three Students: Yes, he will correct you. Also, we would all solve it on the board together.

Researcher: How often does he come to check your work?

Kenneth: Sometimes when he gives us class work, and we are done with the exercise the class prefect will bring it to him.

Firdaus: If sir is marking like this and he sees that this work you do not understand; he will call you in private for you to…

Researcher: So, when he is marking then he will call you.

Magdalene: He will ask somebody to call you then he will teach you the mistakes you made.

Researcher: How many times has he done that this semester?

Magdalene: Three times.

Researcher: What about you Firdaus?

Firdaus: Me, only once.

Researcher: What about you Kenneth?

Kenneth: He did not even call me.

Researcher: He did not call you when he was marking?

Kenneth: Yes.

Researcher: So, you, three times, then once, then none. But you all said also that you do not go to your teacher, you prefer to go to your friends.

All the three Students: Yes.

Discussion on why high-achieving students seek feedback, whilst low-achieving students do not

Research question 5 sought to find out why high-achieving students seek feedback, whilst low-achieving students do not. High-achieving students can be distinguished from low achievers by their use of feedback from their teachers and peers. While high-achieving students actively seek and use feedback, low-achieving students do not (Gamlem & Smith, 2013; Havnes et al., 2012). Two themes emerged from analysis of the focus group discussions; these are the classroom environment and peer feedback.

Both high and low achievers do not find the classroom environment conducive enough to seek feedback from their Chemistry Teachers during lessons. Mary, a high achiever in school C stated, '*Sir, please you see in the class like this, we have people who have learned ahead so if you should ask a question that people have already learnt, they will see it to be some kind of, you don't learn or something so, I prefer to ask him one- on -one for explanation.*' Stefan and Godfred who are also high achievers in school C supported the assertion by Mary. Godfred stated, '*So when you are in the class, there are many people so maybe............but when I go to him personally, as for that one, he can take his time and explain it to me so that I can understand it easily.*' Statements by the following students also depict the classroom environment. Abena affirmed, '*Yes. I'm not really comfortable with asking questions in class so normally I tell someone to ask the question for me. Because the class, you know they are a lot and they make noise.*' Abena and Chris are low achievers in school A; Chris also stated, '*Yes, but if I still have a problem, then I ask him directly after class.*' Micheal and Magdalene are low achievers in schools' C and B respectively. Micheal stated, '*Sir as for me, I don't ask questions I class.*' Whilst Magdalene affirmed, '*Yes, sometimes someone feels shy to stand up and talk in the class so he will ask his friend that 'oh ask sir that this or that'.*'

In spite of the classroom environment, Ann, a low achiever in school A and Georgina, a low achiever in school C will ignore the noise and still ask questions, seeking feedback from their Chemistry Teachers. Ann stated that, '*I ask him that this, I don't get it. Sometimes everybody else will get it but then I will not. I still want to insist to get it.*' When asked about the noise from her classmates she declared, '*That? I don't care.*' Georgina stated, '*I ask questions in the class.*' And further elaborated during the discussions that, '*As for me, I don't listen to them. If I don't understand but the class said what don't you understand, I don't listen to them.*' Both high achievers and low achievers use feedback their Chemistry teachers give them during lessons, especially when they are given exercises and their Chemistry teachers go about inspecting their work and making comments and corrections. However, some students in both groups prefer to contact their Chemistry teachers after class for feedback.

According to Chin and Osborne (2008), students' questions play an important role in the learning process, but, as grade level increases, students ask fewer questions probably because they do not want to call attention to themselves, because of intolerance and subtle disapproving responses of classmates. This assertion explains why both groups of students do not ask questions in class.

Students usually ask questions to get additional information or clarification of ideas. When students are actively engaged in classroom discussions, it helps them to understand what is being studied and trains them to become independent learners (Kaya, 2014). The questions that students ask in class are a rich source of evidence to the teacher about their thinking and level of understanding. The teacher then acts on this information to provide apposite feedback to the students (Chin & Osborne, 2008). Therefore, when students are unable or unwilling to ask questions, it will affect the level of feedback they receive from their teachers. This necessitates teachers creating a suitable ambiance that encourages their students to ask questions and share ideas whether they are confident or not (Black et al., 2006).

