IMPROVING TEACHERS' USE OF FORMATIVE ASSESSMENT IN SCHOOL BASED ASSESSMENT.

Research Project

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NIRMALA RAMNARINE

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School of Education

Faculty of Humanities and Education

St Augustine Campus

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Abstract

This study used Heritage (2007) theoretical framework for formative assessment to plan and implement a three months professional development workshop for three teachers. Teachers and students perceptions on the use of formative assessment in School Based Assessment activities were collected during a concurrent mixed methods action research. Formative assessment is important to improve teaching and learning. It permits teachers to help students evaluate their progress, give them explicit, descriptive feedback, show students where they are and where they need to be. The professional development exercise improved teachers use of formative assessment and increased students' performance within their school based assessment. The perceptions of teachers indicated they have feelings of uncertainty and lacked the skill to give effective feedback. They suggested insufficient time, large classes and lack of resources hindered their implementation.

Keywords: formative assessment, professional development workshop

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CHAPTER 1- Introduction

External examinations are necessary as a quality assurance mechanism as it supplies important feedback on curriculum effectiveness and teaching (Heyneman, 2008). These examinations encourage students to master the curriculum materials and ensuring they are up to the specified standards in order to safeguard their success in the external examinations (Schiller & Muller, 2000). Teachers too can be evaluated based on their students' development using external assessments, their attitudes and expectations should be secondary to the incentives to coach students to learn the required material. If high-stakes testing are designed and done properly, it may increase learning, teaching, and opportunities for further education (Schiller & Muller, 2000).

External examinations have been historically administered in the Caribbean education system. Today, the majority of the external secondary school examinations in Trinidad and Tobago and the rest of the Anglophone Caribbean are administered and regulated by a regional examination agency, the Caribbean Examinations Council (CXC). CXC was established in 1979 to replace the British oriented system of examinations and to provide comparable but relevant examinations to a Caribbean secondary school population. They triggered the current examination-oriented culture among students as their performance is more highly valued as it is related to perceived and actual opportunities as well as increased chances for social mobility (De Lisle, 2009). Students successful in the external examinations are awarded government scholarships and benefits by gaining entry into many prestigious universities outside of the Caribbean region.

CXC examinations assess various skills to accommodate students of different abilities using multimodal assessment (De Lisle, 2009). In particular, performance assessments have been used in the practical and school-based assessments. 52 of the 54 CSEC subjects have an internal school- based assessment component hence teachers have a great responsibility in ensuring these assessments are credible. The School-Based Assessment manual for principals, Caribbean Secondary Education Certificate, CSEC (2013) states that

> Internal Assessment …is envisioned to *assess certain knowledge, skills and attitudes* that are associated with the subjects and are not easily assessed in external examinations. …*The assessment facilitates feedback at various stages and helps build the self-confidence of candidates* as they proceed with their studies. School-Based Assessment also *facilitates the development of the critical skills and abilities* emphasized by the subject and enhance the validity of the examination on which candidate performance is reported.

In this study, the focus is placed on teachers and developing their skills in assessment to ensure they meet the criteria stated by CXC.

Background to Problem

International Context

In 2005, teachers implementing SBA in Hong Kong noted the challenges of insufficient resource supplies and training and the amount of work involved in planning and assessing practical activities for students. Their concerns also included the influence of the mark scheme on student learning and the objectivity of SBA (Yan Yip & Cheung, 2005). Individuals joining the teaching service for the first time may not have the skills and knowledge to effectively

practise school-based formative assessment while others may be unwilling to change their beliefs and practices until they see the positive outcomes of formative assessment. Therefore, current teachers in the school require the patience and professional knowledge to work with the new teachers to ensure they understand the concepts of formative assessment. (Lo, 2006)

An important concern raised is the seemingly strained relationship between formative and the high visibility summative tests (CERI, 2005). This kind of summative assessments serves to make schools liable for student accomplishment and drives what takes place in the classrooms. At times teachers may have the fear of failure (for example bad results disappointing students, parents and administrators) and refuse to employ new methods and techniques in the classroom. Teachers also found it to be difficult to practice formative assessment with the more challenging pupils. Torrance (1995) used evidence from the UK to show how critical the implementation process is and warned against the danger of the new assessment reforms, particularly the essential part of the classroom teacher in facilitating the success of the innovation.

There are research evidence of the problems and inadequacies in the practice of classroom assessment (Black and Wiliam, 1998). Reports from nations such as Canada, France, Belgium and England encountered problems with tests that encourage rote learning, poorly defined standards to support judgements, presentation and quantity of work, no consideration to the assessment practices of other teachers within the same school and insufficient evaluations of the content being assessed. Evidence drawn from Canada showed there were insincerity to classroom assessment and it was alleged to be impractical in their present educational systems. In Scotland there are also concerns about assessment practices and the *Assessment Is for*

Learning initiatives (Hutchinson & Hayward, 2005). According to the Assessment Reform Group it is similarly in the UK as assessment literacy is top on their agenda.

Stiggins (2002) states "Few teachers are prepared to face the challenges of classroom assessment because they have not been given the opportunity to learn to do so" (p. 762). He explains in about 12 states in USA teachers need to show they are competent in assessment as a criterion for teacher license. Although there are policies and programming issues to, one of the main shortcoming to offering a formalised assessment course is the lack of good assessment knowledge. Volante and Fazio (2007) vie, "There is still relatively little research devoted to understanding the assessment literacy of classroom teachers" (p. 750).

The condition in Ireland is in no better shape. A detailed in-career assessment development programme was requested several years ago by the Irish National Teachers' Organisation but there was no response (INTO, 1997). An evaluation of the new primary school curriculum in 1999 highlighted assessment as an area requiring 'significant attention and improvement' (DES Inspectorate, 2005a). The National Council for Curriculum and Assessment's (NCCA) *Primary curriculum review* noted that teachers themselves indicated "a need to increase their knowledge of and competencies in assessment of student progress" and they "requested greater advice on the use of different assessment tools and resources" (NCCA, 2005a).

It is unexpected to know that teachers in the US are no more experienced in classroom assessment than their colleagues elsewhere, considering the importance they place on testing and assessment. An issue that was of great concern for numerous years to this country was the teachers' assessment literacy (Popham, 2004). At one point classroom assessment was referred to

as the ‘stepchild of the measurement community’ because specialists in the field were spending less time on educating teachers on assessments and more time putting together refined paper-and-pencil tests (Stiggins, 2000).

The Role of Formative Assessment in SBA

Assessment can be termed formative only if the students and teachers use its results to enrich student teaching (Black, 1993). Formative assessment is progressively being used while teaching and learning is taking place to provide feedback to students and teachers. This dialogue or feedback is understood as a vital component in the implementation of formative assessment especially when the goal is to support learning (Perrenoud, 1998). It can be used by the teacher and students, to amend their work and increase its standards (Black, 1995). The unique attributes of formative assessment is that it permits student-teacher partnerships during class activities (Newman, Griffin, & Cole, 1989) through which pupils can receive valued feedback.

Regional and Local Context

In the Caribbean region, secondary school science teachers engage in teaching the science subjects Biology, Chemistry, Physics, Integrated Science and Agricultural Science. These subjects are assessed by means of an SBA component and paper and pencil tests at the CSEC (Caribbean Secondary Education Certificate) by the CXC. Students attain marks for the skill they develop and show while carrying out their SBA activities. Teachers often place emphasis on assigning a mark for the specific competence for which the practical activity is planned. They seldom use the opportunity to carry out formative assessment to assist in their teaching. Their personal beliefs can greatly influence their assessment practices. While some

teachers believed in giving students opportunities, regardless of the time taken to master major concepts and skills others felt that this practice was unfair to those who were able to complete their work to the desired standard in less time. Most teachers accept the notion of formative assessment, but they encounter troubles in putting it into their everyday practice and giving up their familiar and comfortable practices. In most cases new teachers do not have the professional understandings about school-based formative assessment, while some other may refuse to accept to change their mind-set of their practice.

CXC has acknowledged teachers as key role players in the assessment of candidates (CXC, 2012). School-based assessment is known in schools across the CXC region and it provides teachers with a say in 20 to 50 % of their students' final results. It was emphasized in an examiner's report that "SBA gives the teachers (as well as parents) the opportunity to see the strengths and weaknesses of their children, and therefore, become an integral part of the teaching-learning process; this is by no means the only opportunity for teachers to contribute to the CXC assessment process" (CXC, 2012).

Justification of the Study

While SBA provides a summative score for the practical skills students develop and demonstrate, it also provides an opportunity for teachers to formatively assess students and to monitor and guide their performance over time. Therefore, in order to improve teaching and learning and to show students where they are and where they need to be, teachers must help students evaluate their progress in the learning process and give them explicit, descriptive feedback specific to the practical activities. From their extensive work with classroom teachers, Black, Harrison, Lee, Marshall, and Wiliam (2004) found that it was more productive for

teachers to implement formative assessments by focusing on one area of change at a time because “wholesale changes can be too risky and demanding” (p. 20). They also discovered that having teachers collaborate with other teachers who attempt similar assessment changes increases the likelihood of success. Other researchers have found that implementing formative assessment that results in improved student achievement is time consuming and requires sustained professional development and support (Black, Harrison, Lee, Marshall, & Wiliam, 2004). This study can therefore, provide teachers with insights about the role and implementation of formative assessment in SBA, and be beneficial to students and teachers of different classes.

Statement of the Problem

Low assessment literacy of teachers and the tension between formative and summative assessment might be two of the factors that can lead to the limited use of formative approach in school based assessment (CERI, 2005). Although teachers might use SBA activities to provide a mark for a skill that is assessed (summative), formative feedback may not be practised. This formative feedback is essential to increase student knowledge, skills, and understanding in some content area or general skill (e.g. problem solving).Black (1993) has stated that assessment can be considered formative only if it results in action by the teacher and students to enhance student learning. Hence, teachers require professional guidance to improve their classroom practice and track students understanding during SBA. This professional guidance for teachers need to be at least 50 hours and related to formative assessment in order to begin to make this innovation part of their practice (Darling-Hammond et al., 2009). Furthermore, according to Black, Harrison, Lee, Marshall, &Wiliam (2004), three years of professional development is generally necessary to bring about broad-based change in teaching practices. Thus, to foster formative assessment and assessment literacy require more than a single workshop. To carry out formative assessment

effectively and consistently, teachers may require substantial in-house support over time. This is because changes in instruction occur slowly and iteratively, and educators need time to familiarise and revise their instructional routines based on new knowledge and understandings (Leahy & Wiliam, 2009).

Therefore, in this action oriented study, an extended in-house professional development intervention was designed to effect a change in both teachers' perception and use of formative assessment in SBA. The professional development workshop was a long term investment that has to be connected to practice and nested in the work of professional learning communities to ensure it effectively improved the teachers' practice (Darling-Hammond et al., 2009). It included training, practice, feedback, and follow-up support. It involved teachers in learning activities that are similar to ones they will use with their students, and encouraged the development of teachers' learning communities (CERI, 2005). It is hypothesized that educating teachers about the use of formative assessment during the school based assessment will lead to improved teacher knowledge and skills, better pedagogy and enhanced student understanding.

Purpose of the Study

The purpose of this action-oriented study is to improve teachers' use of formative assessment in school based assessment at a south denominational school. The intervention involves professional development training in the use of formative assessment practices for three teachers of Forms 4 and 5 Science classes.

Professional development is defined as activities that develop an individual's skills, knowledge, expertise and other areas of expertise as a teacher. Effective professional development is on-going; it includes training, practice and feedback, and provides adequate time

and follow-up support (CERI, 2005).In the past, the predominant strategy for professional development was to use outside experts to increase teachers' knowledge of content, a particular teaching approach, or a specific program. Howe and Stubbs (1997) suggest that this passive approach to professional development is unlikely to affect individual teachers or school wide change. More recently, research has shown a more purposeful approach to professional development that includes job embedded practices and ongoing opportunities for professional growth and systemic change is more effective in improving teaching (Guskey et al., 2003). Heck, Banilower, Weiss& Rosenberg (2008) report that recent research reveals the following essential elements of effective professional development: (a) situating the activity in classroom practice, (b) actively involving teachers, (c) treating teachers like professionals, and (d) focusing on disciplinary content.

Research Questions

Overarching Question

How can a professional development workshop be used to improve teachers' use of formative assessment in SBA?

Sub-questions

1. What are the effects of a professional development workshop on teachers' use of formative assessment during their SBA practical activities?
2. What are teachers' perceptions towards the use of formative assessment during their SBA practical activities?
3. What are students' perceptions toward the use of formative assessment during their SBA practical activities?

Statement of Hypotheses

Hypothesis testing was conducted to investigate the extent to which a professional development workshop impacted on teachers' use of formative assessment in SBA. The hypotheses included:

1. H_o: there is no significant change, at the 0.05 alpha level, in teachers' use of formative in their SBA practical activities after being involved in a professional development workshop.

2. a. H_o: there is no significant change, at the 0.05 alpha level, in treatment teachers' perceptions towards the use of formative assessment during their SBA practical activities after being involved in a professional development workshop.

b. H_o: there is no significant change, at the 0.05 alpha level, in the control teachers' perceptions towards the use of formative assessment during their SBA practical activities.

3. a. H_o: there is no significant change, at the 0.05 alpha level, in treatment students' perceptions towards the use of formative assessment during their SBA practical activities after their teachers' were involved in a professional development workshop.

b. H_o: there is no significant change, at the 0.05 alpha level, in control students' perceptions towards the use of formative assessment during their SBA practical activities.

Definition of Terms

1. Formative assessment

"Formative assessment is defined as assessment carried out during the instructional process for the purpose of improving teaching or learning. . . . What makes formative assessment formative is that it is immediately used to make adjustments so as to form new learning" (Shepard, 2008, p. 281).

2. Formative feedback

Formative feedback is the facts communicated to the teacher or student that is hoped to improve their thinking or behaviour. The teacher receives feedback for varying instruction, to increase student understanding, knowledge and skills, and in some subject area or common skill (e.g., problem solving). (Shute, 2007)

3. Professional Development

Professional development is defined as activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher. As CERI's comparative review on teachers noted (CERI, 2005), "Effective professional development is on-going, includes training, practice and feedback, and provides adequate time and follow-up support. Successful programmes involve teachers in learning activities that are similar to ones they will use with their students, and encourage the development of teachers' learning communities."

4. School Base Assessment

School-Based Assessment (SBA) is an internal assessment that includes activities determined by teachers' and assessed using specified guidelines given by CXC. Students participate in the activities over a two year period mastering specific skills as stated in the subject syllabus. Marks are awarded by the teachers and weigh 20% of the final grade.

5. Perceptions

Hargie (1996) described perception as how we make sense, beliefs or even understand from all the information we receive via our five senses. In this particular study it is the way in which the students and teachers regard, understand, or interpret the use of formative assessment in their SBA.

Significance of the Study

The study is significant to help develop the researcher in conducting professional development teacher workshops and to give support to teachers in enhancing the teaching learning environment in the science classroom. It provides an example of how teachers perceive professional development programmes and how it is applied. The study can also improve current classroom practice**.** The researcher introduces to teachers a new tool that can be used to engage students and encourage them to be critical and innovative thinkers. Hence, the study may provide results and recommendations to encourage teachers to use formative assessment in their SBA as well as in their daily teaching practice. The study will provide the school's administration with invaluable information to inform internal school policy and best practices across all disciplines. This study is significant in that it adds to the growing body of knowledge available in the local context on the use of formative assessment in the teaching and learning of science.

CHAPTER 2 - Literature Review

Formative assessment

Formative assessment is a systematic process used to continuously gather evidence about learning. This evidence can be used to recognise a student's level of understanding and to adjust lessons to help the student reach the learning goal. In formative assessment, students work alongside their teachers, with the same learning targets and understanding of how their learning is succeeding and what steps they need to follow. Heritage (2007) explains formative assessment consists of a variety of approaches to gathering evidence. They can be grouped into three broad types: on-the-fly assessment, planned-for interaction, and curriculum-embedded assessment.

On-the-fly assessment occurs spontaneously during a lesson. Heritage (2007) gives an example of a teacher eavesdropping into group discussion can pick up on student's misconceptions of science concepts. The teacher can then include a quick "pop-up" lesson within the session which facilitates the clearing up of the initial misconceptions before moving to the next planned lesson. In planned-for assessments, teachers decide in advance how they will stimulate students' thinking for the duration of the assignment. For example, teachers design questions to ask while the activity is in progress to give students an opportunity to explore ideas. These questions can also be used to elicit valuable assessment data.

Curriculum-embedded assessments can be categorized into those that are part of an ongoing class activity and those that curriculum developers use to extract feedback at main points in the learning progression. Heritage (2007) gives an example of student graphical representations completed while in class can serve as a form of formative assessment. Similarly examination of students' science notebooks can provide evidence to monitor student's learning

and can be part of the regular classroom activity. In this study the three types of formative assessment was used as part on ongoing classroom activities.

Black & Wiliam (1998) indicated that student's learning can be improved tremendously if formative assessment is implemented properly. Formative assessment is already implemented in schools in countries such as England, New Zealand, Canada, Demark, Finland, Italy and Scotland (CERI, 2005). In Australia, the state of New South Wales allocates 50% of the weight of final assessments to the judgement of each school; the other 50 % is based on the state's formal tests. The state of Queensland goes further, with school leaving certificates wholly dependent on school-based assessments. However, in these states there is a coherent state system to train teachers as assessors through collaborative professional development at earlier stages in the school year.

Formative assessments have numerous benefits to schools (CERI, 2005). For example, the quality of teaching in the classroom can be improved. Teachers develop the skills to adjust instructions and provide scaffolding to ensure the students learning needs are met. They can regularly repeat the assessment strategies that worked well with their students to increase its benefits. Hence, it will be beneficial for teachers to learn how to implement formative assessment in their classrooms. This idea was re-iterated in Hong Kong by their recent assessment reform policy. They aimed to increase the learning skills of students and to enhance their life-long capabilities in schools through the use of formative assessment (CDC 2001).

Black and Wiliam (1998) conducted a meta-analysis of 250 research studies on the effects of formative assessment and found that, when implemented with fidelity, it "produced significant and often substantial learning gains" (p. 140). The studies also indicated that

formative assessment was especially effective with low-achieving students and in reducing achievement gaps. In a more recent analysis of the research, Wiliam and Thompson (2008) found that formative assessment produced more significant increases in student achievement than reducing class size or increasing teachers' content knowledge.

Bennett (2011) describes formative assessment as sharing expectations, giving detailed feedback, self and peer assessment. These actions supposed to encourage students to reflect on the internal standards of their work, to take ownership of their learning and become autonomous learners. Traditional definitions of learner autonomy have tended to see autonomy as an inherent trait with a fixed skill set that is located within the individual's mind, similar to that of Little (1994) who described learner autonomy as "the capacity for detachment, critical reflection, decision making, and independent action"(p. 81) Teachers who were successful in helping students develop autonomy through assessment for learning practices in Marshall and Drummond's (2006) research recognised the importance of social interaction and sharing responsibility for learning with students. Finally, research by Wiliam, Lee, Harrison and Black (2004) also showed that formative assessment increased student involvement in their own learning and teachers' professional satisfaction. These similar improvements in student learning is hoped to be achieved by the improving teachers assessment literacy.

Challenges of implementing formative assessment

Implementing formative assessment requires teachers to have specific knowledge and skills (Bennett, 2011).A teacher who is uncertain of the subject content would unlikely know what inquiries to involve students in, what evidence to extract from their performance, how to

interpret the evidence in terms of the student's knowledge and what instructional adjustments need to be taken. Failure in this can decrease the usefulness of formative assessment. If the conclusions about the students are incorrect, the criterion for adjusting instruction is weakened. Likewise if the conclusions are correct but instruction is adjusted inappropriately, learning likely to occur (Bennett, 2011).

There have been many practitioners who have attempted and succeeded to varying degrees in implementing formative assessment into classroom practice. However, according to Carless (2007), implementing the theories from the previous research into the classroom is a challenge. He considers that within international contexts where summative assessments have dominated, the possibilities for implementation of formative assessment are even more discouraging. The barriers that exist to formative assessment include large class sizes and heavy workloads which could lead teachers to think formative assessment whilst having a good theoretical foundation, risks being somewhat impractical, too time-consuming and thus incompatible with the demands of schooling. Popham (2008) also endorses this view, as he writes, "…theoretically teachers and students could make adjustment decision in the wake of every incoming piece of assessment information. But in the real world, this is unrealistic and would be exhausting for both the enervated teachers and decisions drained students"(p 11). Black and Wiliam (1998) suggest " teachers need a variety of living examples of implementation, as practiced by teachers with whom they can identify and from whom they can derive the confidence that they can do better" (p 146). Teachers need to see the positive results and implementation techniques before they adopt the process into their everyday practice.

