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TEACHING MATHEMATICS IN A HIGH STAKES AND CURRICULUM REFORM ENVIRONMENT USING INQUIRY-BASED TEACHING

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Abstract: *This study is the examination of critical incidents drawn from the implementation of a new mathematics curriculum in a high stakes learning environment using Inquiry-based Teaching (IBT). The teacher in the study (also the second author) selected the critical incidents from her yearlong effort using IBT to implement the new mathematics curriculum at the Secondary Entrance Assessment (SEA) level in a primary school in Trinidad. These critical incidents comprised teacher-student dialogue during IBT implementation, student work samples, students' struggles, frustrations, and insights and the teacher's own reflections, emotions, challenges and musings during the process. The critical incidents also formed the core of the data and were subjected to both outsider and insider reflective analyses by the first and second authors respectively. These reflective analyses revealed that students at the same class level varied in their ability to apply the principles of IBT. They also showed that success was contingent upon critical thinking and that at times there was pedagogic regression to teacher-centered mechanisms and strategies. Further, time limitations presented additional pressures that compromised proper implementation of the new mathematics curriculum using IBT. These and other findings are discussed in relation to existing literature on IBT implementation and their implications for future efforts at contemporary pedagogies with student-centered orientations are explored.*

Keywords: *mathematics education, inquiry-based teaching, high-stakes environment, SEA.*

INTRODUCTION

Secondary Entrance Assessment (SEA) teachers in the Trinidad and Tobago education system are presently facing two major education challenges. The first is due to the nature and importance of the SEA which is the high stakes primary school examination in Trinidad and Tobago. The second is the fact that there has been a significant mathematics curriculum reform in the country's education system. As such, SEA teachers are facing pressures from external stakeholders and those within school systems because there is

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much acclaim and status riding on successful academic outcomes here. Nevertheless, each teacher faces issues related to self-efficacy for success in curriculum delivery, adjusting to new curriculum demands and preparing students to perform at their best. This study examined critical incidents in the confluence of old and new approaches to the delivery of the mathematics curriculum at the SEA level in primary school during the 2018-2019 school year.

Mathematics education is seen not only as foundational numeracy competence but also as a critical developmental skill required for adaptive functioning in the data-driven environment of the present era (Palmer et al., 2014). It is well established that Caribbean nationals have difficulty mastering the fundamentals of mathematics at various stages of the education process (Palmer et al., 2014). More specifically, in Trinidad and Tobago, teachers, students and parents face considerable trepidation about successfully completing the Secondary Entrance Assessment (SEA) examination which includes a significant mathematics component (De Lisle & McMillan-Solomon, 2017). The SEA is perceived to be the high stakes examination because it is seen as determining the quality of secondary education (De Lisle et al., 2012), and subsequent academic and other achievements of students.

Recently, in an attempt to develop critical thinking and important cognitive abilities in students, the primary school mathematics curriculum was restructured and inquiry-based teaching introduced as the preferred pedagogy to deliver it (Curriculum Planning & Development Division, 2013). In-service teachers have been re-trained by the Ministry of Education to deliver the curriculum as stated. It is hoped that this new mathematics curriculum delivered using inquiry-based teaching will redound to better developmental skills and competencies in mathematics (Magee & Flessner, 2012).

LITERATURE REVIEW

Inquiry-Based Teaching Method

Although there has not been universal agreement in the literature on exactly what inquiry-based teaching involves (Bhattacharyya et al., 2009), Gutierez (2015) defined inquiry-based teaching as the confluence of constructivist principles and the blending of the theories of Piaget, Vygotsky and Ausubel. Blair (2014) advised that inquiry-based teaching is premised on inductive reasoning and therefore requires that students explore, observe and generalize from many examples during the learning process. As such, the inquiry-based method is seen as an approach that allows students to build on their prior knowledge, question and mess around with their own propositions and generate their own solutions to authentic questions presented to them (Blair, 2014; Magee & Flessner,

2012). Similar to critical thinking, the inquiry method is considered one that awakens students' curiosity, builds their analytical skills and guides them in synthesizing and applying information to problem solving (Gutierez, 2015).