Both high and low achieving students prefer peer feedback. Nana Yaa, a high achiever in school B stated, *'maybe Francis had it correct, then I will go for his book, look at where I made the mistakes and do the corrections'*. Albert, a high achiever in school A, when he has difficulties solving questions prefers discussing it with his friends instead of contacting his Chemistry teacher. He stated, '*Okay, in that case, most of the time, I don't get some of them correct so I try, the person sitting next to me, to compare and sometimes he shows me the way to do it.*' Statements by Abena and Chris, both low achievers in school A support this assertion. Abena stated, '*Okay, first I try with the steps, if I do not get it; I may go through with someone else.*' Whilst Chris affirmed, '*I ask my class colleagues.*' Michael and Firdaus who are also low achievers in schools C and B respectfully all prefer peer feedback. Firdaus stated, '*My friends, I go to the person that understands. Sometimes we stay in class after closing and study. Francis will put us together and teach us.*' Michael also stated, '*I do not go. I ask my friends.*'

Two themes emerged from analysis of the focus group discussions. These are the classroom environment and peer feedback. Both high and low achieving students respond the in the same manner with respect to these two themes. For that reason, the results from this study do not support the assertion by Gamlem and Smith (2013), Havnes et al., (2012), that high-achieving students can be distinguished from low-achieving students by the way they seek and use feedback.

CHAPTER FIVE

SUMMARY, CONCLSIONS AND RECOMMENDATIONS

This chapter summarises the study, key findings and draws conclusion of the study. Furthermore, it gives recommendations and suggestion for further studies.

Overview of the study

The study used the case study approach to explore feedback practices among Chemistry teachers in selected senior high schools in Greater Accra. It also looked into how their students' perceived and used teacher feedback. The five research questions below guided the study.

1. What are students' perception of the usefulness of feedback that they receive from their Chemistry teachers?
2. What is the level of feedback that is prominent in Chemistry teachers' feedback practices in SHS classrooms in Ghana?
3. Which level of feedback from Chemistry teachers do their students find useful?
4. How do students use feedback from their Chemistry teachers?
5. Why do high-achieving students seek feedback, whilst low-achieving students do not?

The study used extensive observation of teachers and their students in the classroom setting as well as inspection of students' marked assignments, tests and practical lessons to determine the level of feedback that is prominent in Chemistry teachers' feedback to their students. This extensive observation helped to classify levels of feedback and identified which level of feedback practice is prominent in Chemistry classrooms. Three instruments were also used to gain a holistic view of the study. The first instrument used was an open-ended questionnaire with six items that explored students' perception of the usefulness of the feedback they received from their Chemistry teacher, the level of feedback student found useful and how students used feedback to improve learning. The second and the third instruments comprised four two-tier items with four options for students to choose and give reasons for their choice. It was to find out students' perception of the usefulness of Chemistry teacher feedback and which level of Chemistry teacher feedback student found useful, respectively.

Key Findings

1. It was found that majority of students find Chemistry teacher feedback useful. Those who find teacher feedback useful are likely to use feedback to improve learning. However, those who find feedback not useful are not only unlikely to use teacher feedback, but also are more concerned with using other means to pass examinations rather than improving in understanding of the topics taught to them.
2. The study found four levels of feedback among teacher feedback practices. These are self-level, task level, process level and self-regulatory level feedback. All the four levels of feedback were identified in classroom interactions, but self-regulatory feedback was absent in students' assignments, tests and practical work. The prominent level of feedback, however, was identified as task level feedback. Though Hattie and others

assert that self-level feedback is the least effective to enhance achievement (Hattie, 2009 & 2012; Hattie & Timperley, 2007), the current study showed that self-level feedback is useful and motivate students to work hard to improve learning.

3. Majority of the respondents found all the four levels of feedback as useful. However, the respondents ranked process level, self-regulatory level, task level and self-level feedback in decreasing order of usefulness.

4. It was found that students used teacher feedback in at least four major ways. Firstly, students use feedback to synthesise easier strategy to improve performance. Students compare teacher feedback to other standard documents to help them map out strategies to solve problems. The second major way is that students use feedback to analyse mistakes and apply comments provided to enhance student self-efficacy and motivation. Thirdly, students use feedback as scaffold. Students use teacher feedback to learn how to solve problems. They try questions or problems and when they have issues, they go back to study the feedback further and try to improve on their learning. Lastly, students use feedback to help them to engage in self-evaluation of their ability and self-regulation of their learning behaviour. The teacher feedback serves as mirror which students use to reflect the level of learning as well as understanding. Becoming aware of the level of understanding, they then adjust their learning behaviour. Students' state of metacognition helps them to self-regulate and independently make effort to improve learning.