Assessment Literacy

The term "assessment literacy" has become accepted to refer to the range of abilities and knowledge that stakeholders require to deal with the new world of assessment into which we have been thrust (Fulcher, 2012).An assessment literate person knows and understands the theoretical and philosophical underpinnings of the various assessment practices (Volante and Fazio, 2007). Improvements in teaching and increase in students' learning are two major benefits linked to assessment literacy (Wilson, Floden, and Ferrini-Mundy, 2001). Current philosophies see assessment as a means of measuring student attainment and as a learning tool that encourage independent learning behaviour combined with metacognitive skills (Black and Wiliam 1998).

Ogan-Bekiroglu (2009) used a mixed-methods study to obtain Physics teacher's students' attitudes towards assessment. In his study, he concluded that teachers had difficulties with student's subject content knowledge and their will to succeed. Volante and Fazio (2007) looked at the assessment literacy development of students in a teacher education program and concluded the students here as well had relatively low levels of self-efficacy. However, the students highlighted the need for real-world knowledge about assessment (i.e. what are the practices, how it is developed, scored, and administered). Hence, assessment literacy programmes must develop teachers' knowledge and skills so they can adapt their instructions, measure students' progress and most importantly effectively integrate the assessment instruments.

Heritage (2007) identifies four critical elements of teacher knowledge to use formative assessment successfully in the classroom: 1) domain knowledge, 2) pedagogical content knowledge, 3) knowledge of students' previous learning, and 4) knowledge of assessment.

Domain knowledge

Teachers need to have a comprehensive understanding of the theories, knowledge, and skills within their subject area, the foundations required to achieve them and the various ways in which successful work can be presented (Heritage, 2007). As mentioned earlier, teacher and students need to practise self-reflection to assess their learnings and recognise where students are in the learning progression. Finally, teachers must be aware of the culture of the students in their classroom and how they can motivate or increase their competence or self-efficacy. (Harlen, 2006)

Pedagogical content knowledge

Pedagogy is the correct use of various teaching strategies. Teachers must first be familiar with the multiple styles of teaching and the purpose for modelling a particular style to ensure maximum student achievement and effective adjustment of instructions. (Heritage, 2007). Teachers need to be aware that students learn at varying pace. They all have different gap levels between their current understandings and learning goals but teachers need to have the skill to use differentiated instructional strategies to ensure all students reach their learning targets.

Students' previous learning

Students come to the classroom with a wide range of previous learnings. This prior knowledge is a combination of subject content, understanding of concepts, skills to perform tasks, attitudes and languages. Teachers need to elicit this knowledge from the students in their classroom firstly, then built on it to move their learning forward (Heritage, 2007).

Assessment knowledge

Teachers must be acquainted with several formative assessment strategies and how to align each into their lessons so that they can gather maximum evidence of students' learnings. However

care must be taken to ensure the assessments supports the instructional goals and the evidence are interpreted accurately (Heritage, 2007)

Assessment literacy also encompasses the specific teacher skills required to create a classroom atmosphere that will permit self- and peer assessment. Once students can openly make a contribution, reflect on their performance and admit when they do not understand, they can become independent achievers. However, teachers must be their guide to examine their responses and prove substantial feedback to ensure misconceptions are cleared up and knowledge and understandings are internalised.

Professional development of teachers

Teacher quality can be improved tremendously through a teacher professional development exercise (Trumbull & Gerzon, 2013). It includes teacher actively learning through highly engaging experiences such as mentoring, demonstrating teaching observation, self-assessment and reflection, practise in the classrooms, review of student work and presentation of results. Professional development exercises need at least 50 hours of teachers involved in continuous educational innovations (Darling-Hammond et al., 2009). Effective professional development will enhance teacher quality, which results in improved student learning and achievement. Hence professional development for teachers is often recommended as a strategy for school improvement.

Smylie (1988) adds that "… teachers' opportunities to learn should be problem oriented and grounded in inquiry, experimentation and reflection" (p10).When teachers engage in professional development that enables them to make connections with their teaching, they are

more likely to sustain the development over an extended period of time (Garet et al, 2001). Hence professional development must be linked with *practice*.

Black & Atkin (1996) did a study on teacher professional development in 13 countries and made the following conclusions:

- There is an increase in possibilities and alternative that makes a change in practice favourable.
- Increased moral support is given to teacher since there is proof that the new strategy worked well.
- Teachers' understandings are increased by the demonstration of actions and creating the new ideas in a real world context.

They continued to explain that teachers who choose to make a policy change can regulate how change is made to their professional practice which, in turn, improves their professional consciousness. This study extends this point by showing teachers how important it is to have their professional consciousness directed towards increasing the students learning during their SBA lessons.

Professional development workshops with teachers can only be effective if there is a strong, collective working relationships among the teachers involved (Borko, 2004). A professional teaching community could be difficult to form and prosper because it demands a lot time and in most cases reshuffling of regular school schedules (Darling-Hammond et al., 2009). Teachers can work collaboratively in professional learning communities (PLCs). This is where two or more of teachers from different subject areas come together to share their expertise and promote their growth in their profession (Saunders, Goldenberg & Gallimore, 2009). PLCs teachers can discuss topics or current issues with their colleagues, as well as have hands-on

practice with particular assessment or teaching techniques. PLC provides an opportunity for teachers to communally scrutinize their thinking about teaching (Garet et al., 2001).

Professional development workshops in formative assessment must not only look at benefits and implementation of formative assessment but it must also address the challenges that may be encountered. Some literature anticipates that successful formative assessment practices are dependent on good teaching or pedagogical knowledge (e.g., Black and Wiliam 1998c). Bennett (2011) has argued there needs to be cognitive knowledge and knowledge of assessment as well. He continues to explain that well-ordered professional teacher learning communities can be the venue to link both assessment, pedagogical and domain knowledge. However, if teachers have to grasp these multiple aspects of knowledge they will need *significant time*. Time to practice in the classroom and learn to adapt to the formative-assessment activities. Such activities might include items, building models, creating a musical pieces, projects or observational and interpretive guides. Thus, this research is focused on creating an innovative teacher professional development focused in the area of formative assessment in SBA.

A theoretical framework for formative assessment proposed by Heritage (2007)

In this study Heritage (2007) theoretical framework for formative assessment was used to plan and implement a professional development exercise for Form 4 teachers on the use of formative assessment in SBA. There were four core elements of formative assessment framework: 1) identifying the "gap," 2) feedback, 3) student involvement, and 4) learning progressions. Teachers were required to have a clear understanding of each of these elements.

Identifying the gap

In an influential paper in 1989, Sadler explained that formative assessment can be used to identify the gap between a student's present status in learning and some chosen goal. He went on

further to say the 'gap' will be different for each child in a classroom and described the consequence for pedagogy: "If the gap is perceived as too large by a student, the goal may be unattainable, resulting in a sense of failure and discouragement on the part of the student. Similarly, if the gap is perceived as too 'small,' closing it might not be worth any individual effort." (p 130)

When a teacher delivers subject content, children internalises it and subsequently use the information to understand and solve problems. However, this process may not be as simple for all students. At times they require scaffolding which entails the support that teachers give to learners to take them from what they already know to what they can do next. Effective formative assessments, then, should permit teachers to manage their teaching in such a way to reduce the gap between the student's current state of learning and the desired state.

Feedback

Formative assessment is designed to provide feedback to both the teacher and student at various levels. The teacher receives feedback to evaluate their students understanding which can be used guides their next step in a lesson. The student receives feedback also to guide their learning and to gauge how far they are from their learning objectives. Sadler's model (1989) says there is a feedback loop whereby both teachers and students are continuously providing feedback for each other. Feedback can yield positive results only if it consists of clear, descriptive, criterion-based information and outlines the steps that are necessary to close the gap between the current and desired learning.

Student involvement

Student involvement in their own learning is essential when implementing formative assessment (Assessment Reform Group, 1999) Students are required to always collaborate with their

teachers and develop the skills for self- and peer assessment (Sadler, 1989). They are also encouraged to monitor their learning and to construct strategies to fulfil their learning desires.

Learning progressions

If formative assessment is to provide guidance to teachers and students, it must be linked to a learning progression (Heritage, 2007). Learning progressions show sub goals as steps towards achieving an ultimate goal. It guides what is taught in the classroom and describes the success criteria. A success criterion keeps the student on track when they are engrossed in SBA tasks and assists teachers in an impartial interpretation of the evidence collected from formative assessment (Clarke, 2005).

Summary

Formative assessment if used effectively can provide teachers and their students with the information they need to move learning forward. (Heritage, 2007) However, several factors can hinder its implementation hence, ongoing support and professional development opportunities are essential for maintaining assessment literate teachers. The following chapter describes the procedure used in this action research to investigate how a professional development workshop can be used to improve teachers' use of formative assessment in SBA.

CHAPTER 3 - Methodology

The objective of this study was to investigate how a professional development workshop can be used to improve teachers' use of formative assessment in SBA. The research questions were as follows:

1. What are the effects of a professional development workshop on teachers' use of formative assessment during their SBA practical activities?
2. What are teachers' perceptions towards the use of formative assessment during their SBA practical activities?
3. What are students' perceptions toward the use of formative assessment during their SBA practical activities?

The design of the study

This study is grounded in the concurrent mixed methods design. According to Leacock et al. (2009, p. 6) the mode of research "depends on how the data are collected, the nature of the data and the methods of analysis." A combination of quantitative and qualitative approach was chosen for this study because a more comprehensive account of the effectiveness of the professional development exercise was sought. Quantitative research allows the researcher to gather data and observe trends from a large number of participants over a large geographical area (Creswell, 2008). Conversely, qualitative research provides comprehensive information conveyed through the voices of participants in their natural settings (Creswell, 2008). When researchers bring together both quantitative and qualitative research, the strengths of both approaches are combined, leading it can be assumed, to a better understanding of research problems than either approach alone (Creswell & Plano Clark, 2007). I chose this design because

it afforded me the opportunity to gain in-depth understanding of the teachers and students' perception on the professional developmental process.

Another advantage of using mixed methods was the flexibility afforded to the researcher to carry out whatever data collection and analysis best suited the research question. This was a characteristic of the pragmatic paradigm which accommodates singular or multiple realities, is extremely practical in the choice of data collection technique, allows the research to move between unbiased and acknowledged bias and uses both quantitative and qualitative data (Creswell & Plano Clark, 2007).In this study, data on students' and teachers' views toward the use of formative assessment during their SBA practical activities were collected using a rating scale. In addition, the effects of the professional development workshop on teachers' use of formative assessment during their SBA practical activities were captured by an observational checklist while the teacher's perceptions were obtained from reflective journals. Figure 1 below demonstrates when the quantitative and qualitative data will be collected.

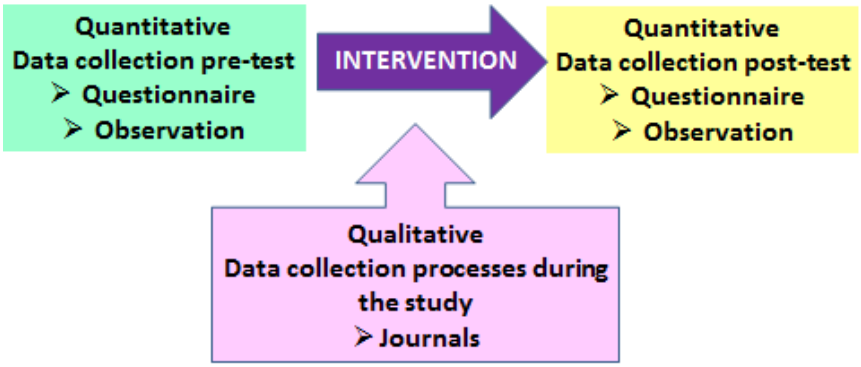

Figure 1. Quantitative data collected before and after the intervention and the qualitative data collected during the intervention.

This study used a quasi-experimental strategy to evaluate an intervention and the intended effect on the study's participants. A pre- post-test design with a control group was employed. The treatment group consisted of 3 teachers and 92 students while the control group consisted of 2 teachers and 36 students. The treatment group participated in the professional development workshop intervention while the control group carried on with their usual everyday activities. By having both a control and treatment group, the researcher was able to control for the likelihood that other factors not associated to the intervention (e.g., students getting accustomed to assessment strategies, or simple maturation over the intervening time) are accountable for the difference between the pre and post-questionnaire results.

Quasi experimental research is more practical in most cases, given the limited time and organizational constraints. One disadvantage of using quasi experiment research is the lack of random assignment which leads to a reduced internal validity and hence causal claims become quite difficult to make within the study (Prater, 1983). However, quasi experimental research allows the phenomena under investigation to present itself in real-world conditions, thus increasing the external validity of the study. This type of design is pre-existing constructions whereby fewer variables are able to be controlled. This also limits the ability to make causal claims from the study (Henrichsen, Smith & Baker, 1997). Figure 2 below shows a summary of the study.

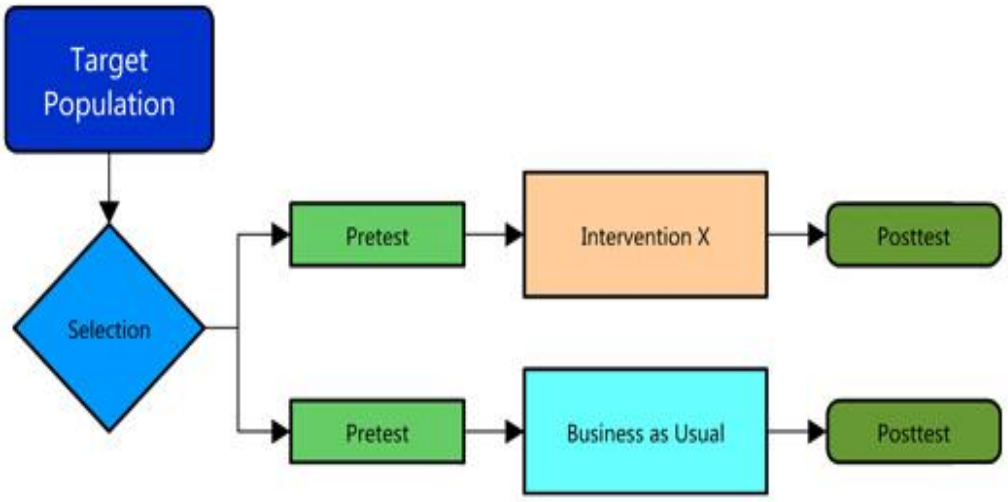

Figure 2. Pre- and Post-test administered to the treatment and control groups

The study incorporated an action research to provide information immediately to improve teaching and learning. Action research has always been understood as people taking action to improve their personal and social situations, and offering explanations for why they do so. It is a natural part of teaching. Teachers are continually observing students, collecting data and changing practices to improve student learning and the classroom and school environment Action research provides a framework that guides the energies of teachers toward a better understanding of why, when, and how students become better learners. (Miller, 2007)

Action research was used to study current problems ((McMillan & Schumacher, 2006) in which participants are actively involved in finding possible solutions to the given problem (Cohen, Manion, & Morrison, 2000). Initially, a problem was diagnosed. This was followed by a collective postulation of several possible solutions, from which a single plan of action emerged and was implemented. Data on the results of the intervention was collected and analysed, and

the findings were interpreted in light of how successful the intervention has been. In this study the intervention was a professional development work shop for three teachers and it was used in an attempt to improve teachers' use of formative assessment in school based assessment.

The Participants

The sample consisted of 128 students and 5 teachers from a denominational boy secondary school located in a rural area in south Trinidad. Although the school is denominational, approximately half of the sample is Hindu while the remaining 50% is comprised of Christian, Muslim and Roman Catholic students. Most of the boys, though, are of East Indian descent with only about five percent mixed-race or African students. The students belonged to Forms 4 and 5 classes and range between ages 14-16 years and are of mixed ability.

Two teachers were used in the control group, one is untrained and has five years of experience and specialised in teaching of Biology and the other is trained and has fourteen years of experience and specialised in the teaching of Chemistry. Three teachers were used in the treatment group one is trained with fourteen years of experience and specialised in teaching of Physics while the two others are untrained with three years of experience and specialised in teaching of Biology and Chemistry. All five teachers are holders of Bachelor in Science Degrees and teach Integrated Science.

Sampling Procedure

The participants were selected through convenience sampling. The sample selected to participate in this study were teachers who taught Science subjects (Biology, Chemistry, Physics or Integrated Science) and do SBA practical activities with their students in preparation for the CSEC examinations. Convenience sampling is a nonprobability method. This means that

subjects are chosen in a non-random manner, and some members of the population have no chance of being included. With nonprobability sampling, researchers have no way of calculating how well their sample represents the population as a whole. Creswell (2013) states that convenience sampling saves time, money and effort but at the expense of information and credibility.

Methods and instruments of data collection

A professional development work shop was conducted over a three month period (See Appendix A for schedule of events and theory of action). The work shop entailed a combination of face to face and online meetings as well as practice sessions and in-class application of new knowledge. The face to face session was held in the school's Physics lab in one hour sessions. It aimed at educating teachers professionally in the use of formative assessment to create authentic SBA activities (See Appendix B for sample lessons) and encourage students to become autonomous learners.

The three treatment teachers actively engaged in the workshop and kept a professional development reflective journal. Journals are a written record of the teacher's experiences of, and feelings about planning, preparing and delivering teaching and learning. It contained general accounts of learning sessions and identified critical incidents which contribute to their continuing professional development. The most distinctive of these very good teachers was that their practice is the result of careful reflection. They themselves learnt lessons each time they teach, evaluating what they do and using these self-critical evaluations to adjust what they do next time. (Ofsted, 2004) These journals were collected by the researcher fortnightly and analysed

qualitatively. Additionally, the researcher used the journals to gather the teachers' uncertainties or concerns and tried to address them in the following sessions of the workshop.

Best and Kahn (2006) recommends a questionnaire when factual information is required. They continue to support this form of data collection by explaining that when questionnaires are administered personally to groups of individuals , they have an opportunity to establish a rapport explain the purpose of the study and explain the meaning of items that may not be clear. The students' and teachers' perceptions were measured using two questionnaires which were adapted from Pat-el, Tillema, Segers & Vedder (2013). The instruments designed by Pat-el, Tillema, Segers & Vedder consisted of a 28-item survey with agree-disagree statements on a 5-1 Likert scale. These statements described how participants perceived monitoring and perceived scaffolding in the classroom. However, for the purpose of this study the instrument used was modified to consist of twenty five items focused on the formative assessment practises. The items consisted of two scales: (1) perceived monitoring (13 statements) and (2) perceived scaffolding (12 items).

The instrument (See Appendix C for student questionnaire) was administered to students before and after their teachers participated in the professional development workshop on formative assessment. This was done to obtain the students' views on the use of formative assessment in their SBA and to determine whether there were any changes in their initial views. The statements were focused on capturing whether the teachers identified the gap in the student's learning, gave feedback, involved the students and identified where students are in the learning progression.

The students were required to complete the questionnaire in thirty minutes at the end of an SBA activity lesson. Similarly, data about teachers' views on the use of formative assessment in their SBA were obtained using a rating scale which was administered before the intervention. The same instrument (See Appendix D for teacher questionnaire) was administered to teachers after they have participated in the professional development workshop on formative assessment to determine whether there were any changes in their initial views. The statements gathered the teachers' personal perception on the way they used the evidence from the use of formative assessment to identify the student's current level of learning and to adapt lessons to help student reach the desired learning goal. The items in the questionnaire were rated 1-5, 1 being strongly disagrees and 5 strongly agree. The statements describing the students' and teachers' perceptions were all positively slanted and the scoring was assigned as shown below:

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

The raw scores for each item in the questionnaire for both treatment and control teachers and students were entered and collated using **The Statistical Package for the Social Sciences** (**SPSS 22).** The program was used to obtain descriptive statistics such as means and standard deviations and to perform paired sample t-tests.

In addition, the teachers were observed in their classroom practice and an observational checklist (See Appendix E) was used to record the effects of the professional development workshop on teachers' use of formative assessment during their SBA practical activities. The participating teachers were viewed before and after the intervention in the same class. The

checklist was adapted from Little (2004) and consisted of ten items with a 5-1 Likert scale from excellent to not observed. They were all positively slanted and the scoring was assigned as shown below:

Excellent	Above average	Expected level	Not at expected level	Not observed
5	4	3	2	1

Since only the three treatments were observed, each item was able to achieve a range of values between the total minimum score of 3 with a mean value of 1 to a total maximum score of 15 with a mean value of 5. The raw data was entered and collated using Microsoft Excel and **SPSS** for Microsoft Windows**.**

Observation checklists not only give an observer a structure and framework for an observation but also serve as a tool to get specific feedback on varying aspects of the class. Observation, as a research data gathering process, demands rigorous adherence to the spirit of scientific enquiry (Best and Khan, 2006).Hence, it was done by the researcher who knew what to look for and what was irrelevant to the situation. In addition, the observer was objective, recognised the likely biases, and strived to eliminate their influences on what was done in the class and what was reported.