Notwithstanding the premise of independence, Blair (2014) advanced that inquiry-based teaching is not about independent discovery but more about meaningful and flexible collaboration between teachers and students in which the teacher can introduce concepts that are needed to anchor students or point them in the right direction. Cartwright et al. (2014) posited that constructivism and the inquiry-based method are intertwined and that teachers who are conversant with the former are more likely to attempt the latter, especially in high stakes environments. They also argue that self-efficacy in the use of the inquiry-based method determines whether or not teachers would actually utilize this approach. Accordingly, Gutierez (2015) stated that the implementation of inquiry-based teaching in Japan was successful because of the employment of a specially designed programme called *Lesson study.*

How is inquiry-based teaching operationalized?

Teachers are required to facilitate the development of critical questioning competence in students who must process problems in the learning process (Gutierez, 2015). More specifically, Gutierez (2015) noted that this approach requires the integration of active thinking processes with prior and existing knowledge bases in decision making. In essence, students have to be trained to use their prior knowledge to ask the right questions that would lead to critical understanding of the particular problem and to the correct steps or approaches to finding the solution. He further argued that "in mathematics… students should be encouraged to make conjectures by analyzing the structure of even a single case and prove that conjecture through deductive reasoning" (Blair, 2014, p. 33).

Blair (2014) argued that many teachers do not realize that direct teaching is sometimes required in the inquiry-based method if students need or request it. The latter is seen as necessary to advance the inquiry-based learning process. Essentially, teachers have to use their discretion to guide, direct or control the teaching-learning process as much or as little as is required, based on students' abilities or the nature of the lesson.

Benefits of Inquiry-based teaching

Mumba et al. (2015) found that inquiry-based teaching leads to better student engagement, higher curiosity, more interdependence and learning through collaboration as well as students seeking understanding of concepts via learning activities and taking responsibility for their own learning. Magee and Flessner (2012) viewed inquiry-based

teaching as important in developing independent thinkers who value personal sense making in the learning process. These independent thought processes are considered to engender deep conceptual understanding of real world phenomena and not simply procedural knowledge of math and science content related to traditional teaching methods (Magee & Flessner, 2012). In some circumstances, researchers have found that students perform better with inquiry-based teaching (Blair, 2014) and that in other instances they struggle for various reasons (Mumba et al., 2015).

Challenges implementing inquiry-based teaching

A fundamental challenge using the inquiry-based method is teachers' lack of complete knowledge of its pedagogy which leads to inadequate implementation (Mumba et al., 2015). Cartwright et al. (2014) suggested that teacher preparation programmes do not spend sufficient time on reform-oriented pedagogy and therefore teachers struggle to implement the more contemporary approaches like the inquiry-based method. Other researchers argue that a lack of modelling of the inquiry-based teaching method in teacher preparation programmes is a critical oversight that results in less confidence and desire among teachers in practice to attempt this method (Magee & Flessner, 2015). In fact, teachers in one case study (Gutierez, 2015) identified the lack of proper hands-on training and institutional support as critical challenges in the implementation of inquiry-based teaching.

Teachers also argued that the expectation of covering the whole curriculum in a timely manner in preparation for administrative or national tests also militated against the inquiry-based method which is very time-consuming (Mumba et al., 2015). They have also identified challenges managing large classes, having students with very different competencies and the pairing of weak and strong students as considerable deterrents to implementation (Mumba et al., 2015).

Furtak and Alonzo (2010) posited that teacher beliefs about teaching and learning can act as a barrier to implementing the inquiry-based method because their beliefs are sometimes at variance with the theoretical underpinnings of the method. Teachers' perceptions of the emphasis (whether experience-centered, problem-centered or question-centered) in inquiry-based learning were also important to their execution of the same (Ireland et al., 2012). Additionally, some teachers viewed inquiry-based teaching as unstructured, unfocused and chaotic, and were therefore reluctant to attempt it (Magee & Flessner, 2012).

Aims of the study

The main aims of this study were to identify and analyse critical incidents relating to the challenges and insights of implementing the inquiry-based method of teaching in a high stakes education environment in Trinidad. In the context of the study, three (3) key research questions emerge:

1. What challenges will an SEA teacher face in using the inquiry-based method to deliver the new mathematics curriculum?
2. What insights can be garnered from teachers and students who experience the said math curriculum using the inquiry-based teaching?
3. What might be the implications of the challenges identified in the critical incidents captured in this study?