5. The study revealed that high achievers and low achievers respond the same way to feedback from their teachers and peers. Two themes emerged from analysis of the focus group discussions; these are the classroom environment and peer feedback. Both high and low achieving students respond the in the same manner with respect to these two themes. For that reason, the participants who took part in this study do not support the assertion that high-achieving students can be distinguished from low-achieving students by the way they seek and use feedback.

Conclusions

The study has successfully executed and answered the five questions it sought to provide answers to. The revelation that majority of students find teacher feedback useful is encouraging and shows that when teachers provide quality feedback, students are likely to progress and improve on performance. This assertion is anchored in the further evidence in the study that indicate that students who find teacher feedback useful are likely to use feedback to improve learning but those who find feedback not useful are likely not to use teacher feedback. These findings imply that teachers should ensure that all students are aware of the usefulness of feedback in order to divert students' overly concern of passing examinations and rather focus on development of lifelong skills and activities that train them to become independent learners.

The four levels of feedback among chemistry teacher feedback practices (self-level, task level, process level and self-regulatory level feedback) identified in the classroom interactions collaborate what is established in literature. However, the absence of self-regulatory level feedback found in students' assignments, tests and practical work suggests that chemistry students are not challenged enough in these activities to be self-dependent learners who are aware of their learning environment with the ability to succeed beyond just passing examinations. The revelation that task level feedback dominate the level of feedback in Chemistry teachers' feedback practices confirms other works that show concern that Chemistry teachers overemphasise in practices that assist students to engage in memorisation and recalling of scientific facts for the purpose of passing examination. The implication of these practices includes failure on the part of students to develop skills like inferring, classifying, experimentation and evaluations which enable one to identify and solve scientific problems. Though research by Hattie and others indicate that self-level feedback is the least effective to enhance achievement, the finding from this study showed that self-level feedback is a major level feedback which motivates students to work hard to improve learning.

Ironically, the over emphasis on task level feedback in teacher – student interactions do not correspond to students' attachment of usefulness to task level feedback. Though, students had less encounters with process level and self-regulatory feedback than they had with task level feedback, they rightly rated both process and self-regulatory feedback as more useful feedback practices. This observation shows that majority of students are likely to be receptive to these higher feedback practices. The study therefore contains evidence that should motivate teachers to strategize to progress from task level feedback to higher level process and self-regulatory feedback for effective performance and achievement.

The process and self-regulatory level feedback seem to be the right feedback practice needed to make the four major ways identified as how students apply feedback provided to them effective. For example, to use feedback to synthesize learning strategies, one needs to compare ideas. The ability to relate ideas is nurtured in the provision of process level feedback and for students to become aware of their learning in the state of metacognition where students are able to self-evaluate and self-regulate learning behaviour, self-regulatory feedback practice is key to develop such approach to learning.

The study collaborates, confirms as well as provides alternative views thereby making significant contribution to literature. For example, in the quest to answer the research question 5, the study not only confirms literature evidence that low achieving students do not often seek feedback for fear of intolerant and disparaging comments, but it also provides evidence that this fear is not only inherent to low achievers but also ingrain to high achievers. The study therefore suggests that both low and high achievers have similar behaviour in seeking for teacher feedback in Chemistry classrooms. This finding is one of the major contributions this study is making to science education literature. The use of case study approach to collect data for the study enabled a natural and unmanipulated data which depicts what actually pertains in Ghanaian Chemistry classroom environment to be investigated.

Recommendations

The following are recommended based on the findings in the study:

1. Since students who find teacher feedback useful are likely to use it to improve learning while those who find feedback not useful are unlikely to use feedback practice, it is recommended that teachers of the studied schools make effort to ensure all students are exposed to the usefulness of feedback. For example, students should be presented with evidence of past students who adhered to feedback practices and the effect on their performance and vice versa.
2. The study shows that self-regulatory feedback was absent in marked assignments, tests and practical work of students, and task level feedback dominates in feedback practices. It is recommended that teachers of the studied schools should take time to progress feedback from task level to self-regulatory level via process level rather than over emphasizing task level feedback. Teachers should also plan assignments, tests and practical work well to ensure that students are engaged in self-regulatory feedback.
3. The study found that though students valued self-regulatory and process level feedback than task level feedback, students encounter far less exposures with the higher feedback levels. The National Teaching Council should ensure that teachers are equipped with strategies to give these higher feedback levels via workshops.
4. All the four major ways students use teacher feedback seem quite useful to improve performance. National Teaching Council should therefore ensure

that teachers are aware of these ways and trained to enhance students' experiences of these approaches to learning.