Procedures for data analysis

The study merged quantitative and qualitative data in order to provide a comprehensive analysis of the research problem. The researcher collected both forms of data at the same time and then integrates the information in the interpretation of the overall results. (Creswell, 2008)

Quantitative Analyses

Firstly, the raw scores collected for each item of the observational checklist were recorded using an excel sheet. This was done for the checklist completed before and after the intervention for all three treatment teachers. The mean scores for each of the observed behaviours before and after the intervention were then calculated and represented in a histogram. The graphical representation was used to observe the changes in the mean score after the intervention. To verify if there was a significance difference in the mean between pre- and post-observation scores, the data was exported to **SPSS** and a paired samples t-test was conducted. The null hypothesis which was tested using the observation scores was:

1. H_o: there is no significant change, at the 0.05 alpha level, in teachers' use of formative in their SBA practical activities after being involved in a professional development workshop.

The null hypothesis was accepted for the item if the *p* value was greater than 0.05 while it was rejected if the *p* value was less than 0.05.

Secondly, the quantitative data from the teachers' and students' questionnaires were entered in an excel sheet. The percentage of students and teachers choosing the options strongly disagree to strongly agree were collated for each item. This was done for the pre and post questionnaire for both the treatment and control group. The percentages were represented graphically by constructing a 100 % Stacked Bar chart. The chart emphasized the contributions of the five data series (strongly disagree, disagree, neutral, agree and strongly agree) to the total. It was used for comparison and looking at the changes in each set of data before and after the

intervention. The data analysis examined whether the professional development workshop was perceived as supportive for teachers in their use of formative assessment.

Furthermore the raw data was copied into **SPSS** and descriptive statistics (mean and standard deviation) were provided in the analysis. Paired sample t tests were performed to test for differences in the mean. I analysed the data for trends using the proper statistical tool to compare the out puts from the test and to determine if there were significance differences in the mean between pre-test and post-test scores. The null hypotheses were not rejected if the *p* value was greater than 0.05 and it was rejected if the *p* value was less than 0.05. Each item on the questionnaire were analysed individually followed by a general evaluation in terms of the sub scales. The hypotheses which were tested using the questionnaires for this study included:

1. a. H_o: there is no significant change, at the 0.05 alpha level, in treatment teachers' perceptions towards the use of formative assessment during their SBA practical activities after being involved in a professional development workshop.

   b. H_o: there is no significant change, at the 0.05 alpha level, in the control teachers' perceptions towards the use of formative assessment during their SBA practical activities.

2. a. H_o: there is no significant change, at the 0.05 alpha level, in treatment students' perceptions towards the use of formative assessment during their SBA practical activities after their teachers' were involved in a professional development workshop.

   b. H_o: there is no significant change, at the 0.05 alpha level, in control students' perceptions towards the use of formative assessment during their SBA practical activities.

An additional comparative analysis of the results between the control and treatment group determined whether the variations observed were the result of the intervention or other factors not relating to the study. The students' and teachers' chart and t-test results were analysed firstly quantitatively and then qualitatively using the teachers' written record of their experiences to capture their perceptions on the use of formative assessment in their SBA.

Qualitative Analyses

Emerging data from participants' reflective journals was colour-coded, segmented and re-grouped by connecting views. Initial or open coding was done by examining the data sentence by sentence multiple times to gain an understanding of the views of the participants as it is related to the context of the research question. This allowed the researcher to build ideas inductively while deterring her from imposing existing theories or her own beliefs on the data (Chamaz, 2000).It also permitted a rigorous review of the data and provided a structure for analysis and interpretation. Once the initial codes have been identified, axial coding along with the constant comparative method will be employed to identify patterns as well as paradoxes in the data (Wellington, 2000).Each category in the data was colour coded which highlighted items of data in the transcripts and made recognition of data easier when reviewing the transcripts at a later stage. (See Appendix I) Finally the categories was examined and reassembled in order to identify emerging patterns and construct a coherent description of the phenomenon under study (LeCompte, 2000). The emerging themes and categories obtained were interpreted to attain teachers' perceptions towards the use of formative assessment during their SBA practical activities during the professional development workshop.

Ethical Considerations

The participants were assured that all data and demographic information collected during the study will be kept confidential and anonymous. The participants' identity was kept anonymous through the use of code numbers for students and pseudonyms for teachers which were assigned to them for use during the course of the study. They were also assured that they will be privy to the information reported in the study upon its completion and/or their request. Prior to the intervention the participants were informed of the nature and purpose of the study and that they may withdraw from the study at any time. Additionally, the identity of the school was kept anonymous in this paper. Furthermore, written permission to conduct research was sought from the Principal as well as participants.

Delimitations

The study was confined to one secondary denominational school in a single educational district. The findings were specific to the five Science teachers and are therefore not generalizable to other contexts. In addition, a convenient sample of 128 Forms 4 and 5 students was chosen which "decreases the generalizability of findings". (Creswell, 2006)

Limitations

Limitations were those conditions in which the researcher had no control over, which may hamper the study. In this study the limitations were-

- Validity of participant response - it was entirely up to the participant to choose to articulate honest and relevant responses. The study was dependent on continuous participant support. It required participants to willingly use their personal time to reflect on their practice and record them in the form of journals. Furthermore data was collected in the classroom through only two observations of each teacher. While the two

"snapshots" of teaching provided some data about their use of formative assessment practices, more observations would have enhanced the validity of the results. Teachers knew they were observed, so there is the possibility that the lessons were not representative of their usual teaching methods.

- Time constraints –Although there were a few positive outcomes obtained, three months were insufficient time to expect significant changes in teaching practices and particularly student achievement. School activities and other commitments of participants limited the time they had to participate in the planning and implementation of the formative assessment activities. As mentioned earlier, incorporating formative assessments effectively into instruction requires teachers to shift beliefs and philosophies about teaching. Furthermore, according to Black, Harrison, Lee, Marshall, & Wiliam (2004), three years of professional development is generally necessary to bring about broad-based change in teaching practices.
- Researcher bias - due to the researcher's immersion in the research environment, reporting bias-free information was a challenge. The researcher was cognizant of the importance of acknowledging the values she brought to the study as she interpreted the perceptions of the participants shared in the reflective journals.

CHAPTER 4 –Presentation of Findings

In this action research a professional development workshop was used as an intervention to improve teachers' use of formative assessment in SBA. The workshop was conducted over a three month period and involved a blend of face to face and online meetings as well as practice sessions and in-class application of formative assessment. There were three treatment teachers actively engaged in the workshop and two control teachers whom were not exposed to the theory covered on the use of formative assessment in SBAs.

The central research question in this study was how a professional development workshop can be used to improve teachers' use of formative assessment in SBA. Quantitative data was collected before and after the workshop using questionnaires and observational checklist. This study employed a concurrent mixed methods design since teachers wrote reflective journals for the duration of the workshop, hence adding a form of qualitative data. In this chapter the findings were presented as it is related to the three sub questions:

1. What are the effects of a professional development workshop on teachers' use of formative assessment during their SBA practical activities?
2. What are teachers' perceptions towards the use of formative assessment during their SBA practical activities?
3. What are students' perceptions toward the use of formative assessment during their SBA practical activities?

The findings were described using descriptive statistics, comparison of means and graphical presentations.

SUB QUESTION 1: What are the effects of a professional development workshop on teachers' use of formative assessment during their SBA practical activities?

The three treatment teachers were observed in their classrooms during an SBA practical activity. They were observed once before and once at the end of the professional development workshop. A checklist with 10 behaviours was used during the observation to capture their use of formative assessment. The results from these statements were tabulated (see Table 1 in Appendix F) and analysed quantitatively. The following is Figure 3 showing the mean scores of each statement before and after the intervention.

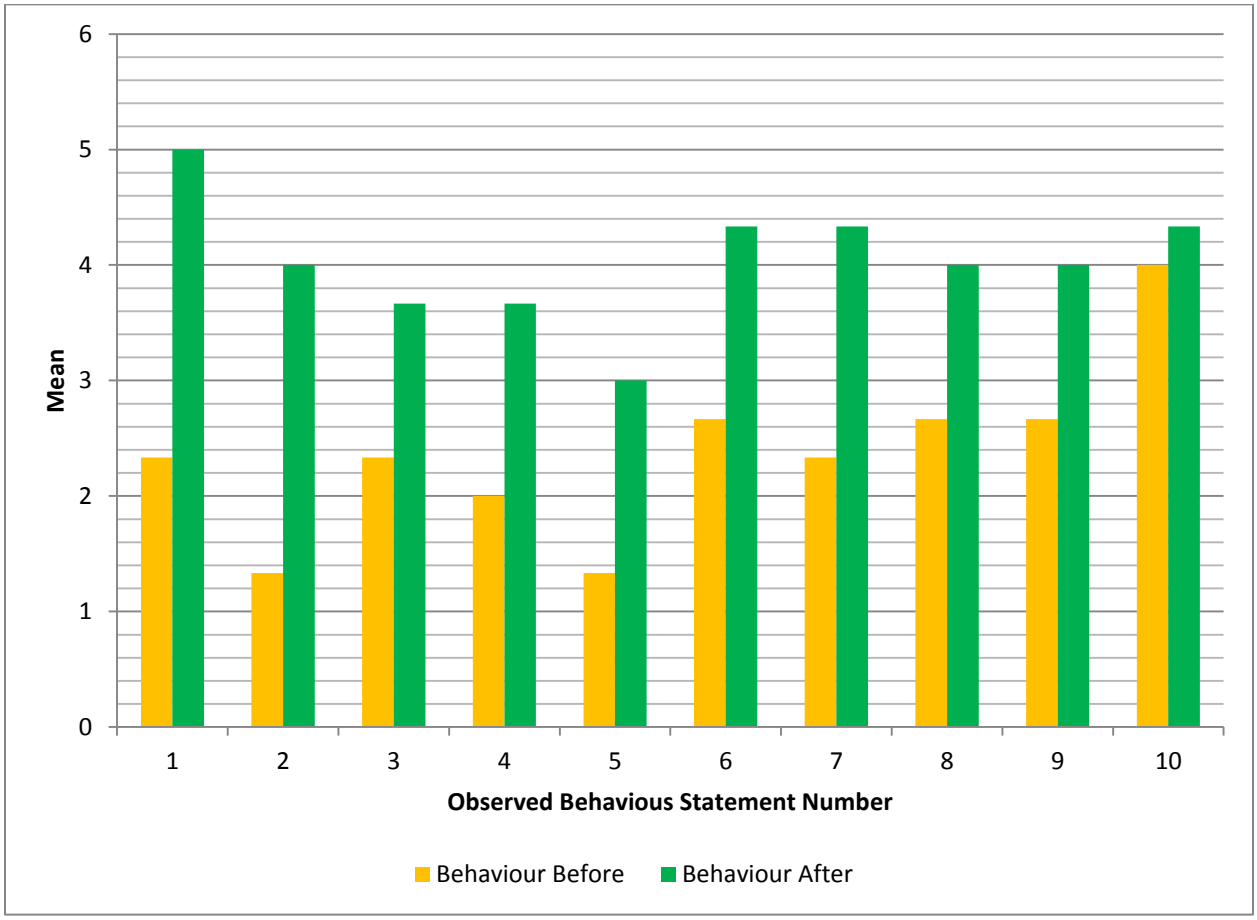

Figure 3. Mean values for observed behaviours before and after the professional development workshop.

Figure 3 showed statement 1 had the highest increase in mean which indicated the teachers clearly communicated the purpose of class session and instructional activities to the students. Statements 3, 8 and 9 had the least improvement in their mean values which suggest that teachers may have had difficulty in using formative assessment to foster student-to-student interaction, motivate the students and to determine whether students understand course material.

90 % of the behaviours have a mean value less than 3 and 10 % have a mean value greater than 3 before the intervention which showed at the start of the study most of the teachers were not effectively using of formative assessment. 100 % of the behaviours have a mean value greater than 3 after the intervention which showed at the end of the study all of the teachers were using of formative assessment above the expected level. Teachers seem to have improved their use of formative assessment during their SBA practical activities. This is clearly illustrated by Figure 3 where there is an increase in the mean scores from before to after the professional development workshop.

The second method used to observe the effects of a professional development work shop on teachers' use of formative assessment during their SBA practical activities was a paired sample t-test. The paired samples t-test procedure compares the means of two variables for a single group. The procedure computes the differences between values of the two variables for each case and tests whether the average differs from 0. The results from the t-test was used to test the null hypothesis, Ho: there is no significant change, at the 0.05 alpha level, in teachers' use of formative in their SBA practical activities after being involved in a professional development workshop. The following is Table 2 showing the paired sample t-test results obtained from the SPSS Statistics 22 program.

Table 2

Summary of Paired Samples T-Test for Treatment Teachers

Statement	Pre-test Output		Post- test Output		*t*- value	*p*-value
	Mean	*SD*	*Mean*	*SD*		
1. Teacher clearly communicates the purpose of class session.	2.33	0.58	5.00	0.00	-8.0	0.015
2. Teacher uses a variety of assessment activities to engage students.	1.33	0.58	4.00	0.00	-8.0	0.015
3. Teacher uses the assessment activities to determine whether students understand course material.	2.33	1.53	3.67	0.58	-1.5	0.270
4. Teacher varies their instructions to meet the diverse student's needs.	2.00	1.00	3.67	0.58	-2.5	0.130
5. Teacher incorporates the assessment activities with the SBA efficiently.	1.33	0.58	3.00	0.00	-5.0	0.038
6. Teacher listens in on small-group conversations to identify problems and address immediately.	2.67	0.58	4.33	0.58	-5.0	0.038
7. Teacher provides feedback to students.	2.33	0.58	4.33	0.58	---------	---------
8. Teacher fosters student-to-student interaction.	2.67	1.16	4.00	0.00	-2.0	0.184
9. Teacher motivates students.	2.67	1.16	4.00	1.00	-1.5	0.270
10. Teacher uses time effectively.	4.00	0.00	4.33	0.58	-1.0	0.423

The paired samples t-test was conducted to compare the means of the ten different observed behaviours before and after the intervention of a professional development workshop to improve teachers' use of formative assessment during their SBA practical activities. Table 2 showed in the first behaviour there was a significant difference in the mean before the intervention (M=2.33, SD=0.577) and after the intervention (M= 5.00, SD=0.00) for this study with t (2) = -8.0, p = 0.015. Hence, the intervention encouraged teachers to clearly communicate to the students the purpose of class session and instructional activities. The second behaviour results also showed there was a significant difference in the mean before the intervention (M=1.33,

SD=0.577) and after the intervention (M= 4.00, SD=0.00) for this study with t (2) = -8.0, p = 0.015. Thus, teacher used a variety of assessment activities to ensure all students are engaged.

The third and fourth behaviours showed there were no significant difference in the mean with values before the intervention (M=2.33, SD= 1.528) and after the intervention (M= 3.67, SD=0.577) with t (2) = -1.512, p = 0.270 and before the intervention (M=2.00, SD=1.000) and after the intervention (M= 3.67, SD=0.577) with t (2) = -2.500, p = 0.130 respectively for this study. Thus, the workshop may have not assisted teachers in using the assessment activities in class to determine whether students understand course material or efficiently adjusting their instructions to meet the diverse student's needs.

The results showed in the fifth behaviour there was a significant difference in the mean before the intervention (M=1.33, SD=0.577) and after the intervention (M= 3.00, SD=0.000) for this study with t (2) = -5.000, p = 0.038.Therefore the professional development workshop assisted teachers in incorporating the assessment activities within the SBA. Similarly the results for the sixth behaviour indicated there was a significant difference in the mean before the intervention (M=2.67, SD=0.577) and after the intervention (M= 4.33, SD=0.577) for this study with t (2) = -5.000, p = 0.038. The result suggests that teachers improved their practice by increasing the frequency in which they listened in on student partners or small-group conversations to quickly identify problems or misconceptions, and addressed immediately.

Behaviour seven displayed a difference in the mean from before the intervention (M=2.33, SD=0.577) to after the intervention (M= 4.33, SD=0.00). However, the correlation and t value cannot be computed because the standard error of the difference in mean is 0. Hence, it could not be determined whether or not this difference is a statistically significant difference.

Nonetheless, the numerical statistic and graphical presentation in Graph 1 demonstrated that an increase in mean which indicated teachers improved their timely, specific and understandable feedback to students.

The eighth and ninth behaviours showed there were no significant difference in the mean with values before the intervention (M=2.67, SD= 0.667) and after the intervention (M= 4.00, SD=0.000) with t (2) = -2.000, p = 0.184 and before the intervention (M=2.67, SD=0.667) and after the intervention (M= 4.00, SD=0.577) with t (2) = -1.512, p = 0.270 respectively for this study. Thus, the workshop may have not assisted teachers in developing the skill of motivating students or encouraging fruitful student-to-student interaction while using formative assessment in their SBA practical activities. The results also showed in the tenth behaviour there was a no significant difference in the mean before the intervention (M=4.00, SD=0.000) and after the intervention (M= 4.33, SD=0.333) for this study with t (2) = -1.000, p = 0.423. Teachers used their time effectively before and after the intervention hence the professional development workshop did not affect their time management.

In summing up, the professional development workshop on the use of formative assessment during SBA practical activities enhanced teachers practise by improving their use and integration of a variety of assessment within their SBA sessions. They also ensured they communicated the purpose at the start of the session and effectively listened in small-group conversations to quickly identify problems or misconceptions, and addressed them immediately. However no significant change were noted with respect to teachers using the assessment activities in class to determine whether students understand course material, varying their instructions to meet the diverse student's needs, motivating students or using time effectively. Thus, for this sample the null hypothesis was accepted.

SUB QUESTION 2: What are teachers' perceptions towards the use of formative assessment during their SBA practical activities?

To effectively capture the teachers' perceptions towards the use of formative assessment during their SBA practical activities both quantitative and qualitative data were sought.

Quantitative Analysis

Questionnaires were completed by the 3 treatment teachers and the 2 control teachers before and after the professional development workshop. The results from the questionnaires were tabulated (see Table 3 in Appendix G) and analysed graphically and by a statistical t-test. A t-test measures how different the two means of the sample are (the t-value) and how likely it is that such a difference would appear in two means of the samples from the same population (the p-value). The results from the t-test used to test the null hypothesis, Ho: there is no significant change, at the 0.05 alpha level, in treatment teachers' perceptions towards the use of formative assessment during their SBA practical activities after being involved in a professional development workshop. The following is Table 4 showing the paired sample t-test results obtained from the SPSS Statistics 22 program.

Table 4

Summary of Paired Samples T-Test for Treatment Teachers

Statements	**Mean**		**Std. Dev**		***t*- value**	***p*-value**
	pre	post	*pre*	*post*		
1. After an SBA, I discuss the report submitted with each student.	3.00	4.67	1.00	0.58	-1.8	0.199
2. While working on their SBA activities, I ask my students how they think they are doing.	3.67	5.00	0.57	0.00	-4.0	0.057
3. I involve my students in thinking about how they want to learn at school.	3.33	3.67	1.16	0.58	-0.4	0.742

Table 4 Continued

Statements	Mean		Std. Dev		*t*- value	*p*-value
	pre	post	*pre*	*post*		
4. I ask my students to indicate what went well and what went badly concerning their SBA activity.	3.00	3.67	1.00	0.58	-1.0	0.423
5. I encourage students to reflect upon their learning processes and how to improve their learning.	3.00	4.33	1.00	0.58	-4.0	0.057
6. I inform my students on their strong points concerning learning.	3.33	4.00	1.16	0.00	-1.0	0.423
7. I inform my students on their weak points concerning learning.	3.33	4.33	1.16	0.58	-1.7	0.225
8. I encourage my students to improve on their learning processes.	3.67	4.33	0.58	0.58	-1.0	0.423
9. I give students guidance and assistance in their learning.	4.00	4.33	0.00	0.58	-1.0	0.423
10. I discuss the activities with my students to help them understand the content better.	4.00	4.67	0.00	0.58	-2.0	0.184
11. I discuss with my students the progress they have made.	3.00	4.33	1.00	0.58	-1.5	0.270
12. I discuss with my students how to utilize their strengths to improve on their SBA activity.	2.67	4.33	0.58	0.58	-5.0	0.038
13. Together with my students, I consider ways on how to improve on their weak points.	2.67	3.00	0.58	1.00	-1.0	0.423
14. I adjust my instruction when I notice that my students do not understand the activity.	3.00	4.33	1.00	0.58	-1.5	0.270
15. I provide my students with guidance to help them gain understanding of the content taught.	3.00	4.33	1.00	0.58	-4.0	0.057
16. During my class, students are given the opportunity to show what they have learned.	3.33	4.33	0.58	0.58	_____	_____
17. I ask questions in a way my students understand.	3.67	4.33	0.58	0.58	-1.0	0.423
18. By asking questions during class, I help my students gain understanding of the content taught.	3.67	4.67	0.58	0.58	-1.7	0.225
19. I am open to student contribution in my class.	2.67	4.00	1.16	1.00	-4.0	0.057
20. I allow my students to ask each other questions during class.	2.67	4.00	1.16	0.00	-2.0	0.184
21. I ensure that my students know what areas they need to work on in order to improve their results.	2.67	4.33	1.16	0.58	-5.0	0.038

Table 4 Continued

Statements	Mean		Std. Dev		*t*- value	*p*-value
	pre	post	*pre*	*post*		
22. I give my students opportunities to ask questions.	3.33	4.00	0.58	0.00	-2.0	0.184
23. My students know what the evaluation criteria for their work are.	3.33	4.33	0.58	0.58	-1.7	0.225
24. I ensure that my students know what they can learn from their SBA.	3.00	5.00	1.00	0.00	-3.5	0.074
25. I can recognize when my students reach their learning goals.	3.00	4.67	1.00	0.58	-2.5	0.130

Table 4 above showed for both the monitoring and scaffolding sub scale statements there have been an increase in the mean after the intervention. However, 22 statements (excluding 12, 16 & 21) had *p* values greater than 0.05 indicating that the difference in the means were not meaningfully different. Hence, the null hypothesis of "there is no significant change, in treatment teachers' perceptions" was accepted.