METHODOLOGY

Participants

The participants in this study were a mixed ability class of 27 standard 5 (grade 6) boys and their teacher (the second author). The students ranged in age from 11 to 13 years and the teacher had 23 years of teaching experience. The critical incidents and analytic reflections were selected from classes conducted during the second year (2018-2019) of the two-year SEA mathematics curriculum.

Theoretical Approach–Critical Incidents and Reflective Analysis

This study used a critical incidents reflective analysis approach. The critical incidents research method can be defined as a flexible, retrospective qualitative approach, initially developed for psychological research (Flanagan, 1954 as cited in Papouli, 2016). Serna-Gutierrez and Mora-Pablo (2018) pointed out that although the analysis of critical incidents has been historically used in psychology, it has also been extended to other domains including education. This qualitative research method allows researchers to select specific critical incidents, events or episodes that define their personal experiences. Researchers have identified critical incidents as those incidents or events that researchers or participants determine to be highly important in the context of the phenomena under study (Serna-Gutierrez & Mora-Pablo, 2018). According to Holligan and Wilson (2015), critical incidents provide an insider's perspective on what is important and meaningful from a specific experience. They further argue that these specific incidents shape the meaning, purpose, value and understanding of the insider's

work (Holligan and Wilson, 2015). Sisson (2016) posited that critical incidents are particularly important for a teacher's development of agency and teaching competence.

In the context of this study, the second author selected critical incidents that were representative of successful implementation of the IBT strategy in Mathematics as well as those episodes that characterized failure in implementation. These critical incidents included teacher-student interaction and dialogue, student work samples and teacher analytical reflections about successful and unsuccessful lessons. These critical incidents comprised the core data in the study and were subjected to further analysis by the first author who examined them in relation to the findings of existing literature.

Procedure and analysis

The teacher identified two key lessons that she delivered to her class. She labelled lesson 1 as successful and lesson 2 as not successful. She reflected on and analysed her own feelings, mindset and insights regarding implementation and expectations. She also used reflective analysis of her own experiences (critical incidents) in the classroom while applying the inquiry-based teaching method. In essence, she identified her perspective of her own experiences (Pine, 2009). Additionally, she incorporated the perspectives of her students as those engaged in the actual process. This provided a context for further analyses and insights of what transpired (Falk & Blumenreich, 2005). Subsequently, the first author subjected the critical events to further examination and explication as an outsider.

Limitations

There are limitations because of the non-generalizability of the critical incidents identified in this study. Also self-reflection does include inherent biases. However, the teacher did include positive as well as negative reflections and insights in terms of perspectives on success and failure of implementation. The teacher in the study also used actual student responses and their personal thought processes and insights as the basis for further analysis using deductive and inductive logic. These student perspectives are limitations because they are from a small convenience sample.

RESULTS & DISCUSSION

Teacher's first critical incident

Lesson 1: Geometry

I looked around at my students because I noticed that they were just sitting and staring at me.

> *"Why aren't you all working"? I asked, trying not to sound frustrated. No one responded and they just looked at each other. One boy's hand shot up, the lone hope in the forest of blank faces:*
>
> *"Miss, you eh tell we what we have to do and plus you eh teach we dem ting".*

It was Earl, one of my more vocal students who was expressing this opinion. It garnered a few nervous chuckles from the others who still did not move an inch. I clenched my fists and squeezed my eyes shut just for a second. I needed a break, some time to gather my thoughts. I wasn't thinking clearly, and I did not want to jeopardize my chances of really making a difference in the way mathematics is taught at my school. I excused myself and stepped out into the corridor. I went through everything that I had done: I had randomly divided my twenty-seven students in groups of three and gave them the task in geometry. I knew they had previously done identification of shapes in the lower classes. Because the curriculum is spiral in design, they would have interacted with shapes at every level in the primary school, each time gaining more information to add to the knowledge they would have already had. I thought of ways to scaffold the lesson so that I did not fall back into the old practice of "drill and kill". I stepped back into the classroom, determined to give it my best shot.

First author's analysis of first critical incident

In this first lesson, the teacher delineates her attempts to operationalize inquiry-based teaching (IBT) as well as she could. Her efforts demonstrate a good grasp of the teaching strategy as well as her insight into the prior knowledge of her charges. This meant that the foundation was established for meaningful engagement using the IBT. However, it also reflected the view of researchers who posit that implementation is by and large open to variability and the interpretation of different practitioners (Blair, 2014; Gutierez, 2015). While this can be a drawback, flexibility in implementation can also be valuable to successful implementation as occurred here.