5. Teachers should ensure that their approach to teaching boost student self-confidence and freedom to express one-self without fear of intimidation. This recommendation is targeted to eliminate or limit the evidence that both high and low achievers usually fail to seek teacher feedback.

Suggestion for Further Studies

Throughout the study, how to improve teacher feedback practices in Ghanaian Chemistry classrooms came up. The following research areas are suggested for further studies.

1. More quantitative studies should be pursued in order to generalise students' perception of teacher feedback.
2. There is the need for teachers to be exposed to empirical ways to improve teacher feedback. Developmental research is therefore needed to identify effective feedback practices that improve performance of students.
3. Research into how Ghanaian Chemistry teachers perceive and give self-regulatory feedback in the classroom should be carried out.

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APPENDICES

APPENDIX A

STUDENT QUESTIONNAIRE - GENERAL

This questionnaire is part of a university study. For its success, it is important that you answer all the questions. Please write your answers with a pen.

Thank you for your cooperation!

Name:.. ...... **Form:**....................

Age:................

Date:................................ **School:**................................

1. Please give example(s) of corrections/comments about your work; or suggestions/guidelines on how to solve questions (feedback) from your Chemistry teacher recently. Did you find it helpful?

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2. Do you find corrections/comments/suggestions/guidelines (feedback) from your chemistry teacher useful for your work and studies? Please explain.

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3. What do you find very useful (appreciate/value) about corrections/ comments/suggestions (feedback) from your chemistry teacher on your work and why?

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4. What do you find not useful (not valuable) about comments/suggestions (feedback) from your chemistry teacher on your work and why?

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5. How do you use comments/suggestions (feedback) from your chemistry teacher for improving on your performance (or work)? Please give example(s).

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6. How do you use comments/suggestions (feedback) from your chemistry teacher when studying? Please give example(s).

APPENDIX B

STUDENT QUESTIONNAIRE - PERCEPTION

Name:.. ...... **Form:**....................

Age:................

Date:................................ **School:**................................

Instructions:
This questionnaire contains statements about corrections/comments about your work or suggestions/ guidelines on how to solve questions (feedback) from your Chemistry teacher and how it affects your studies.

Please tick the appropriate box on the four-point scale:

- ☐ Completely Disagree
- ☐ Disagree
- ☐ Agree
- ☐ Completely Agree

		Completely Disagree	Disagree	Agree	Completely Agree
1	Corrections or comments (feedback) from my Chemistry teacher about my work (in class or exercise book) help me to see where I can improve.	☐	☐	☐	☐

Please explain the reason(s) for your choice. You can use examples.

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2 Suggestions or guidelines (feedback) from my Chemistry teacher about how to solve similar or difficult questions (in class or exercise book) help me to see where I can improve. ☐ ☐ ☐ ☐

Please explain the reason(s) for your choice. You can use examples.

3 Corrections or comments (feedback) from my Chemistry teacher about my work show me how much I have studied. ☐ ☐ ☐ ☐

Please explain the reason(s) for your choice. You can use examples.

4 When solving questions, suggestions or guidelines (feedback) from my Chemistry teacher show me if I'm better prepared. ☐ ☐ ☐ ☐

Please explain the reason(s) for your choice. You can use examples.

APPENDIX C

STUDENT QUESTIONNAIRE – FEEDBACK LEVELS

Name:.. Form:....................

Age:................

Date:................................ School:................................

Instructions:

The following may be statements from your Chemistry teacher. Use the scale to indicate how useful you find it when studying.

Please tick the appropriate box on the four-point scale:

- ☐ Not Useful
- ☐ Fairly Useful
- ☐ Useful
- ☐ Very Useful

		Not Useful	Fairly Useful	Useful	Very Useful
1	When my Chemistry teacher says my answer is correct or wrong.	☐	☐	☐	☐

Please explain the reason(s) for your choice. You can use examples.

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2	When my Chemistry teacher shows me how (steps to follow) to correct my mistakes	☐	☐	☐	☐

Please explain the reason(s) for your choice. You can use examples.

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3 When my Chemistry teacher gives suggestions/ guidelines /strategies on how to solve questions (or study) on my own. ☐ ☐ ☐ ☐

Please explain the reason(s) for your choice. You can use examples.

4 When my Chemistry teacher says well done (or very good) or lets the class clap for me. ☐ ☐ ☐ ☐

Please explain the reason(s) for your choice. You can use examples.