Though, statement 12 and 21 showed there were significant differences in the mean with values before the intervention (M=2.67, SD= 0.58) and after the intervention (M= 4.33, SD=0.58) with t (2) = -5.000, $p = 0.038$ and before the intervention (M=2.67, SD=1.16) and after the intervention (M= 4.33, SD=0.58) with t (2) = -5.000, $p = 0.038$ respectively for this study. Hence, the teachers may have increased the number of opportunities given to students to show what they learnt in class as well as informed students on what they needed to do to improve their learning. The *p* value for statement 16 cannot be computed thus it cannot be determined whether the difference in its mean was significantly different. To reinforce these decisions, the percentage of treatment teachers choosing the various options for the above mentioned statements before the intervention (pre) and after the intervention (post) was calculated and presented in Figure 4 below.

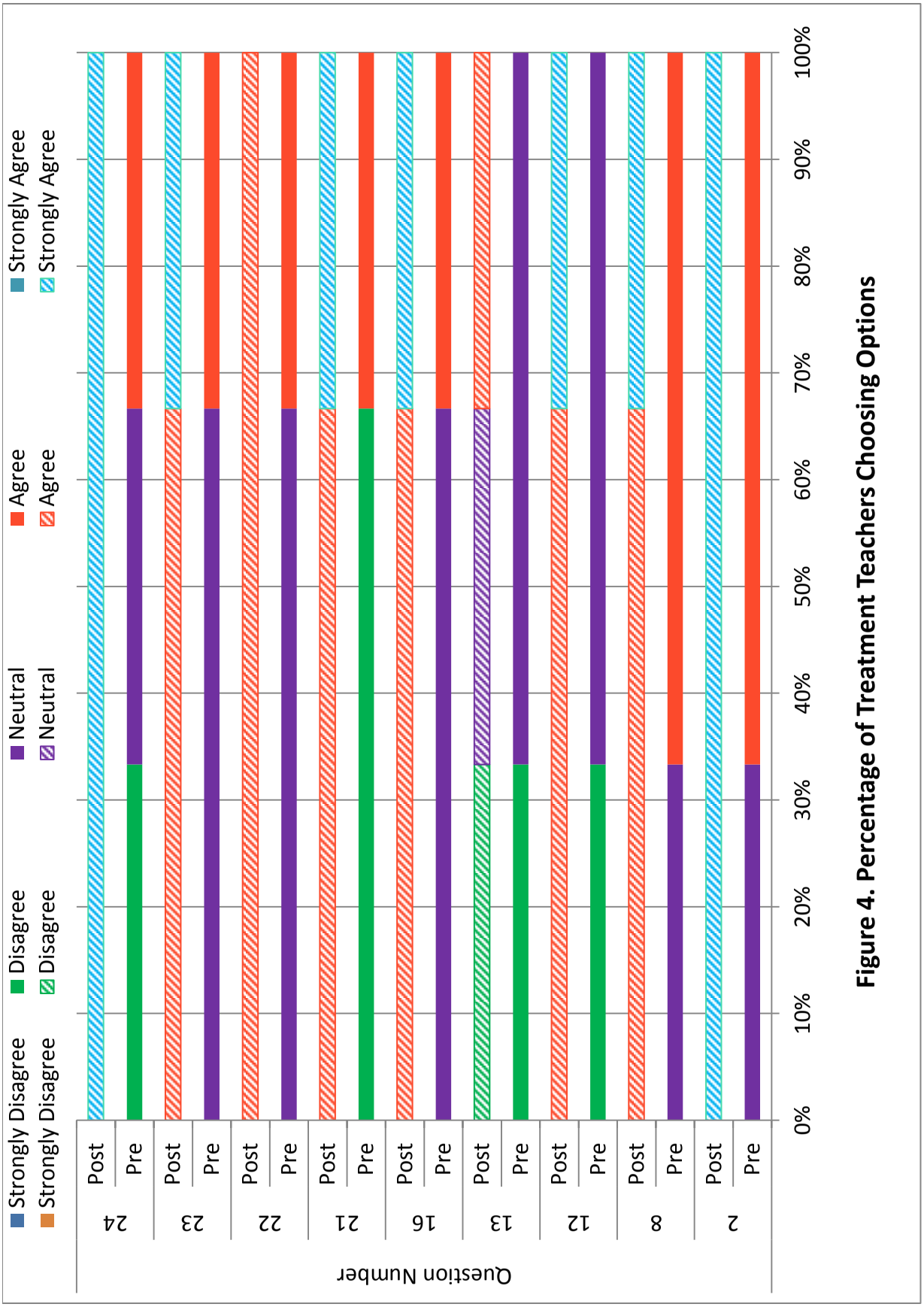

Figure 4. Percentage of Treatment Teachers Choosing Options

Drawing from the analysis of Table 4 and Figure 4 above, statement 12 showed a significant difference in the mean. 66.7% of the teachers had a neutral perception before the professional development workshop and after the workshop 66.7% of the teachers agreed to the statement. This indicated that teachers attempted to discuss with their students how they should utilize their strengths to improve their performance in their SBAs. Item 21 also showed a significant difference when 66.7% of the teachers chose disagree in the pre questionnaire and then changed their views since 66.7 % of teachers chose agree in the post questionnaire. The data suggested that teachers ensured that students knew what areas they needed to work on to improve their results. Teachers seem to have identified the gap between the student's current status in learning and the desired target but were not satisfied with their professional advancement in the areas of encouraging more student involvement and giving explicit descriptive feedback.

Figure 4 displayed 100% strongly agreed bars for statements 2 and 24. This confirms that all three treatment teachers encouraged students to reflect on what they are doing and learning from the SBA practical activities. Statements 13, 22 and 23 had the largest percentage of teachers having a neutral opinion before the workshop. However after the workshop, teachers seem to have changed their perceptions towards their practice. There was an increase in agree and strongly agree options for the statements that assured the teachers informed students of the evaluation criteria, gave them opportunities to ask questions as well as discussed with the students their strengths and how they can improve their weak points.

In statement 16 the percentage of teachers choosing neutral decreased to 0 after the intervention but the percentage for agree increased from 33.3 % to 66.7% and the percentage for strongly agree increased from 0 to 33.3 %. Although the t- test was inconclusive, Figure 4

confirmed that teachers seem to believe the students were granted more opportunities in class to show what they learnt.

To determine whether these changes were due to the intervention, the experimental group was compared to a control group. The control group was composed of participants who did not receive the intervention. In this study the control group consisted of two teachers who closely resembled the participants in the experimental group. The results from their pre and post questionnaire were tabulated (see Table 5 in Appendix H) and used to test the hypothesis, "there is no significant change, at the 0.05 alpha level, in the control teachers' perceptions towards the use of formative assessment during their SBA practical activities." Table 5 revealed that there were no changes in 17 out of the 25 statements which accounts for 68% of the questionnaire. The following is Figure 5 showing the percentage of control teachers choosing the various options in the remaining seven statements (2, 4, 8, 13, 16, 20 &21) as well as item 22 of the questionnaire before the intervention (pre) and after the intervention (post).

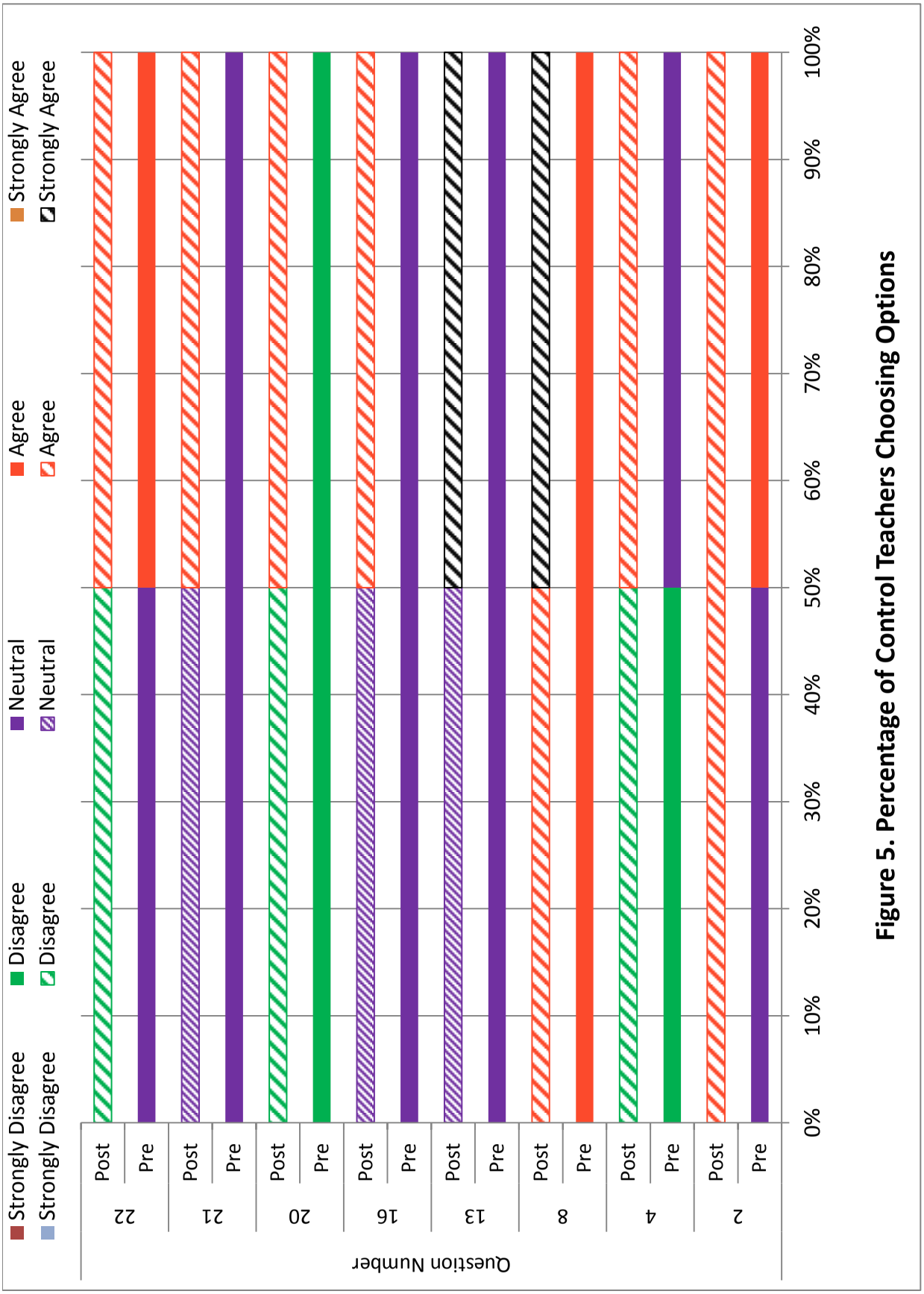

Figure 5. Percentage of Control Teachers Choosing Options

Figure 5 shows statement 2 had an increase in the option agree from 50 % to 100 % which suggest teachers appeared to think they encourage students to do self-reflection. This increase was similar to that observed with the treatment teachers. Quite the opposite was displayed in statement 22 as there was an increased from 0 to 50% of the teachers choosing disagree. This suggests that the control teachers realised they were not giving the students sufficed opportunities to ask questions during their SBA practical activities. In Figure 5 the six statements (4, 8, 13, 16, 20 &21) revealed that there were improvements in the control teachers' opinions from either neutral to agree or disagree to agree. The changes in the choice of scores for these statements resulted in the means before and after the intervention to differ. In order to determine whether or not this difference in means were considerably different, a paired sample t-test was done and the results were observed. Table 6 below shows the results obtained from t-test.

Table 6

Paired Samples T-Test for Control Teachers

Statements	**Mean**		**Std. Dev**		**t-value**	**p- value**
	Pre	Post	Pre	Post		
2. While working on their SBA activities, I ask my students how they think they are doing.	3.50	4.00	0.71	0.00	-1.0	0.500
4. I ask my students to indicate what went well and what went badly.	2.50	3.00	0.71	1.41	-1.0	0.500
8. I encourage my students to improve on their learning processes.	4.00	4.50	0.00	0.71	-1.0	0.500
13. Together with my students, I consider ways on how to improve on their weak points.	3.00	4.00	0.00	1.41	-1.0	0.500
16. During my class, students are given the opportunity to show what they have learned.	3.00	3.50	0.00	0.71	-1.0	0.500
20. I allow my students to ask each other questions during class.	2.00	3.00	0.00	1.41	-1.0	0.500
21 I ensure that my students know what areas they need to work on in order to improve their results.	3.00	3.50	0.00	0.71	-1.0	0.500
22. I give students opportunities to ask questions.	3.50	3.00	0.71	1.41	1.0	0.500

Table 6 revealed that all eight statements have a *p* value greater than 0.05 which signified that there were no statistically significant differences in the means. Thus, the null hypothesis which states that there is no significant change in the control teachers' perceptions towards the use of formative assessment during their SBA practical activities was accepted.

The data analysis verified that the professional development workshop had an effect on the three treatment teachers. Although the t-test showed there was no significant difference, the increase in the percentage of teachers choosing the options agree and strongly agree proved that teachers were of the opinion that they were improving their practise. The two control teachers had business as usual hence their responses did not change significantly in their post questionnaire at the end out the study.

Qualitative Analysis

The data obtained from the three treatment teachers' reflective journals during the professional development workshop was analysed to obtain the teachers' perceptions towards the use of formative assessment during their SBA practical activities. The teachers' names and personal details were anonymised and the pseudonyms Elizabeth, Isabella and Brian were assigned to the teachers. An iterative process of close reading and re-reading of the data was done to retrieve the codes which consisted of the relevant information describing the attributes of the teachers as it is related to the context of the research question. The codes with similar characteristics were grouped into categories and these categories were given descriptive labels.(See Table 7 in Appendix I) The categories that appeared to bear some relationship to each

other were collapsed into themes. Figure 6 below provides a summary of the three main themes and categories emerged from the analysis of the journals (See Appendix J).

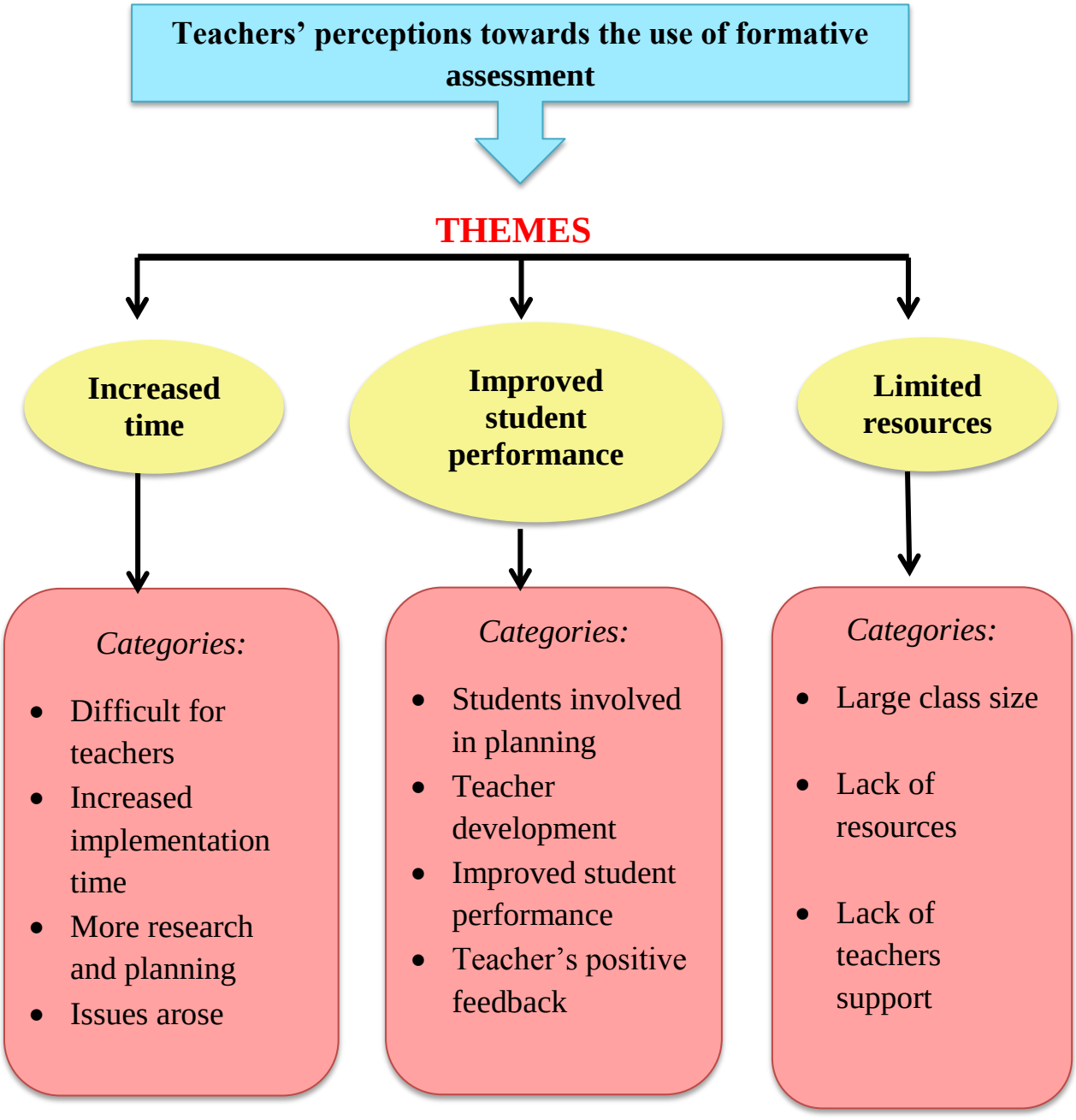

Figure 6.Summary of themes and categories obtained from the teacher's reflective journals.

Increased Time

Increased time was perceived as the greatest limitation when implementing formative assessment for the teachers. It is not a program that can be "adopted" but is a process that teachers learn through practice, reflection, and revision. Hence it took time to plan and implement an SBA with high quality formative assessment.

Difficult for teachers

Not all teachers have bought in to formative assessment as they felt that they do not need to change their teaching methods, or that it was too much work. Isabella, the biology teacher confessed:

> "… it seems complicated. My perception was that it would take a lot of time and effort on my part….This is not an option due to limited free time in school."

This feeling was shared by Elizabeth as she commented:

> "After the lab, I was extremely exhausted. It was definitely a lot of work….. I still have to work on my time management techniques."

Brian felt no different. He shared the view that it was more time consuming than the 'normal' lab exercise.

Increased implementation time

Teachers felt overwhelmed when implementing formative assessment in their classes. They had to think about how to cover the curriculum while using formative assessment in the classroom. This is the interconnecting of the domain, pedagogical and assessment knowledge which is the critical element for successful implementation. Teachers discussed in the group their challenges faced and Elizabeth highlighted one in particular in her journal, "We realised that

finishing on time was a challenge across the board…" They also commented, "it took longer than I expected" and "learning should not be rushed."

More research and planning

Although teachers welcomed the idea of using formative assessment, they have found themselves spending an increased amount of time researching and planning for their classes. They have to plan how to involve the students in order to achieve the sub goals of the learning progression. One teacher mentions, "it is an extra workload", while another says, "it comes with a lot more preparation." Isabella stresses:

> "Planning a lesson geared away from the usual writing notes and doing a question would have required a lot thought, research an preparation for a single class…overall I think I need to make a bigger effort because a lot of time goes into researching and planning for the classes."

She added:

> "…it is a useful method that should be used for the more difficult labs that require a lot of thought and consideration by the students."

Teachers believed that they have had to give time to include formative assessment to ensure it contributes effectively to the students learning.

Issues arose

Teachers implemented SBA labs with formative assessment twice during the professional development workshop. Two unforeseen issues were met and a teacher mentions it as:

> "…the quicker students became bored and restless while waiting on the slowed ones" and"…teachers expressed unwillingness to run over a few minutes into recess or lunch time to ensure that the objectives of the lab were met."

Hence, the increased time did brought some concerns with respect to the teachers managing their planning, implementing the SBAs and ensuring learning takes place by all students at a comfortable pace.

Improved Student Performance

Teachers noted several indicators of improvements resulting from using formative assessment. These included students developing a clear understanding of learning targets and receiving feedback that helps them to improve.

Students involved in planning

Teachers succeeded in involving students into their SBA activities which is one of the pillars in the formative assessment theoretical framework. To ensure students' performance increase, teachers considered the types of students they have in their classroom in their planning. Elizabeth describes it as:

> "…thought about what strengths different students had" and "thought about my students as individuals…"

Isabella echoed the same as she said

> "…determine the various types of students I would need to cater for."

The teachers' action of identifying their students ensured their activities consisted of objectives that were attainable by their students.

Teacher development

Participating in formative assessment aided teachers in developing the skills to detect student's weaknesses or errors at an early stage and then providing feedback on precisely what they need to do to progress. Teachers gained knowledge and skills to develop the active learning process, for example as Elizabeth remarked, "I was able to address problems early on….they (students) could be corrected at the start..."

Improved student performance

Formative assessment strategies used in SBA supported students in developing the reasoning and sense-making skills that they need to reach specific learning targets. It also helped students with the social construction of knowledge. Hence, sub goals from the learning progression were achieved. An example was given by Elizabeth, the Chemistry teacher as she mentioned:

> "This discussion eventually led students to create their own procedure" and "Students seem to understand why they were doing things a certain way and they asked more relevant questions."

A similar view was shared by Isabella the Biology teacher as she commented:

> "…the students grasp the theory behind the lab and recognised it as a teaching aid" and "…they are thinking more practical and bring up more sensible or knowledgeable ideas."

The third teacher, Brian saw the use of formative assessment as a tool to improve his students' cognitive skills. He mentioned in his journal:

"I could use in order to get my students to practice more high order skills…"

Teachers observed an increased in student understanding as well as an increase in student participation while the class is in progress. This was proven as one teacher commented, "…greater involvement by my students" and "the students look forward to their group discussions." This improved student engagement provided information for the teacher about the student current learning status and for the students to determine when they need assistance. Another teacher said, "…other boys became excited and started answering questions without being asked." Brian highlighted on advantage of the increased participation as, 'the weaker students could be encouraged and assisted by the stronger ones.

Teachers commented that students were doing more in the classroom, and paid more attention to the criteria for a good piece of work much more than they used to. Teachers also felt that, in the absence of marks, students are doing much better. Elizabeth gave an example:

"Students took their labs more seriously."

Isabella also noted a change as she said:

"They were very careful and precise in their execution."

Hence, formative assessment was seen to increasing student engagement, understanding and practical skills which subsequently improves student learning.

Teacher's positive feedback

Teachers noted that it has taken some effort to implement formative assessment during their SBA activities but they have also changed their initial views after observing the increased student performance. Two out of the three treatment teachers mentioned positive feedback after being actively involved in their own learning on the use of assessments. They declared:

"…I managed to control the class"

"I felt a little more confident in utilising formative assessment…it showed promise."

Limited Resources

The practice of formative assessment can help teachers inform instruction and can improve student success. However, conducting effective formative assessment was easier said than done. The teachers were faced with limitations such as lack of infrastructure, large class size and lack of learning community for teachers. These were some issues teachers saw necessary that may have affected the way they integrated more ongoing assessment into their teaching.

Large class size

The environment of the classroom should give evidence on what students are currently working on as well as inform the teachers on which students they may need to assist. However, with large classes it was difficult to meet the individual needs of the students. It was difficult to identify the 'gap' and aid in their learning. For example, during the introductory session on formative assessment, one teacher did saw this as a limitation as she said:

"…appeared to be impossible…classes are already very large."

Teachers implementing formative assessment in classes with a large number of students noted a distraction was created as most students wanted to share their ideas at the same time. One teacher described is as

"It was a very noisy ten minutes…"

While another teacher refused to have the class discussions. He commented:

"This generated a lot of discussion but could not entertain them due to excessive noise created."

However, students must feel comfortable to take risks and collaboration with the teacher in order for formative assessment to fully take root in a classroom. On the other hand, with the large classes this became out of hand because while the students were working in groups they had to be corrected multiple times thus making it difficult to for the teacher to attend to all. This point was indeed raised prior to the implementation as another teacher mentioned:

"The class of 36 students requires careful instruction and control…"

Lack of resources

School resources have a significant impact on a teacher's ability to maximize their effectiveness on the use of formative assessment. One main issue raised was access to the lab. The school has two Science labs that accommodate the entire school population but preference is given to the examinations classes. Yet, Elizabeth the Chemistry teacher emphasized:

"There exists a challenge in scheduling labs because the lab itself is shared between the Biology and Chemistry teachers."

In addition to this, there was a lack of equipment in the lab to cater for the large number of students in the various classes. Isabella, the biology teacher in particular stressed that "the availability of the resources in the school to carry out such an assessment" must be considered.

Lack of teachers support

Initially teachers perceived formative assessment was very difficult to implement and irrelevant to their practice. They felt like this because the school lacked professional learning communities or support teachers who understood that formative assessment will look different in each classroom, based on classroom context, content area focus, and teacher pedagogy. Hence, at the start of the study a teacher made the comments:

"I could not conceptualize how it could be implemented in my class….a great deal of trepidation and uncertainty."

The same feelings were shared by a second teacher as she remarked

"I had no clue on how I going to do this in my class."

As the study concluded the teachers were satisfied by the increased students' performance however they did not indicated whether or not they are now better able to integrate formative assessment efficiently into their SBA activities. Also they did not state whether there will be continued support among teachers hence, this limitation may still exist.

Integrating quantitative & qualitative data analysis

Teachers developed their ability to efficiently scaffold the education goals for students. They spent a lot of time in the class room explaining to each student their strengths, weaknesses and how they can improve. This process was time consuming due to the large number of students in the each class. Hence, teachers found it challenging to complete their classes in a timely manner. Some teachers even had to sacrifice part of their recess and lunch time to complete their activities.

Students were given the opportunity to ask questions and lead class discussion. This helped students gain a better understanding of the subject content and hence improving their overall performance. However due to the large class size and improved enthusiasm of the students, the noise level in the classroom increased and became a major distraction. The teachers saw the integration of formative assessment benefiting the students but it also highlighted their need to improve their time and classroom management skills.

Participating teachers found it difficult to adapt their instructions and ask questions in different ways to meet individual learning needs of the students. They also were not aware whether or not the students in their class room were reaching their learning goals. These trials were met due to a lack of sufficient research and planning for the SBA activities. Teachers needed additional time and guidance to ensure they understood the subject content and how to differentiate their instructions as well as even improve their teacher pedagogy.

SUB QUESTION 3: What are students' perceptions toward the use of formative assessment during their SBA practical activities?

Questionnaires were completed by the students of the 3 treatment teachers and the 2 control teachers before and after the professional development workshop. The pre- and post-questionnaires scores were tabulated (see Table 8 in Appendix K) and analysed graphically and by a statistical t-test. The results were used to test two null hypotheses:

Ho: there is no significant change, at the 0.05 alpha level, in treatment students' perceptions towards the use of formative assessment during their SBA practical activities after being involved in a professional development workshop and

Ho: there is no significant change, at the 0.05 alpha level, in control students' perceptions towards the use of formative assessment during their SBA practical activities after their teachers' were involved in a professional development workshop.

The first hypothesis focuses on the students from the three treatment teacher's classes and they will be referred to as the treatment students. The following is Figure 7 showing the percentage of treatment students choosing the various options in the questionnaire before the intervention (pre) and after the intervention (post).

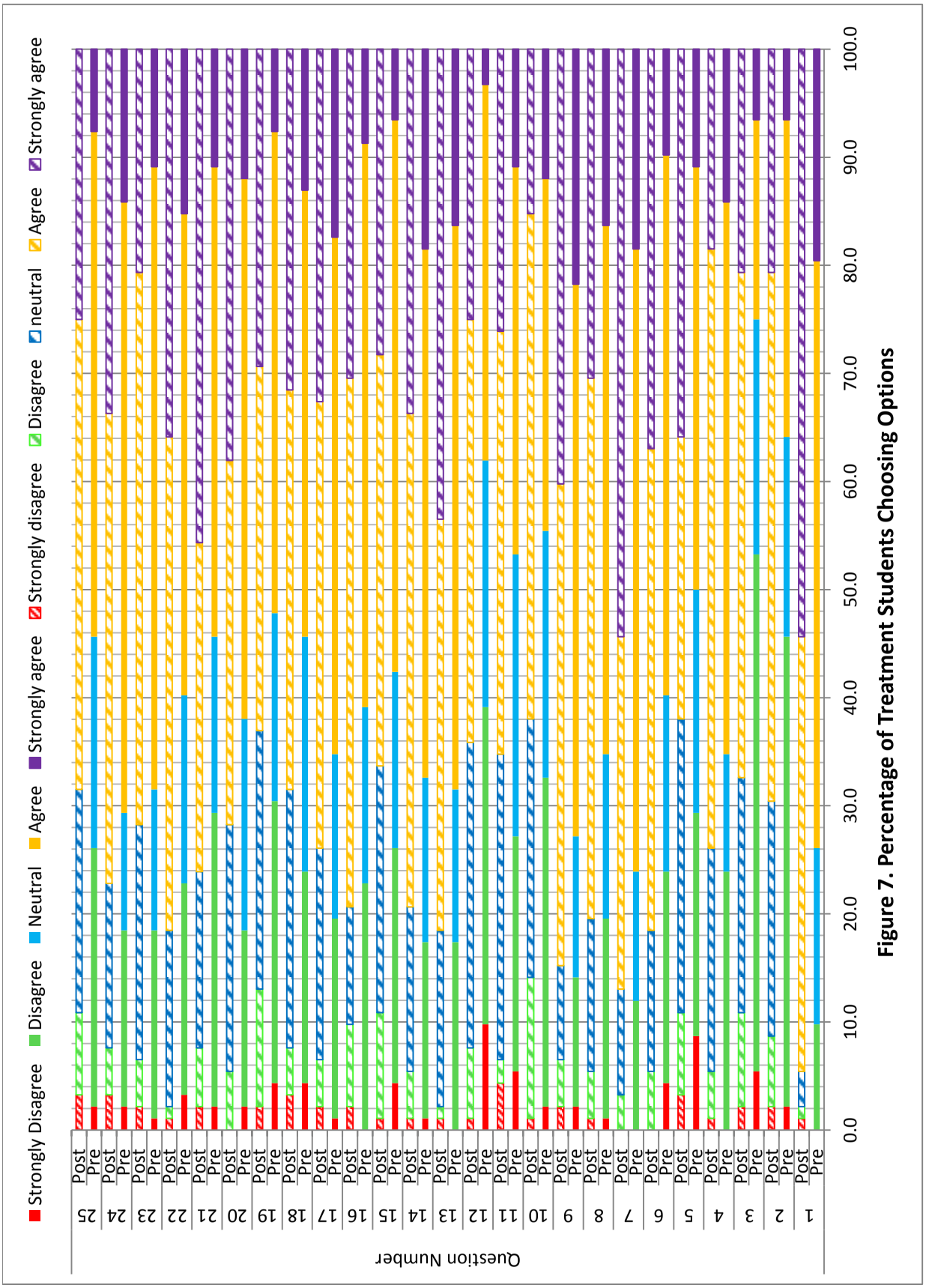

Figure 7. Percentage of Treatment Students Choosing Options

Figure 7 above illustrates a decrease in the percentage of students either strongly disagreeing or disagreeing and an increase in the number of students strongly agreeing in the post questionnaire. This suggests that the students supported the use of formative assessment during their SBA practical activities. Although the teachers perceived that their development on the use of formative assessment was not significant, the students in this study appeared to have benefited from either the small changes or additions to their SBA practical activities.

Item 1 and 7 had the largest increase in the percentage of students choosing the option strongly agree. This suggests that the students favoured the self-reflection aspect of formative assessment. Item 21 showed a similar increase which indicated that students may have preferred a classroom where teacher student interactions were welcomed. On the contrary, items 5,10,11,12 and 19 showed a total of 38%, 38%, 34%, 36% and37% respectively, of students choosing score neutral to strongly disagree. This large fraction of the sample seems to be dissatisfied with the level of individualized feedback received. To support the graphical representations, the results of the SPSS paired sample t-test for the treatment students is presented in Table 9 below.

Table 9

Summary of treatment students' t-test results

Statements	Mean		Std Dev		t- value	p-value
	Pre	**Post**	**Pre**	**Post**		
1. My teacher encourages me to reflect on my learning process and to think about how to improve next time.	3.84	4.46	0.86	0.72	-5.413	.000
2. Whilst working on my activity, my teacher asks me how I think I am doing.	2.95	3.79	1.04	0.92	-6.214	.000
3. My teacher allows me to think about what I want to learn in the SBA activity.	2.73	3.75	10.4	0.96	-7.088	.000

Table 9 Continued

Statements	Mean		Std Dev		t-value	p-value
	Pre	**Post**	**Pre**	**Post**		
4. My teachers inquire what went well and what went badly in my work.	3.55	3.86	1.00	0.81	-2.325	.022
5. My teacher stresses my strengths concerning learning.	3.23	3.84	1.16	1.10	-4.432	.000
6. My teacher identifies my weaknesses concerning learning.	3.41	4.13	1.05	0.84	-5.496	.000
7. I am encouraged by my teacher to improve my learning process.	3.83	4.38	0.87	0.80	-4.616	.000
8. My teacher gives me guidance to assist my learning.	3.61	4.04	1.01	0.85	-4.134	.000
9. My teacher discusses the activity with me to help me understand the subject matter better.	3.78	4.16	0.99	0.92	-2.721	.008
10. My teacher discusses with me the progress I make.	3.22	3.62	1.08	0.94	-3.065	.003
11. My teacher discusses with me how to exploit my strengths to improve my assignment.	3.25	3.80	1.09	1.00	-4.471	.000
12. My teacher and I consider ways to improve my weak points.	2.92	3.80	1.08	0.93	-6.768	.000
13. When I do not understand a topic, my teacher tries to explain it in a different way.	3.67	4.22	0.95	0.84	-4.381	.000
14. My teacher provides me with hints to help understand the subject matter.	3.67	4.07	1.00	0.88	-3.297	.001
15. During class I have an opportunity to show what I have learned.	3.34	3.83	1.03	0.99	-4.103	.000
16. My teacher asks questions in a way I understand.	3.47	3.98	0.94	0.96	-4.398	.000
17. My teacher asks questions that help me gain understanding of the subject matter.	3.62	3.98	1.02	0.95	-3.058	.003
18. My teacher allows for my contribution during the SBA activity.	3.39	3.89	10.8	1.01	-3.826	.000
19. I have the opportunity to ask my classmates questions during the SBA activity.	3.25	3.77	10.7	1.06	-4.079	.000
20. My teacher makes me aware of the areas I need to work on to improve my results.	3.53	4.04	0.98	0.91	-3.965	.000
21. There is an opportunity to ask questions during the SBA activity.	3.34	4.12	1.06	1.01	-5.854	.000
22. I am aware of the criteria by which my SBA activity will be evaluated.	3.49	4.14	1.07	0.81	-5.428	.000
23. When I receive an SBA activity it is clear to me what I can learn from it.	3.60	3.84	0.94	0.88	-2.098	.039
24. My assignments allow me to show what I am capable of.	3.64	4.00	0.99	0.98	-2.762	.007
25. After examining my SBA results, my teacher discusses the report I gave for the SBA with me.	3.34	3.79	1.00	1.01	-3.571	.001

Table 9 demonstrated all twenty five statements with a $p < 0.05$ which indicated that there is a statistically significant difference in the means. This re-iterated the views presented in the graph. Hence, the students endorsed the use of the formative assessment as teachers used it to monitor them and provide scaffolding to ensure they progress. The data collected led to the null hypothesis, "there is no significant change" being rejected and the alternative hypothesis, "there is a significant change, in treatment students' perceptions towards the use of formative assessment during their SBA practical activities after being involved in a professional development workshop" was accepted.

To increase the reliability of the results, and confirm the change was due to the intervention and not any other variable the scores from the students of the control teacher were analysed. The following is Table 10 showing the results of the SPSS paired sample t-test obtained from the controlled students.

Table 10

Summary of control students' t-test results

Statements	Mean		Std Dev		t- value	p-value
	Pre	**Post**	**Pre**	**Post**		
1) My teacher encourages me to reflect on my learning process and to think about how to improve next time.	3.69	3.69	0.86	0.92	.000	1.000
2) Whilst working on my activity, my teacher asks me how I think I am doing.	2.94	3.08	1.01	1.08	-1.000	.324
3) My teacher allows me to think about what I want to learn in the SBA activity.	2.83	3.03	0.97	1.16	-1.484	.147
4) My teachers inquire what went well and what went badly in my work.	3.44	3.53	1.05	1.13	-.595	.556
5) My teacher stresses my strengths concerning learning.	3.14	3.17	1.07	0.97	-.226	.822
6) My teacher identifies my weaknesses concerning learning.	3.42	3.36	1.02	1.20	.349	.729
7) I am encouraged by my teacher to improve my learning process.	3.78	4.06	0.96	0.92	-2.249	.031
8) My teacher gives me guidance to assist my learning.	3.56	3.81	0.94	0.86	-2.707	.010

Table 10 Continued

Statements	Mean		Std Dev		t- value	p-value
	Pre	Post	Pre	Post		
9) My teacher discusses the activity with me to help me understand the subject matter better.	3.75	3.75	1.03	0.91	.000	1.000
10) My teacher discusses with me the progress I make.	3.31	3.36	1.26	0.93	-.312	.757
11) My teacher discusses with me how to exploit my strengths to improve my assignment.	3.36	3.22	1.10	0.99	1.221	.230
12) My teacher and I consider ways to improve my weak points.	2.97	2.94	1.28	1.29	.167	.869
13) When I do not understand a topic, my teacher tries to explain it in a different way.	3.50	3.64	1.10	1.02	-1.303	.201
14) My teacher provides me with hints to help understand the subject matter.	3.36	3.53	1.02	1.00	-1.183	.245
15) During class I have an opportunity to show what I have learned.	3.36	3.22	0.87	1.20	.867	.392
16) My teacher asks questions in a way I understand.	3.42	3.58	1.03	0.94	-1.000	.324
17) My teacher asks questions that help me gain understanding of the subject matter.	3.50	3.64	0.85	1.05	-.777	.443
18) My teacher allows for my contribution during the SBA activity.	3.47	3.42	10.3	0.94	.422	.676
19) I have the opportunity to ask my classmates questions during the SBA activity.	3.36	3.44	1.22	1.13	-.463	.646
20) My teacher makes me aware of the areas I need to work on to improve my results.	3.39	3.42	1.25	1.18	-.373	.711
21) There is an opportunity to ask questions during the SBA activity.	3.44	3.39	1.05	1.13	.388	.701
22) I am aware of the criteria by which my SBA activity will be evaluated.	3.47	3.78	1.03	1.07	-2.231	.032
23) When I receive an SBA activity it is clear to me what I can learn from it.	3.44	3.50	0.90	0.91	-.388	.701
24) My assignments allow me to show what I am capable of.	3.83	4.00	0.70	0.93	-1.357	.183
25) After examining my SBA results, my teacher discusses the report I gave for the SBA with me.	2.97	3.11	1.11	1.35	-1.000	.324

Table10indicatedthe seventh and eighth statements showed there were a significant difference in the mean with values before the intervention (M=3.78, SD= 0.96) and after the intervention (M= 4.06, SD=0.92) with t (35) = -2.249, p = 0.031 and before the intervention (M=3.56, SD=0.94) and after the intervention (M= 3.81, SD=0.86) with t (35) = -2.707, p = 0.010 respectively for this study. There was a significant difference in the mean in statement 22 as well with values before the intervention (M=3.47, SD=1.03) and after the intervention (M=

3.78, SD=1.07) with t (35) = -2.231, p = 0.032.These three statements described teachers informing students of the marking criteria and encouraging and guiding them in the learning process to become successful students. Since the teachers of this group were not participants of the professional development workshop, the differences observed may have been the result of an external factor that was not controlled during the study. Although the means differ, the majority of the statements showed there were no statistically significant differences in the means which leads to the acceptance of the null hypothesis of "there is no significant change, in control students' perceptions".

The control students' views differ from that of the participating students which indicated that the participation of teachers in the professional development workshop persuaded teachers to make a difference in the classroom. This transformation was appreciated by the students' and changed their personal perception towards using formative assessment as an assessment for learning within their SBA practical activities.

Summary of findings

The analysis of the data revealed the professional development workshop enhanced teachers practise by improving their use and integration of a variety of formative assessment within their school based assessment. The perceptions of teachers all indicated that they have feelings of uncertainty in the implementation. Teachers were critical, finding several factors that militated against implementation such as insufficient time and resources. However, they saw an improvement in students' performance and appreciation of the subject content. The students supported the use of formative assessment and welcomed the self- reflection and increased

classroom discussions. Teachers and students found the individualised feedback was insufficient and this was due to the limited time assigned to classes with a large number of students. Increasing the use of formative assessment was beneficial to both the students and teachers, but teachers are yet to develop the skills to manage their time and instantaneously adapt their practice to ensure students meet their learning targets.

CHAPTER 5- Discussion& Recommendations

Introduction

This study was disused to be an action research project that sought to capture how a professional development workshop be used to improve teachers' use of formative assessment in School Based Assessments. Formative assessment is essential as it allows the student and teacher to gather a more detailed understanding of the student's abilities, which can be used to inform remediation, re-teaching, or instructional strategy in the learning process. Having been in the teaching profession for some years I discovered that teachers use SBA activities only to obtain a grade to contribute to the external examinations. They hardly ever used the activities to adjust their practice to enhance the students' understanding of the subject content. Hence, to ensure teachers were enlighten on the planning and implementing of formative assessments a three months professional development workshop was held.

The study involved a pre- post-test design with a treatment group of 3 teachers and 92 students and a control group of 2 teachers and 36 students of a denominational boy secondary school in south Trinidad .In this section the impact of the workshop on the teachers' practice and the teachers' and students' perceptions on the use of formative assessment during their SBA practical activities will be discussed extensively. Discussion of the findings will be presented and compared to previous studies to determine whether these findings are consistent with the literature in these fields. Following these discussions will be the implications of the study, recommendations and conclusions.

Discussion

In this study I used Heritage's (2007) theoretical framework for formative assessment to design and implement a professional development exercise to improve three treatment teachers'

use of formative assessment in SBAs. The findings of the study will be discussed in relation to the four core elements of the formative assessment framework: 1) identifying the "gap," 2) feedback, 3) student involvement, and 4) learning progressions.

The statistical analysis of the observations of the teachers' practice revealed that teachers used a variety of assessment activities to engage the students and communicated clearly the purpose of these activities in class. The t-test results showed a significant difference for the questionnaire items describing the manner in which the activities were used to increase student conversations. Teachers listened to these conversations, identified the students' misconceptions and addressed them immediately. This practise is what Heritage (2007) called a strategy for gathering evidence of students learning. The teachers also indicated in the questionnaire that they ensured students knew what area they needed to work on to improve their results and attempted to give them the necessary guidance required. They provided scaffolding which describes the support teachers give to students to move them from what they already know to what they can do next. Sadler (1989) recognised this as the crucial purpose of formative assessment as it transports students closer to their educational goals.

However, teachers did not readily develop the skills to identify the 'gaps'. They encountered difficulties as they mentioned in their reflective journals, "I was unable to address problems early on…" and "…appeared to be impossible … classes are already very large." The literature did advise there would be barriers that exist in implementing formative assessment such as large class sizes and heavy workloads which could lead teachers to believe formative assessment whilst having a solid theoretical foundation, risks being somewhat impractical, too time-consuming and thus incompatible with the demands of schooling. (Carless, 2007)

Findings further revealed the inadequacy of teachers' use of formative assessment to provide feedback for the students and themselves. The observation of teachers showed they had difficulty motivating students and determining whether they understood the subject material. While the statistical t-test results also confirmed there were no significant differences in the way the teachers used the assessment to efficiently adjust their instructions to meet the diverse student's needs. However, Shepard (2008) stated that formative assessment is made formative only if it is immediately used to make adjustments so as to form new learning. Likewise, it was noted in the literature that assessment can be considered formative only if it results in action by the teacher and students to enhance student learning. (Black, 1993) Hence, there was a shortcoming in the professional development workshop that may have led to inefficient use of the assessment to provide feedback.

The graphical representation of observations showed in item 7 there was an increase in the mean score which indicated teachers improved their timely, specific and understandable feedback to students. Interestingly though the students' questionnaire results showed a large fraction of the sample dissatisfied with the level of individualized feedback received. Therefore, the teachers may have attempted to improve the quality of their feedback and teaching but this did not add to the students learning. Just as Bennett (2011) explained in the writings if the inferences about students resulting from formative assessment are wrong, the basis for adjusting instruction is weakened. Similarly, if the inferences are correct but instruction is adjusted inappropriately, learning is also less likely to occur.

Additionally, the data collected from the teacher's questionnaire demonstrated an increase in student involvement during SBA sessions. All three teachers encouraged students to reflect on what they are doing and learning from the SBA practical activities. They also urged

students to consider ways to utilize their strengths and improve their weak points to increase their performance. These practices encourage students to become autonomous learners as described by Little (1994) as "the capacity for detachment, critical reflection, decision making, and independent action" (p. 81)

Teachers also involved students in their planning as stated in their journals, "… thought about the strengths different students had" and "...students I would need to cater for." They went on further to describe the improved student performance seen, "… discussion eventually led students to create own procedure…they are thinking more practical and bring up more sensible and knowledgeable ideas" and "…greater involvement by my students." These findings were supported in Hong Kong by their recent assessment reform policy saying that formative assessment used in schools equipped students with the relevant learning skills and abilities to support them for a lifetime (CDC 2001).

Teachers felt satisfied with the use of formative assessment and expressed it in their journals by mentioning, "I felt a little more confident…it showed promise." These views were echoed in research by Wiliam, Lee, Harrison and Black (2004) who showed that formative assessment increased student involvement in their own learning and teachers' professional satisfaction. As well as by Black & Wiliam (1998) who indicated that formative assessment, if properly implemented in schools, is a powerful means to improve student learning.

Learning progressions are foundational to eliciting evidence about learning to close the gap between current and desired performance, providing feedback and involving students in the assessment and learning process. All support and guidance delivered to students must be interconnected to a learning progression (Heritage, 2007). This study showed that teachers

developing sub skills that are acts as building blocks to learning goals. These include encouraging classroom discussions, inspiring students to become autonomous learners and increase in student understanding subject content.

However teachers found themselves spending an increased amount of time researching and planning for their classes. One teacher remarked, "it is an extra workload". Furthermore during implementation teacher found it difficult to meet the individual needs of the students. Another teacher explained, "…appeared to be impossible…classes are already very large." Popham (2008) endorses this view, as he says theoretically teachers and students can benefit from assessment information, but in the real world, it is unrealistic and would be exhausting. According to the teachers in the study this revolution requires the investment of great deal of extra time and effort for the change to be implemented properly. Nonetheless, supporters of formative assessment such as Black & Wiliam (1998) indicates that, if properly implemented in schools, formative assessment is a powerful means to improve student learning.

Implications

The findings of this report can impact upon various stakeholders including students, teachers, administrators and even society. Infusing formative assessment into SBA can assist students in developing a deeper understanding of science and scientific processes. Students may develop greater interest and motivation to learn science and become more engaged in scientific activities. Thus, teachers and administrators may be faced with less indiscipline in the classrooms. This may also result in more students entering science-related careers leading to an increase in productivity in the country.

Additionally, this intervention could assist educators in realising their initiatives for enhancing their practice. Educators are more competent in creating students centered classrooms, with a comfortable environment where each child can share their ideas and learn from each other. Teachers as educators can listen to what students say and look at what students do to assess their level of understanding and monitor their progress to stated learning goals. Though, I believe that additional professional development beyond these three months would have yielded stronger evidence. In particular, I felt that more time was needed to help teachers with adjusting their instructions and providing feedback to students.

The community, too, may benefit from students enhanced understandings of science as they develop into more productive citizens. Students become more responsible while carrying out practical activities and understand the significance of their actions. They would be able to make a more meaningful contribution to society and to the economy of the country.

Recommendations

This section discusses recommendations in the context of formative assessment implementation on a large scale.

- Staff Training

Training could be conducted at workshops and professional development seminars hosted by the Ministry of Education (MOE). The MOE can make this training compulsory for all science teachers so that they will be adequately equipped with the knowledge and skills from which their students will benefit. The teachers may need to move away from traditional instructional strategies such as “chalk and talk” and adopt a more constructivist approach to learning. Strengthening assessment reform in classrooms nationally is should be a long-term undertaking. To get positive, permanent result there must be an ongoing, sustained and high-quality

professional development. Also it should be conducted by qualified, experienced personnel in the field of assessment and education.

- Supportive Environment

Teachers should also be encouraged to collaborate actively through in-school professional learning communities. Professional learning communities or collaborative work cultures at the school are critical for the implementation of reforms. Collaboration among teachers can build key domain knowledge as well as pedagogical content knowledge and assessment skill linked to modifying instruction. This can be done by employing techniques such as pair coaching, reflecting on how specific activities had fared in their different classes, and planning for future lessons to engage students in evaluating their own learning. For example, when teacher communities develop common formative assessments throughout the school year, each teacher can identify how his or her students performed on each skill compared with other students. Individual teachers can call on their team colleagues to help them reflect on areas of concern while each teacher has access to the ideas, materials, strategies, and talents of the entire team. Hence, teachers can support each other with the goals to improve student learning.

- Resources

Ongoing resources are an important part of making change work. The understanding, therefore, must be if formative assessment is to be successfully implemented in schools, the Ministry of Education must provide the resources to support the educational change. Resources such as laboratory space and equipment are essential for students to generate possibilities and make choices, thereby supporting their sense of autonomy and competence. Teachers need time to plan formative assessment activities for their lessons and reflect upon their experiences. They also need additional time to understand and respond to the learning needs of individual pupils when

using formative assessment approaches such as tracking tools, providing effective feedback or peer learning. Thus, resources such as materials and time are requires to ensure successful implementation of formative assessment.

Conclusion

Formative assessment is an integral part of the teaching learning process. This action research used a professional development workshop to improve teachers' use of formative assessment in SBA. The findings suggest that the workshop successfully encouraged teachers to prepare and implement their SBA with formative activities in mind. In particularly, teachers improved their practice by involving the students more, informing them of the objectives and discussing with them their strengths and weaknesses. However, teachers had difficulties using the feedback from the assessment to adapt their instruction and to inform students on ways to improve their learning. This may have resulted due to the workshop being only twelve one hour sessions. Teachers had limited time to familiarise themselves with the assessment and pedagogical knowledge shared and had very few practise sessions. Hence, if this type of formative assessment is to be an integral part of a professional practice, there must be a major investment made towards the training of teachers. Beginning teachers must have opportunities to develop and practice the skills of assessing before they become responsible for a class of students.

The professional development workshop required the three treatment teachers and the researcher to work together. We formed a professional learning community, where we shared ideas, found solutions to problems and did peer reviews. I believe forming this group was a major accomplishment because each teacher has different personalities and styles of teaching but

they came together to give each other support and guidance. I hope to see the group continuing its work an increasing in membership. However, it was challenging for me to train my co-workers. I had to deliver the knowledge in a manner whereby teachers appreciate it was to improve their practice and not as additional work. I also had to humbly request their continuous participation multiple times to ensure they were working at the right pace to complete the undertakings that were required. In addition, I was deeply concerned about the way I communicated with the teachers because I did not want to disturb the friendly, co-operative relationship we shared. Hence, I opted to recommend that professional development exercise be co-ordinated from external personnel.

Infusing formative assessment into SBA has shown the teachers how SBA can be used to improve learning while at the same time be entertaining and relevant to the students. Students understand the subject content well plus develop skills such as reasoning and self-reflection which mould them into more productive citizens who are capable of making well-informed scientific decisions. In knowing where students stand on a day-to-day basis enables teachers to determine where they are in relation to where they should be, so that they can provide the appropriate scaffolding to move their students forward in their learning. In short, the effect of assessment for learning, as it plays out in the classroom, is that students keep learning and remain confident that they can continue to learn at productive levels if they keep trying to learn. In other words, students don't give up in frustration or hopelessness. (Stiggins, 2002).

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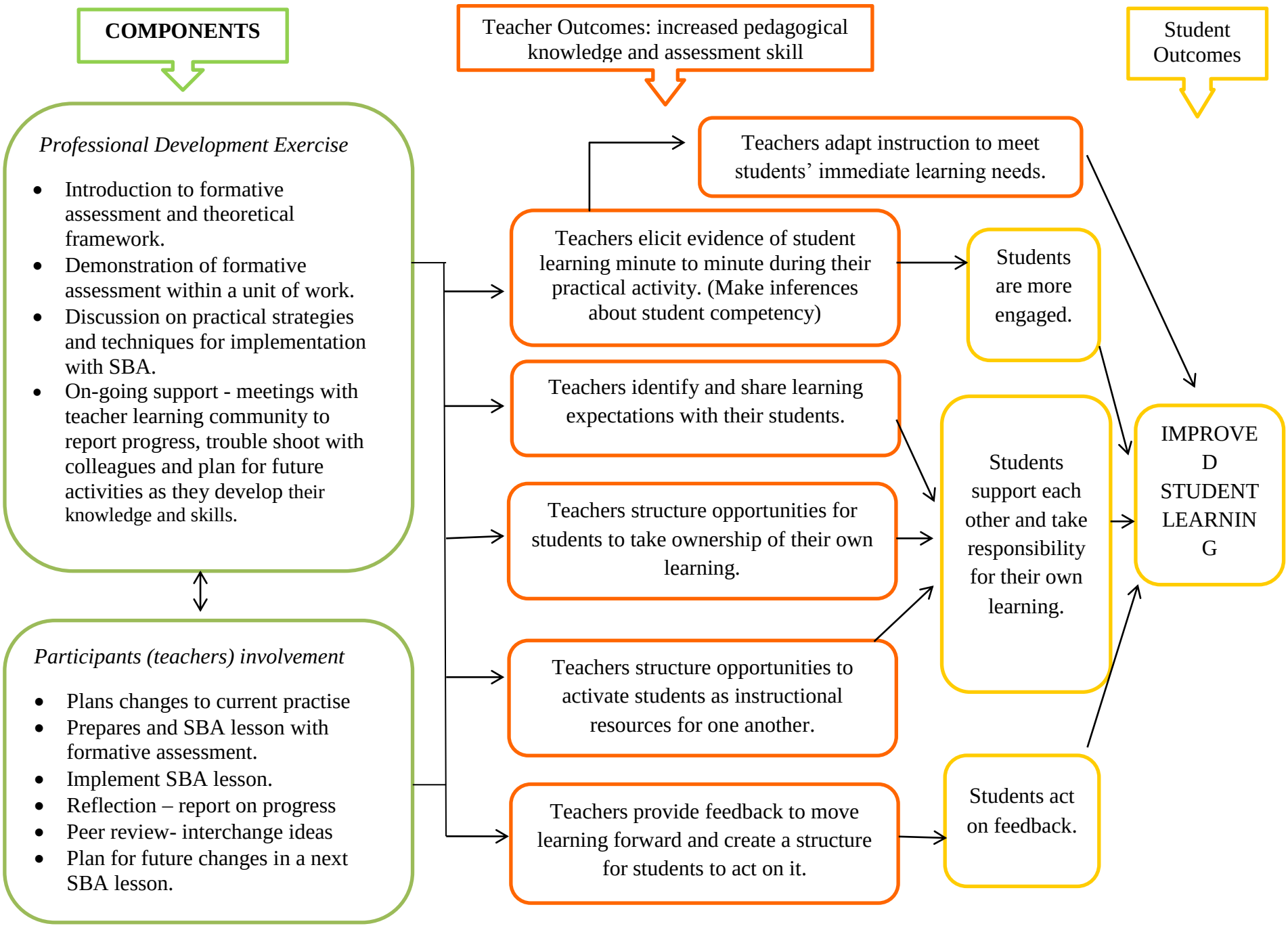
APPENDIX A1

Professional Development Workshop- Diary of Events

Dates	***Events***
1 Face-face 27/01/2014	• Written informed consent submitted to principal. • Written informed consent submitted to teachers. Informed teachers about the professional development exercise.
2 Face-face 03/2/14-07/2/14	• Pre- questionnaires completed by for 5 teachers • Pre- questionnaires for all students • Observed 3 Treatment teachers in their classroom during an SBA activity. • Explained reflective journals to the 3 treatment teachers.
3 Online 10/2/14	• Resource material emailed to the 3 participants- Introduction to formative assessment and theoretical framework. • http://jeromedelisle.com/tobago_workshop_july_2013/first_steps-formative_assessment • http://jeromedelisle.com/tobago_workshop_july_2013/giving_formative_feedback • Power point on Formative Assessment in the Classroom by Margaret Heritage(2007) • Journal Article: The Characteristics of Formative Assessment in Science Education by Beverley Bell & Bronwen Cowie (2000) • Journal Article: Teachers' Concerns on school-based assessment of practical work by Din Yan Yip & Derek Cheung (2005)
4 Face-face 17/2/14	• Discussion on formative assessment – framework, procedures, benefits etc. • Teachers discussed resource materials and how they taught they can use the concept in their classes. • Teachers asked questions to clear up their understandings.
5 Face-face 24/2/14	• I showed teachers lesson plans for a unit of work with formative assessment.(forwarded via email to teachers after the session) • I demonstrated how formative assessment can be implemented with a form 3 class during a 20 minutes session. • Treatment teachers guided into planning an SBA with formative assessment.
6 Online 24/2/14-02/03/14	• Teachers discussed and planned SBA 1 using formative assessment. • Teachers emailed each other their work. • Teachers and researcher reviewed and gave feedback
7 Face - face 03/03/14	• Discussion on the practical strategies and techniques with the implementation of formative assessment in SBA. • Teachers clarified and classified student performance objectives and outcomes. • Final review on SBA 1.

8 Implementation 4/3/14-14/3/14	• Participating teachers re-visited their work. • Participating teachers implemented their plan. • Participating teachers reflected and wrote a journal entry.
9 Face-face 17/03/14	• Peer review session with all the teachers interchanging ideas, reporting progress and showing each other ways to improve. • Teachers requested more discussion on time management issues and classifying objectives. These topics were addressed via emails.
10 Online 24/03/14-28/03/14	• Addition resources send via email – more sample lesson plans • Article- Practice and Challenges of School-based Formative Assessment by Dr LO Yiu Chun • Formative assessment: a critical review by Bennett • Towards learner a
10 Online 01/04/14-11/04/14	• Planned for SBA 2 with formative assessment during their Easter vacation • Participating teachers emailed each other their work on SBA 2. • Participating teachers and researcher reviewed and gave feedback. • Participating teachers re-visited their work.
11 Implementation 22/04/14-29/04/14	• Participating teachers implemented their plan. • Researcher observed and completed post observational checklist • Participating teachers reflected and wrote a journal entry. • Post- questionnaires completed by all students
12 Face-face 30/4/14	• Peer review session with all the teachers interchanging ideas, reporting progress and showing each other ways to improve. • Post- questionnaires completed by 5 teachers

APPENDIX A1 – Theory of Action



APPENDIX B

Sample SBA Lessons

TEACHER: Nirmala Ramnarine

CLASS: Form 4 Physics

TIME: 50 minutes

UNIT: Statics

TOPIC: Turning effect of Forces

<table>
<tr><td colspan="2">REFERENCES (exclude class text. Include page numbers)</td><td></td></tr>
<tr><td colspan="3">CSEC Physics Syllabus(effective May—June 2015)
http://www.youtube.com/watch?v=NNUYKLuRe4g</td></tr>
<tr><td>PREREQUISITES</td><td colspan="2"></td></tr>
<tr><td colspan="3">Knowledge:- Students should know:
1. Fundamental and derived quantities and their S.I. units.
2. Scalars & vectors.
3. Mass and weight.
4. Effects and types of forces.

Skill:- students should know how to:
1. Read and follow instructions.
2. Solve an equation to find an unknown value.</td></tr>
<tr><td colspan="2">MATERIAL & RESOURCES</td><td></td></tr>
<tr><td>For Teacher</td><td colspan="2">For Student</td></tr>
<tr><td>Teaching Notes, laptop, projector</td><td colspan="2">Activity Sheet
Access to lab materials</td></tr>
</table>

OBJECTIVES		Classification
At the end of the lesson, student will be able to: 1. Design a crane to demonstrate the turning effects of forces. 2. Practise cooperation in group activities.		Synthesis Characterization by Value (affective)
PROCESS SKILLS		

During the lesson, student will be engaged in:

Identifying/formulating a problem	☐
Designing and Planning an experimental procedure	☒
Setting up and executing experimental work	☒
Observing and measuring	☒
Recording of data and observations	☒
Interpreting and evaluating data and observations	☐
Communicating scientific ideas, observations and arguments	☒
Applying scientific ideas and methods to solve qualitative and quantitative problems	☒
Decision-making based on examination of evidence and arguments	☐
Extracting from available information data relevant to a particular situation	☐

ACTIVITIES	

Introduction:

1. Ss asked to name some daily examples of forces applied to cause a turning effect.

T.S. "In today's lesson we are going to look at the "turning effect" of a force."

Development:

1. Ss shown a youtube video of the crane.
2. T and Ss discus the operation of the crane. (class discussion)
3. Ss placed in groups of 5.
4. Ss given an outline of their project.
5. Ss start to plan their project.

Consolidation:

1. Ss& T discuss their ideas.

Bridging Statement "In our next class you will build look at some more questions on the principle of moments."

PROJECT: BUILD A CRANE

Cranes are traditionally used in the construction industry or where there is a need to move heavy items. Cranes use a pulley system to reduce the strain and increase the weight that can be moved. Some cranes have magnets rather than hooks to grab items and move them. A model crane can be built using simple craft items and supplies from around the home. You are required to build a crane with either a magnet or hook to lift an object of mass 400g, 40cm above ground level and displace it 40° in a clockwise direction.

You are given:

2 packs of Popsicle sticks	Glue
Masses	2 Thread spools
Cereal box	Scissors

In addition you have access to all laboratory equipment

SCIENCE LESSON PLAN

TEACHER**: NIRMALA RAMNARINE**

DATE:

CLASS: Form 4 S

TIME: 90 Minutes (2 periods)

UNIT: Forces

TOPIC: Centre of gravity

REFERENCES (exclude class text. Include page numbers)	
CSEC Syllabus Avison, J., Henry, D.&Neeranjan, D.(20070 Physics for CSEC (p 34&35)	
PREREQUISITES	

Knowledge:-students should know that:

1) A force is push or pull.
2) Everything is made up of matter.
3) Moments

Skill:- Students should know how to:

1) Read and follow instructions.
2) Work in groups.
3) Use scissors.

MATERIAL & RESOURCES	
For Teacher	For Student
Laptop, video, project & teaching notes	Activity sheet, retort stand, pendulum, cork, optical pin, scissors, cardboard.

CONCEPT OR PRINCIPLE	
The centre of gravity is the centre of mass of an object. It is the average location of the weight of an object. We can completely describe the motion of any object through space in terms of the translation of the centre of gravity of the object from one place to another and the rotation of the object about its centre of gravity if it is free to rotate.	
OBJECTIVES	Classification
At the end of the lesson, student will be able to: 1. Determine the location of the centre of gravity of anirregular body. 2. Practise cooperation in group activities.	Comprehension Characterization by Value (affective)
PROCESS SKILLS	

During the lesson, student will be engaged in:

Identifying/formulating a problem	☐
Designing and Planning an experimental procedure	☒
Setting up and executing experimental work	☒
Observing and measuring	☐
Recording of data and observations	☒
Interpreting and evaluating data and observations	☐
Communicating scientific ideas, observations and arguments	☐
Applying scientific ideas and methods to solve qualitative and quantitative problems	☐
Decision-making based on examination of evidence and arguments	☐
Extracting from available information data relevant to a particular situation	☐

ACTIVITIES	

Introduction:

1. Ssgiven an irregular piece of card board and asked how they would locate the centre of gravity.
2. Ss discuss with the person next to them.
3. Ss share their ideas with the class

T shows the video :http://www.youtube.com/watch?v=R8wKV0UQtlo

Development:

1. Ss placed in groups and given the activity.
2. Ss discuss within their group the activity.
3. T and Ss discus the activity.
4. Ss work on making additions to their mobile.
5. T observes the group work and gives feedback.

Consolidation:

1. Ss present their final product to the class.
2. Ss complete their reflections.
3. T and Ss summarizes how to locate the centre of gravity of irregular shapes.

ACTIVITY

The mobiles our Physics class created with various triangles and regular shapes are a big hit. The principal would like us to add other irregular geometric shapes such as birds and flowers to our mobiles. Remember each mobile has properly balanced geometric shapes hanging parallel to the floor. Find the centre of gravity of the various irregular shapes then add them to the mobile. You may use choose a theme and use additional materials (dry branches, cotton, beads, etc.) to make a creative and fun mobile.

You are provided with cardboard, fish line, ruler, pencil, clothes hanger, soft wire, retort stand, pendulum, cork, optical pin etc.

What shape do you think we should consider making to bring out the theme? Explain your response.

_____

_____

_____

What do you need to do to ensure the point of centre of gravity is found accurately? Explain your response.

_____

_____

_____

Reflections

Write a summary about making your group's mobile include what your group did and how you did it, weaknesses strengths and learnings.

SCIENCE LESSON PLAN

TEACHER**: NIRMALA RAMNARINE**

DATE:

CLASS: Form 4 S

TIME: 50 Minutes (1 period)

UNIT: Forces

TOPIC: Centre of gravity

REFERENCES (exclude class text. Include page numbers)	
CSEC Physics Syllabus Avison, J., Henry, D.&Neeranjan, D.(20070 Physics for CSEC (p 34&35)	
PREREQUISITES	

Knowledge:-students should know that:

4) A force is push or pull.
5) Everything is made up of matter.
6) Moments
7) The different types of triangle and what is a median.

Skill:- Students should know how to:

4) Read and follow instructions.
5) Work in groups.
6) Use scissors.

MATERIAL & RESOURCES	
For Teacher	For Student
Teaching notes	Activity sheet, cardboard, fish line, ruler, pencil, clothes hanger, soft wire etc.

CONCEPT OR PRINCIPLE	

The centre of gravity is the centre of mass of an object. It is the average location of the weight of an object. We can completely describe the motion of any object through space in terms of the translation of the centre of gravity of the object from one place to another and the rotation of the object about its centre of gravity if it is free to rotate.

OBJECTIVES		Classification
At the end of the lesson, student will be able to: 3. Determine the location of the centre of gravity of a regular body. 4. Practise cooperation in group activities.		Comprehension Characterization by Value (affective)

PROCESS SKILLS	

During the lesson, student will be engaged in:

Identifying/formulating a problem	☐
Designing and Planning an experimental procedure	☐
Setting up and executing experimental work	☒
Observing and measuring	☐
Recording of data and observations	☒
Interpreting and evaluating data and observations	☒
Communicating scientific ideas, observations and arguments	☐
Applying scientific ideas and methods to solve qualitative and quantitative problems	☐
Decision-making based on examination of evidence and arguments	☐
Extracting from available information data relevant to a particular situation	☒

ACTIVITIES	

Introduction:

4. Ss given meter rulers and asked to balance them on their fingertips.
5. Ss asked to explain how they got the meter ruler to balance.
6. T explains centre of mass or centre of gravity.

Development:

6. Ss placed in groups and given the activity.
7. Ss discuss within their group the activity.
8. T and Ss discus the activity.
9. Ss work on making their mobile.
10. T observes the group work and gives feedback.

Consolidation:

4. Ss present their final product to the class.
5. Ss complete their reflections.
6. T and Ss summarizes how to locate the centre of gravity of a regular shape.

ACTIVITY

Our Physics class has been asked to decorate the Physics lab. The principal decided mobiles hanging from the ceiling would add to the room. Each mobile will consist of properly balanced regular geometric shapes hanging parallel to the floor. It is our job to determine what geometric shapes to use and how to make the decorations. You may use any 4 regular shapes.
You are provided with cardboard, fish line, ruler, pencil, clothes hanger, soft wire, etc.

What geometric shape do you think we should consider making? Explain your response.

_____

_____

_____

What do you need to do to make a well balanced shape? Explain your response.

_____

_____

_____

EXAMPLE: MAKING TRIANGLES FOR YOUR MOBILE

1. In your group, each one should choose a triangle to make (scalene, isosceles, equilateral, right, or obtuse).
3. Use the method of your choice to draw or construct the medians in order to find the centre of gravity.
4. Carefully cut out your triangle.
5. Attach string or fish line at the centroid then attach to a coat hanger.
6. Balance your shapes to make a good mobile.

Reflections

Write a summary about making your group's mobile include what your group did and how you did it, weaknesses strengths and learnings.

APPENDIX C – Students' Questionnaire

Dear Students:

I am seeking your views and opinions toward the use of formative assessment during your SBA practical activities. The more I know the better my ability to help you the student to succeed. Please help me by circling a number between 1 and 5 that you think is the most appropriate for the statements below. The numbers represents:

1: Strongly Disagree
2: Disagree
3: Neutral
4: Agree
5: Strongly Agree

1) My teacher encourages me to reflect on my learning process and to think about how to improve next time.	5	4	3	2	1
2) Whilst working on my activity, my teacher asks me how I think I am doing.	5	4	3	2	1
3) My teacher allows me to think about what I want to learn in the SBA activity.	5	4	3	2	1
4) My teachers inquire what went well and what went badly in my work.	5	4	3	2	1
5) My teacher stresses my strengths concerning learning.	5	4	3	2	1
6) My teacher identifies my weaknesses concerning learning.	5	4	3	2	1
7) I am encouraged by my teacher to improve my learning process.	5	4	3	2	1
8) My teacher gives me guidance to assist my learning.	5	4	3	2	1
9) My teacher discusses the activity with me to help me understand the subject matter better.	5	4	3	2	1
10) My teacher discusses with me the progress I make.	5	4	3	2	1
11) My teacher discusses with me how to exploit my strengths to improve my assignment.	5	4	3	2	1
12) My teacher and I consider ways to improve my weak points.	5	4	3	2	1
13) When I do not understand a topic, my teacher tries to explain it in a different way.	5	4	3	2	1
14) My teacher provides me with hints to help understand the subject matter.	5	4	3	2	1
15) During class I have an opportunity to show what I have learned.	5	4	3	2	1
16) My teacher asks questions in a way I understand.	5	4	3	2	1
17) My teacher asks questions that help me gain understanding of the subject matter.	5	4	3	2	1
18) My teacher allows for my contribution during the SBA activity.	5	4	3	2	1
19) I have the opportunity to ask my classmates questions during the SBA activity.	5	4	3	2	1
20) My teacher makes me aware of the areas I need to work on to improve my results.	5	4	3	2	1
21) There is an opportunity to ask questions during the SBA activity.	5	4	3	2	1
22) I am aware of the criteria by which my SBA activity will be evaluated.	5	4	3	2	1
23) When I receive an SBA activity it is clear to me what I can learn from it.	5	4	3	2	1
24) My assignments allow me to show what I am capable of.	5	4	3	2	1
25) After examining my SBA results, my teacher discusses the report I gave for the SBA with me.	5	4	3	2	1

APPENDIX D – Teachers' Questionnaire

Dear Colleague:
I am seeking your views and opinions toward the use of formative assessment during your SBA practical activities. Please help me by circling a number between 1 and 5 that you think is the most appropriate for the statements below. The numbers represents:

1: Strongly Disagree
2: Disagree
3: Neutral
4: Agree
5: Strongly Agree

1. After an SBA, I discuss the report submitted with each student.	5	4	3	2	1
2. While working on their SBA activities, I ask my students how they think they are doing.	5	4	3	2	1
3. I involve my students in thinking about how they want to learn at school.	5	4	3	2	1
4. I ask my students to indicate what went well and what went badly concerning their SBA activity.	5	4	3	2	1
5. I encourage students to reflect upon their learning processes and how to improve their learning.	5	4	3	2	1
6. I inform my students on their strong points concerning learning.	5	4	3	2	1
7. I inform my students on their weak points concerning learning.	5	4	3	2	1
8. I encourage my students to improve on their learning processes.	5	4	3	2	1
9. I give students guidance and assistance in their learning.	5	4	3	2	1
10. I discuss the activities with my students to help them understand the content better.	5	4	3	2	1
11. I discuss with my students the progress they have made.	5	4	3	2	1
12. I discuss with my students how to utilize their strengths to improve on their SBA activity.	5	4	3	2	1
13. Together with my students, I consider ways on how to improve on their weak points.	5	4	3	2	1
14. I adjust my instruction whenever I notice that my students do not understand the activity.	5	4	3	2	1
15. I provide my students with guidance to help them gain understanding of the content taught.	5	4	3	2	1
16. During my class, students are given the opportunity to show what they have learned.	5	4	3	2	1
17. I ask questions in a way my students understand.	5	4	3	2	1
18. By asking questions during class, I help my students gain understanding of the content taught.	5	4	3	2	1
19. I am open to student contribution in my class.	5	4	3	2	1
20. I allow my students to ask each other questions during class.	5	4	3	2	1
21. I ensure that my students know what areas they need to work on in order to improve their results.	5	4	3	2	1
22. I give my students opportunities to ask questions.	5	4	3	2	1
23. My students know what the evaluation criteria for their work are.	5	4	3	2	1
24. I ensure that my students know what they can learn from their SBA.	5	4	3	2	1
25. I can recognize when my students reach their learning goals.	5	4	3	2	1

APPENDIX E

Observational Checklist

Teacher: _____ Date _____
Class: _____ Subject: _____

	Excellent	***Above average***	***Expected level***	***Not at expected level***	***Not observed***
Observed behaviours	***5***	***4***	***3***	***2***	***1***
11. Teacher clearly communicates the purpose of class session and instructional activities.					
12. Teacher uses a variety of assessment activities to ensure all students are engaged.					
13. Teacher uses the assessment activities in class to determine whether students understand course material.					
14. Teacher varies their instructions to meet the diverse student's needs.					
15. Teacher incorporates the assessment activities with the SBA efficiently.					
16. Teacher listens in on student partners or small-group conversations to quickly identify problems or misconceptions, and address immediately.					
17. Teacher provides feedback to students. (timely, specific, understandable)					
18. Teacher fosters student-to-student interaction.					
19. Teacher motivates students.					
20. Teacher uses time effectively.					

Adapted from Little, M. (2004) Professional Development to Improve Student learning: a systems approach.

APPENDIX F

Table 1

Summary of participating teachers' observation checklist scores

Observed Behaviours #	**Pre-test**							**Post- test**							***t*- value**	***p*-value**
	% scores					**Output**		**% scores**					**Output**			
	1	2	3	4	5	*Mean*	*SD*	1	2	3	4	5	*Mean*	*SD*		
1	0.0	66.7	33.3	0.0	0.0	2.33	0.58	0.0	0.0	0.0	0.0	100.0	5.00	0.00	-8.0	0.015
2	66.7	33.3	0.0	0.0	0.0	1.33	0.58	0.0	0.0	0.0	100.0	0.0	4.00	0.00	-8.0	0.015
3	33.3	33.3	0.0	33.3	0.0	2.33	1.53	0.0	0.0	33.3	66.7	0.0	3.67	0.58	-1.5	0.270
4	33.3	33.3	33.3	0.0	0.0	2.00	1.00	0.0	0.0	33.3	66.7	0.0	3.67	0.58	-2.5	0.130
5	66.7	33.3	0.0	0.0	0.0	1.33	0.58	0.0	0.0	100.0	0.0	0.0	3.00	0.00	-5.0	0.038
6	0.0	33.3	66.7	0.0	0.00	2.67	0.58	0.0	0.0	0.0	66.7	33.7	4.33	0.58	-5.0	0.038
7	0.0	66.7	33.3	0.0	0.0	2.33	0.58	0.0	0.0	0.0	66.7	33.3	4.33	0.58		
8	0.0	66.7	0.0	33.3	0.0	2.67	1.16	0.0	0.0	0.0	100.0	0.0	4.00	0.00	-2.0	0.184
9	0.0	66.7	0.0	33.3	0.0	2.67	1.16	0.0	0.0	33.3	33.3	33.3	4.00	1.00	-1.5	0.270
10	0.0	0.0	0.0	100.0	0.0	4.00	0.00	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.0	0.423

APPENDIX G

Table 3

Summary of participating teachers' questionnaire scores

Statement #	**Pre-test**							**Post- test**							***t*- value**	***p*-value**
	% choosing scores					**Output**		**% choosing scores**					**Output**			
	1	2	3	4	5	*Mean*	*SD*	1	2	3	4	5	*Mean*	*SD*		
1	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	0.0	33.3	66.7	4.67	0.58	-1.8	0.199
2	0.0	0.0	33.3	66.7	0.0	3.67	0.57	0.0	0.0	0.0	0.0	100.0	5.00	0.00	-4.0	0.057
3	0.0	33.3	0.0	66.7	0.0	3.33	1.16	0.0	0.0	33.3	66.7	0.0	3.67	0.58	-0.4	0.742
4	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	33.3	66.7	0.0	3.67	0.58	-1.0	0.423
5	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-4.0	0.057
6	0.0	33.3	0.0	66.7	0.0	3.33	1.16	0.0	0.0	0.0	100.0	0.0	4.00	0.00	-1.0	0.423
7	0.0	33.3	0.0	66.7	0.0	3.33	1.16	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.7	0.225
8	0.0	0.0	33.3	66.7	0.0	3.67	0.58	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.0	0.423
9	0.0	0.0	0.0	100.0	0.0	4.00	0.00	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.0	0.423
10	0.0	0.0	0.0	100.0	0.0	4.00	0.00	0.0	0.0	0.0	33.3	66.7	4.67	0.58	-2.0	0.184
11	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.5	0.270
12	0.0	33.3	66.7	0.0	0.0	2.67	0.58	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-5.0	0.038
13	0.0	33.3	66.7	0.0	0.0	2.67	0.58	0.0	33.3	33.3	33.3	0.0	3.00	1.00	-1.0	0.423
14	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.5	0.270
15	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-4.0	0.057
16	0.0	0.0	66.7	33.3	0.0	3.33	0.58	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.0	0.423
17	0.0	0.0	33.3	66.7	0.0	3.67	0.58	0.0	0.0	0.0	66.7	33.3	4.33	0.58		

Table 3 Continued

Statement #	**Pre-test**							**Post- test**							***t*- value**	***p*-value**
	% choosing scores					**Output**		**% choosing scores**					**Output**			
	1	2	3	4	5	*Mean*	*SD*	1	2	3	4	5	*Mean*	*SD*		
18	0.0	0.0	33.3	66.7	0.0	3.67	0.58	0.0	0.0	0.0	33.3	66.7	4.67	0.58	-1.7	0.225
19	0.0	66.7	0.0	33.3	0.0	2.67	1.16	0.0	0.0	33.3	33.3	33.3	4.00	1.00	-4.0	0.057
20	0.0	66.7	0.0	33.3	0.0	2.67	1.16	0.0	0.0	0.0	100.0	0.0	4.00	0.00	-2.0	0.184
21	0.0	66.7	0.0	33.3	0.0	2.67	1.16	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-5.0	0.038
22	0.0	0.0	66.7	33.3	0.0	3.33	0.58	0.0	0.0	0.0	100.0	0.0	4.00	0.00	-2.0	0.184
23	0.0	0.0	66.7	33.3	0.0	3.33	0.58	0.0	0.0	0.0	66.7	33.3	4.33	0.58	-1.7	0.225
24	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	0.0	0.0	100.0	5.00	0.00	-3.5	0.074
25	0.0	33.3	33.3	33.3	0.0	3.00	1.00	0.0	0.0	0.0	33.3	66.7	4.67	0.58	-2.5	0.130

APPENDIX H

Table 5

Summary of control teachers' questionnaire scores

Statement #	**Pre-test**							**Post- test**							***t*- value**	***p*-value**
	% choosing scores					**Output**		**% choosing scores**					**Output**			
	1	2	3	4	5	*Mean*	*SD*	1	2	3	4	5	*Mean*	*SD*		
1	0.0	50.0	50.0	0.0	0.0	2.50	0.71	0.0	50.0	50.0	0.0	0.0	2.50	0.71		
2	0.0	0.0	50.0	50.0	0.0	3.50	0.71	0.0	0.0	0.0	100.0	0.0	4.00	0.00	-1.0	0.500
3	0.0	0.0	50.0	50.0	0.0	3.50	0.71	0.0	0.0	50.0	50.0	0.0	3.50	0.71		
4	0.0	50.0	50.0	0.0	0.0	2.50	0.71	0.0	50.0	0.0	50.0	0.0	3.00	1.41	-1.0	0.500
5	0.0	0.0	50.0	50.0	0.0	3.50	0.71	0.0	0.0	50.0	50.0	0.0	3.50	0.71		
6	0.0	0.0	100.0	0.0	0.0	3.00	0.00	0.0	0.0	100.0	0.0	0.0	3.00	0.00		
7	0.0	50.0	50.0	0.0	0.0	2.50	0.71	0.0	50.0	50.0	0.0.	0.0	2.50	0.71		
8	0.0	0.0	0.0	100.0	0.0	4.00	0.00	0.0	0.0	0.0	50.0	50.0	4.50	0.71	-1.0	0.500
9	0.0	0.0	100.0	0.0	0.0	3.00	0.00	0.0	0.0	100.0	0.0	0.0	3.00	0.00		
10	0.0	0.0	100.0	0.0	0.0	3.00	0.00	0.0	0.0	100.0	0.0	0.0	3.00	0.00		
11	0.0	50.0	0.0	50.0	0.0	3.00	1.41	0.0	50.0	0.0	50.0	0.0	3.00	1.41		
12	0.0	100.0	0.0	0.0	0.0	2.00	0.00	0.0	100.0	0.0	0.0	0.0	2.00	0.00		
13	0.0	0.0	100.0	0.0	0.0	3.00	0.00	0.0	0.0	50.0	0.0	50.0	4.00	1.41	-1.0	0.500
14	0.0	0.0	50.0	50.0	0.0	3.50	0.71	0.0	0.0	50.0	50.0	0.0	3.50	0.71		
15	0.0	50.0	50.0	0.0	0.0	2.50	0.71	0.0	50.0	50.0	0.0	0.0	2.50	0.71		
16	0.0	0.0	100.0	0.0	0.0	3.00	0.00	0.0	0.0	50.0	50.0	0.00	3.50	0.71	-1.0	0.500
17	0.0	0.0	100.0	0.0	0.0	3.00	0.00	0.0	0.0	100.0	0.0	0.0	3.00	0.00		

Table 5 Continued

Statement #	**Pre-test**							**Post- test**							***t*- value**	***p*-value**
	% choosing scores					**Output**		**% choosing scores**					**Output**			
	1	2	3	4	5	*Mean*	*SD*	1	2	3	4	5	*Mean*	*SD*		
18	0.0	50.0	0.0	50.0	0.0	3.00	1.41	0.0	50.0	0.0	50.0	0.0	3.00	1.41		
19	0.0	50.0	50.0	0.0	0.0	2.50	0.71	0.0	50.0	50.0	0.0	0.0	2.50	0.71		
20	0.0	100.0	0.0	0.0	0.0	2.00	0.00	0.0	50.0	0.0	50.0	0.0	3.00	1.41	-1.0	0.500
21	0.0	0.0	100.0	0.0	0.0	3.00	0.00	0.0	0.0	50.0	50.0	0.0	3.50	0.71	-1.0	0.500
22	0.0	0.0	50.0	50.0	0.0	3.50	0.71	0.0	50.0	0.0	50.0	0.0	3.00	1.41	1.0	0.500
23	0.0	50.0	50.0	0.0	0.0	2.50	0.71	0.0	50.0	50.0	0.0	0.0	2.50	0.71		
24	0.0	50.0	50.0	0.0	0.0	2.50	0.71	0.0	50.0	50.0	0.0	0.0	2.50	0.71		
25	0.0	50.0	0.0	50.0	0.0	3.00	1.41	0.0	50.0	0.0	50.0	0.0	3.00	1.41		

APPENDIX I

Table 7

Emerging codes, categories and themes from teacher's reflective journals

Codes	*Categories*	*Themes*
1. address problems early on	Teacher development	**IMPROVED STUDENTS PERFORMANCE**
2. they could be corrected at the start		
3. led students to create their own procedure	Improved student's performance	
4. Boys became excited and started answering without being asked.		
5. I felt even better when I had totalled the marks for this lab. The average mark on this lab increased.		
6. formative assessment had improved their lab performance		
7. Students took their labs more seriously.		
8. more participative		
9. establish a link between these labs and the theory that was being taught		
10. Students seemed to understand why they were doing things a certain way, and they asked more relevant questions		
11. Students very careful and precise in their execution		
12. beneficial to the students in helping them to grasp the theory behind lab work and to recognise it as a teaching aid		
13. greater involvement by the students		
14. students look forward to their group discussions		
15. thinking more practical and bring up more sensible or knowledgeable ideas		
16. students to practice more higher order skills		
17. students would be more appreciative of it		
18. the weaker students could be encouraged and assisted by the stronger ones.		
19. Thought about what strengths different students had.	Students involved in planning	
20. thought of my students as individuals, and not just as a class		
21. to determine the varying types of students I would need to cater for		
22. small adjustments to my own teaching methods can have a big impact on the students		
23. managed to control the class	Teacher's positive feedback	
24. more confident in utilising Formative Assessment		
25. showed promise		

Table 7 Continued

Codes	*Categories*	*Themes*
26. appeared to be near impossible	Difficult for teachers	**INCREASED TIME**
27. I was extremely exhausted		
28. It was definitely a lot of work, tedious		
29. challenging to manage class and time		
30. seems complicated		
31. limited free time in school		
32. take a lot of time and effort		
33. create a back log of work		
34. took longer than I expected	Increased implementation time	
35. finishing on time was a challenge across the board		
36. learning should not be rushed		
37. quicker students became bored and restless while waiting on the slower ones	Issues arose	
38. teachers expressed unwillingness to run over a few minutes		
39. a lot more preparation	More researching and planning	
40. a lot of thought, research and preparation for a single class		
41. should be used for the more difficult labs that require a lot of thought		
42. a lot more time goes into research and planning for classes		
43. extra workload		
44. classes are already very large	Large class size	**LIMITED RESOURCES**
45. my limitations of class size		
46. very noisy		
47. students required careful instructions and control		
48. discussion but could not entertain them due to excessive noise created		
49. challenge in scheduling labs	Lack of resources	
50. my limitations of lab access		
51. The availability of resources in the school		
52. I could not conceptualize how it could be implemented in my class	Lack of teachers' support	
53. Great deal of trepidation and uncertainty		
54. I had no clue on how I going to do this		

APPENDIX J

Coded Journals

Colours represented the categories were:

1. Teacher development
2. Improved student's performance
3. Students involved in planning
4. Teacher's positive feedback
5. Difficult for teachers
6. Increased implementation time
7. Issues arose
8. More researching and planning
9. Large class size
10. Lack of resources
11. Lack of teachers' support

*Journal 1(**TEACHER: ELIZABETH ARDEN**)*

The concept of introducing formative assessment for SBA at Form 4 level initially appeared to be near impossible. Form 4 Chemistry classes are already very large. There exists a challenge in scheduling labs, because the lab itself is shared between the Biology and Chemistry teachers. At the time, I doubted the feasibility of "hand-holding" through baby steps to get students to where they were supposed to be.

Formative assessment appeared to be a sound theory on paper. Its benefits were undeniable. But I could not conceptualize how it could be implemented in my class, given my limitations of class size ,lab access and the short time by which the syllabus had to be completed. Having been supported and guided by Ms. Ramnarine, I decided to try to introduce formative assessment in evaluating Form 4 Chemistry SBAs.

Journal 2

I began to plan my first formative assessment with a great deal of trepidation and uncertainty. The SBA Lab required students to investigate energy changes when potassium nitrate was dissolved in water. The usual mode of assessment involved informing students of the procedure, and then assigning them 30 minutes to get it done. They would be marked both on their manipulation of apparatus as well as their responses to questions about the lab.

This lab is mandatory by CSEC, and over the years students have encountered several problems. These include skipping a step which is implied (but not written) in the procedure, or inaccurate use of thermometers and/or electronic balance. Some students get accurate results, but as revealed by their responses to the questions, they are not sure why they have done what they have done.

In planning how to integrate formative assessment into the lab, I had to really give some thought about what strengths different students had. I had to find a way to bring these into the lab and actually create marking criteria for it. It took longer than I expected, but at the end, I found that I actually had given more thought to my students as individuals, and not just as a class.

Journal 3

I attempted to implement the formative assessment into an SBA lab. I would like to say it was a resounding success, but honestly, it was not.

I started the lab off by pairing students off. I tried to partner an academically inclined one, with another who had greater skills with manipulation of apparatus. I first asked each pair in turn to identify a piece of apparatus placed in front of them, and explain what it should be used for. It was re-iterated that reactions involve temperature changes, and students were asked to identify how an initial and final temperature should be arrived at. This discussion eventually led students to create their own procedure. One pair was chosen to read their procedure aloud with the others providing feedback as each step was read. For example, if the procedure required the students to "measure 25cm^3 of water into a beaker," a student would be required to explain what he would use to measure it, and what precautions would be taken to ensure he was right. If his answer was right, verbal commendation would follow. This idea started off well. I was able to identify why students were having trouble with measurement. (There was one boy who never used a measuring cylinder, but merely ***averaged*** based on the beaker markings!). However, as the lab progressed, other boys became excited and started answering without being asked. I eventually had to threaten to minus marks for that just to get them to settle back down.

With the procedure clearly understood by all, the lab began. I told them I would be marking on a step by step basis. This meant if the procedure required taking the temperature of the water after 1 minute, each boy had to state his reading after 1 minute. No one would go ahead of the others. Then everyone would go on to the next step together. This was positive in that I was able to address problems early on. If someone was reading their thermometer wrong, they could be corrected at the start, rather than the end of the experiment. However, the quicker students became bored and restless while waiting on the slower ones. The recess bell went and the students still had two more readings to take. Surprisingly though, they were not as disgruntled as I thought they would be. They seemed to enjoy the attention they were getting on a step by step basis.

After the lab, I was extremely exhausted. It was definitely a lot of work. However, it was the first time that I really felt that a class understood the reasons for doing this lab in the steps outlined. I felt encouraged to try this method again. I felt even better when I had totaled the marks for this

lab. The average mark on this lab was 8 out of 10, as compared to the previous year's average of only 6 out of 10.

Journal 4

After the first lab, we were invited to a peer review session, where we discussed our individual experiences about the integration. Everyone agreed that the formative assessment had improved their lab performance. Students took their labs more seriously. They were able to learn from the lab, and not just do it as a mandatory step in passing their SBA. Students who were usually withdrawn or surly were found to be more participative, as there was now a clearer reason for doing the sequence of steps required. Students who were more academically inclined were able to link the lab to a past paper question they had seen a few days before. In general, students were now beginning to establish a link between these labs and the theory that was being taught.

We realized that finishing on time was a challenge across the board, and discussed some ways to improve this. We first talked about ways to hasten the lab along. But it was argued that learning should not be rushed, and teachers expressed unwillingness to run over a few minutes into recess or lunchtime to ensure that the objectives of the lab were met.

Journal 5

I looked back at my first journals, and felt a bit embarrassed at how overwhelmed I sounded when this exercise began. Formative assessment was not as onerous as it first appeared to be. Admittedly, it was time consuming to plan and execute these "new" labs, but I believe the benefits outweighed the disadvantages.

In my class, I observed that there was greater student participation in labs. Students seemed to understand why they were doing things a certain way, and they asked more relevant questions during the lab. They were more open about the things they did not understand, and in their pairs, they talked about ways to improve their techniques when using different apparatus.

On my part, labs used to be challenging to manage, as different students were at different points in the procedure at different times. I have found that by implementing formative assessment techniques, it is easier to mark skills such as Manipulation and Measurement since students perform the lab in sync with each other.

85 I still have to work on my time management techniques, to try to get the labs finished within the allocated time, but I believe that with continued practice, I will succeed. I am grateful to Ms. Ramnarine for this opportunity to participate in this study.

*JOURNAL 1(***TEACHER: ISABELLA BISHOP)**

On hearing about formative assessment my first thought was that it seems complicated. I had no clue on how I going to do this in my class. My perception was that it would take a lot of time and effort on my part. This was especially true with regards to preparation of mark schemes. Additionally planning a lesson geared away from the usual writing notes and doing a question would have required a lot of thought, research and preparation for a single class. This for me was not an option due to limited free time in school. I did not think that formative assessment gave an indication of the students' actual knowledge and would not prepare them for the written final exams that they were required to do. I thought that formative assessment would take away from much needed time to complete scheme of work and syllabi.

JOURNAL 2:

After planning a formative assessment lesson based on paper chromatography for form 4 (four) integrated science students I found this method tedious. It was very difficult to plan as I was trying to determine the varying types of students I would need to cater for. The availability of resources in the school to carry out such an assessment for this topic was a major factor that I needed to take into consideration. The class size of 36 students requires careful instruction and control so any activity be planned would have needed to consider this. It was a task trying to make the lesson that would allow the students to draw the same conclusions and acquire the knowledge required by the syllabus.

JOURNAL 3:

After performing the lab experiment using the formative assessment method I found it to be fairly successful. A double session (90 minutes) was used to carry out the lab. In a class of 36 students, the class was split into groups of 4 with each group having 3 different food substances to test. The students were given some time to talk aloud and recap a description of the various tests that were performed on the food items. It was a very noisy ten minutes but I managed to control the class. The method was written on the board so that students had to copy the method onto their lab books. While writing the method, students were told to read it. Students were informed of the criteria for the lab at the beginning of the session. It was measurement and

manipulation (mm) so the students were more aware of what they were doing. They were very careful and precise in their execution. Even though it was not necessary for students to learn the basis of the tests it was explained along the way. They appreciated knowing why a particular colour change was observed and why certain steps were necessary. For example, the use of hydrochloric acid to break the bonds of the non- reducing sugar. Since these students had never worked with chemicals like these before, the teacher performed the tests in tandem with the students. Demonstrating each step proved to be very tedious and time consuming. Only the results were written up by students in the lab. The marks for mm were unusually high with some even scoring 10/10.

JOURNAL 4:

After the peer review session, teachers found this method of assessment to be successful to a point. The method proved to be beneficial to the students in helping them to grasp the theory behind lab work and to recognise it as a teaching aid and not just mandatory SBA work. However, teachers agreed that it is time consuming to perform such a detailed lesson for each lab session which may lead to many labs incomplete in the allotted time frame. While it is not a big inconvenience finishing a few minutes into lunch or recess, it will create a back log of work if each lab only reaches to the results part of the lab. In my opinion it is a useful method that should be used for the more difficult labs that require a lot of thought and consideration by the students.

The feedback I got from my peers was very useful, but again some things are easier said than done. I felt comfortable working with my colleagues and getting their opinions. They made me aware of simple things that can be useful in the classroom and also suggested some strategies to help me manage planning SBA with formative assessments. Overall I think I need to make a bigger effort because a lot of time goes into researching and planning for the classes. After all I have to ensure the students have a better understanding and appreciation for their learning, which is my main purpose as a teacher.

JOURNAL 5:

On looking back at my journals I realise that my negative attitude towards formative assessment has changed to a more positive outlook. I am glad that my students now look at labs

as a learning experience and not just a monotonous double session. I have realised that small adjustments to my own teaching methods can have a big impact on the students. I had also noticed greater involvement by the students who usually sit quietly or don't participate. The
60 students look forward to their group discussions. They are thinking more practical and bring up more sensible or knowledgeable ideas. This method of assessment comes with a lot more preparation and calls for better time management but I think after a few repetitions it would become easier. I started compiling some formative assessment activities that I plan to use in the near future and looks forward to my colleagues share their resources with me as well.

Journal 1(**TEACHER: BRIAN COX)**

Having completed my Diploma in Education several years ago, I have made it my practice to try to include aspects of Formative Assessment in my classroom activities. However, I will admit that, even though I utilize some aspects of Formative Assessment in my correction of Laboratory exercises, I have not explored in it great detail for the Laboratory exercise itself. As such I was very excited and eager to learn more about the different strategies that I could use in order to get my students to practice more higher order skills that will better prepare them for their Investigative Project (from the new CSEC Physics Syllabus), as well as for Form 6 and Tertiary level. I am aware however, that some activities will lend themselves more readily to some strategies than others, and there may be some that would not be appropriate at all. And whilst it is an extra workload, it is something that can be done gradually, and accumulated over a time period.

Journal 2

So after a few Training sessions with Ms. Ramnarine, I felt a little more confident in utilising Formative Assessment in my Practical Activities. As I was working on my first attempt I started to realise that many of my activities, even those involving Analysis and Interpretation (which are normally considered higher order Laboratory skills), didn't really accomplish that.

Many of the AI lab exercises involved basic calculations using formulae found in theory or in the Textbook. As such, although they used Application, the higher order skills like synthesis were not really present. By putting more effort into the creation of the lab exercise, I realised that I could transform it into a more thought provoking activity for the students (even for the "basic" ORR and MM activities). And whilst the students could still utilise the knowledge from their notes or texts, by changing the format of the lab presentation, I could better make use of their higher order thought processes. Yes, it was a little more time consuming than a "regular" lab, but I felt reassured that the students would be more appreciative of it, and by placing them in (preset) groups, the weaker students could be encouraged and assisted by the stronger ones.

I chose the OWL strategy as I could guide the students along to form their conclusions, but they were the ones formulating and carrying out the actual procedure.

Journal 3

I had my first Lab exercise with my students using the OWL Formative Assessment strategy. Overall the strategy was very effective to start off with. It was a little more time consuming than the "normal" lab exercise, but overall it showed promise. Most of the groups were able to formulate appropriate hypotheses and were able to carry out the experiment successfully. Many were able to relate their observations to what was learnt from notes about refraction of (light) waves and were able to explain their observations of the (concept of) lateral displacement. And by guiding them to use their observations to ask "why did this occur" they were more appreciative of the lesson. It allowed them to discover for themselves as opposed to just proving something that they already know, and, as such, it was well received by the students. They also started to ask a lot of questions linking the theory to practical situations. This generated a lot of discussion but could not entertain them due to excessive noise created. I have realised though, that there will be a time constraint for other lab exercises, so different strategies will have to be used for different labs.

APPENDIX K

Table 8

Summary of participating students' questionnaire scores

Statement #	**Pre-test**							**Post- test**							***t*- value**	***p*-value**
	% choosing scores					**Output**		**% choosing scores**					**Output**			
	1	2	3	4	5	*Mean*	*SD*	1	2	3	4	5	*Mean*	*SD*		
1	0.0	9.8	16.3	54.3	19.6	3.84	0.86	1.1	1.1	3.3	40.2	54.3	4.46	0.72	-5.413	.000
2	2.2	43.5	18.5	29.3	6.5	2.95	1.04	2.2	6.5	21.7	48.9	20.7	3.79	0.92	-6.214	.000
3	5.4	47.8	21.7	18.5	6.5	2.73	10.4	2.2	8.7	21.7	46.7	20.7	3.75	0.96	-7.088	.000
4	0.0	23.9	10.9	51.1	14.1	3.55	1.00	1.1	4.3	20.7	55.4	18.5	3.86	0.81	-2.325	.022
5	8.7	20.7	20.7	39.1	10.9	3.23	1.16	3.3	7.6	27.2	26.1	35.9	3.84	1.10	-4.432	.000
6	4.3	19.6	16.3	50.0	9.8	3.41	1.05	0.0	5.4	13.0	44.6	37.0	4.13	0.84	-5.496	.000
7	0.0	12.0	12.0	57.6	18.5	3.83	0.87	0.0	3.3	9.8	32.6	54.3	4.38	0.80	-4.616	.000
8	1.1	18.5	15.2	48.9	16.3	3.61	1.01	1.1	4.3	14.1	50.0	30.4	4.04	0.85	-4.134	.000
9	2.2	12.0	13.0	51.1	21.7	3.78	0.99	2.2	4.3	8.7	44.6	40.2	4.16	0.92	-2.721	.008
10	2.2	30.4	22.8	32.6	12.0	3.22	1.08	1.1	13.0	23.9	46.7	15.2	3.62	0.94	-3.065	.003
11	5.4	21.7	26.1	35.9	10.9	3.25	1.09	4.3	2.2	28.3	39.1	26.1	3.80	1.00	-4.471	.000
12	9.8	29.3	22.8	34.8	3.3	2.92	1.08	1.1	6.5	28.3	39.1	25.0	3.80	0.93	-6.768	.000
13	0.0	17.4	14.1	52.2	16.3	3.67	0.95	1.1	1.1	16.3	38.0	43.5	4.22	0.84	-4.381	.000
14	1.1	16.3	15.2	48.9	18.5	3.67	1.00	1.1	4.3	15.2	45.7	33.7	4.07	0.88	-3.297	.001
15	4.3	21.7	16.3	51.1	6.5	3.34	1.03	1.1	9.8	22.8	38.0	28.3	3.83	0.99	-4.103	.000
16	0.0	22.8	16.3	52.2	8.7	3.47	0.94	2.2	7.6	10.9	48.9	30.4	3.98	0.96	-4.398	.000
17	1.1	18.5	15.2	47.8	17.4	3.62	1.02	2.2	4.3	19.6	41.3	32.6	3.98	0.95	-3.058	.003

Table 8 Continued

Statement #	**Pre-test**							**Post- test**							***t*- value**	***p*-value**
	% choosing scores					**Output**		**% choosing scores**					**Output**			
	1	2	3	4	5	*Mean*	*SD*	1	2	3	4	5	*Mean*	*SD*		
18	4.3	19.6	21.7	41.3	13.0	3.39	10.8	3.3	4.3	23.9	37.0	31.5	3.89	1.01	-3.826	.000
19	4.3	26.1	17.4	44.6	7.6	3.25	10.7	2.2	10.9	23.9	33.7	29.3	3.77	1.06	-4.079	.000
20	2.2	16.3	19.6	50.0	12.0	3.53	0.98	0.0	5.4	22.8	33.7	38.0	4.04	0.91	-3.965	.000
21	2.2	27.2	16.3	43.5	10.9	3.34	1.06	2.2	5.4	16.3	30.4	45.7	4.12	1.01	-5.854	.000
22	3.3	19.6	17.4	44.6	15.2	3.49	1.07	1.1	1.1	16.3	45.7	35.9	4.14	0.81	-5.428	.000
23	1.1	17.4	13.0	57.6	10.9	3.60	0.94	2.2	4.3	21.7	51.1	20.7	3.84	0.88	-2.098	.039
24	2.2	16.3	10.9	56.5	14.1	3.64	0.99	3.3	4.3	15.2	43.5	33.7	4.00	0.98	-2.762	.007
25	2.2	23.9	19.6	46.7	7.6	3.34	1.00	3.3	7.6	20.7	43.5	25.0	3.79	1.01	-3.571	.001

APPENDIX L

Permission Letter

Soft Copy of Research Project