From the dialogue with Earl, the teacher recognized the need to switch to direct instruction mode as this was required at this point. Her reflection about "not wanting to fall back on direct instruction" does articulate the tension of how much direct instruction, if any at all, is required, which is a normal concern of teachers using the inquiry-based method (Blair, 2014). However, it appears that she switched to this mode to facilitate learning rather than recognize that direct teaching is sometimes a requirement depending on the learning situation.

Teacher's second critical incident

Her dialogue continued:

> *"Everyone, I will come around to each group to assist. In the meantime, feel free to quietly discuss what you see on the board", I said, sounding brave and confident.*

My first strategy was to help Earl break down the task into smaller bits of information so that he could make connections and not feel intimidated by the actual questioning.

> *"Tell me exactly what you don't understand",*
>
> *"Everything. What we supposed to do"?*
>
> *"The first thing you should take note of is all the terms there that you know. Tell me the words you saw before".*
>
> *"I know about pyramids an ting from Ms. Watkins in Std. 3 but this is Std. 4".*
>
> *"Well, Earl, the information that you gathered in one class can be used to help you in another class. It is all connected. We give you small bits of information each time at each level and then you use that information to gain even more information. So, tell me more about what words you know and what information you already have because I am almost sure that you know enough to attempt the task".*

I made my way around the room and felt encouraged by the responses as the students got moving and attempted the questions. The initial feeling of hopelessness dissipated as we moved through the lesson and all in all, I was happy with my attempt. Now that I sit and reflect on the experience, it seems as though the students needed permission to do mathematics. I am guessing that it must be some type of conditioning as they are accustomed to teacher-led discussions and teacher-led activities. They had adequate previous knowledge about the topic and so it wasn't

entirely new to them and so I felt that they should have been able to dive right in and attempt the activity set before them.

First author's analysis of second critical incident

The perspective on her feelings and how they transitioned is valuable insight for those who would engage in the IBT process. It helps one to see the mixed emotions that can be experienced at different stages in the IBT process. In this way, practitioners will be more determined to persevere when challenged by strong negative personal affect in the process. Note should be taken of her insight on giving students "permission to do mathematics" which is a critical axiological frame of reference that deals with the freedom and liberation which IBT should facilitate (Magee & Flessner, 2012). The teacher also brought to view student metacognition, which is developmental and, as such, younger students may not easily know how much they know or how to transfer knowledge (Eggen & Kauchak, 2015). Again, she had to be directive in the process to guide them in tapping into and using prior knowledge to good effect.

The response I hoped to get:

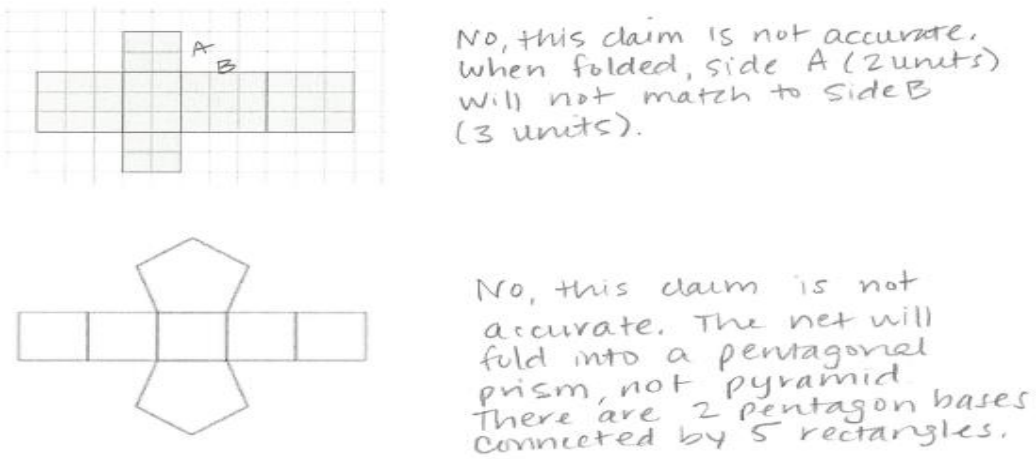

Figure 1. Model answers

Some of the responses I actually got:

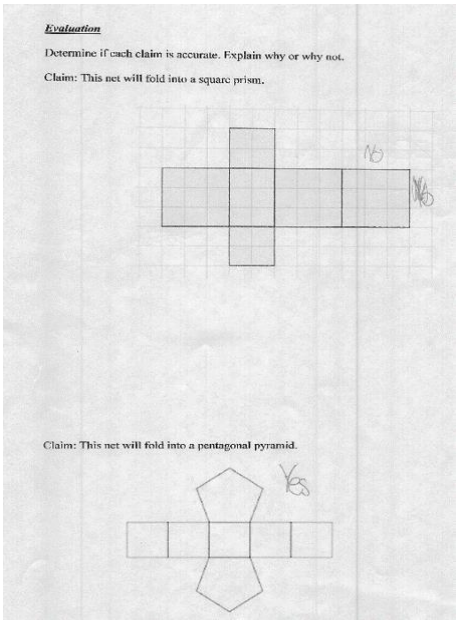

Figure 2. Student response 1

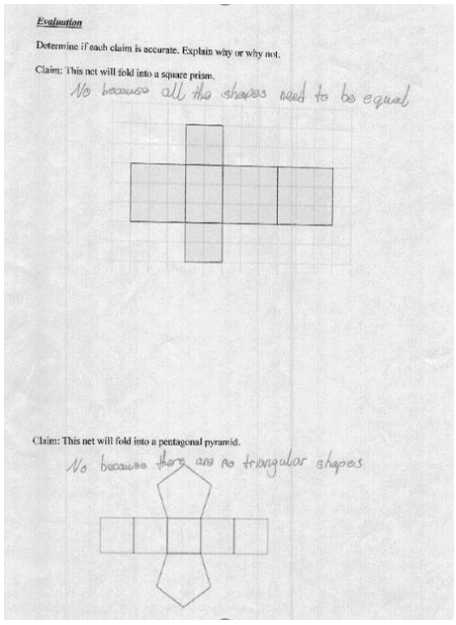

Figure 3. Student 2 response 1

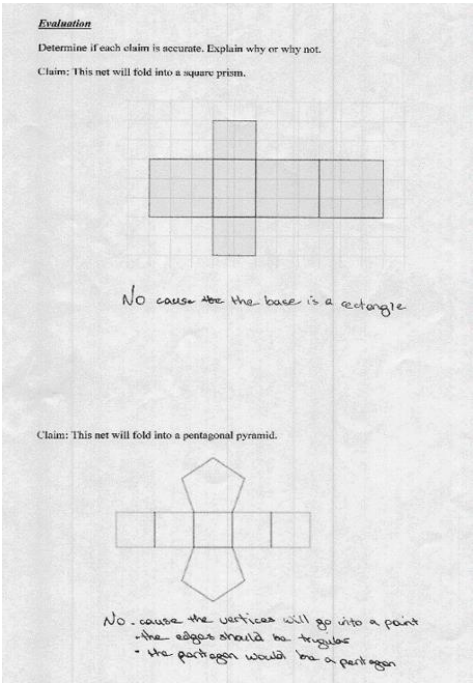

Figure 4. Student response #4

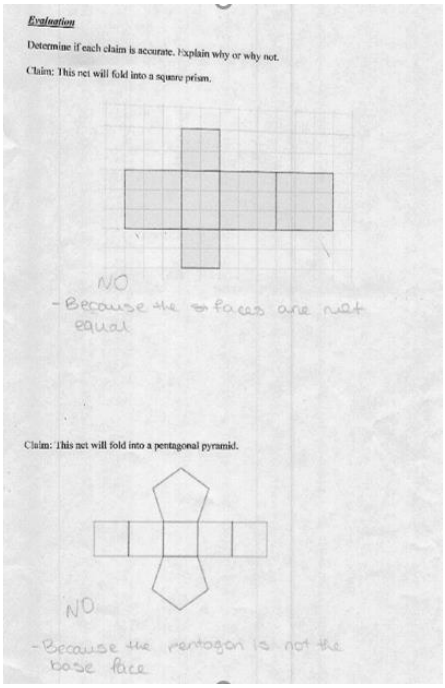

Figure 5. Student response #5

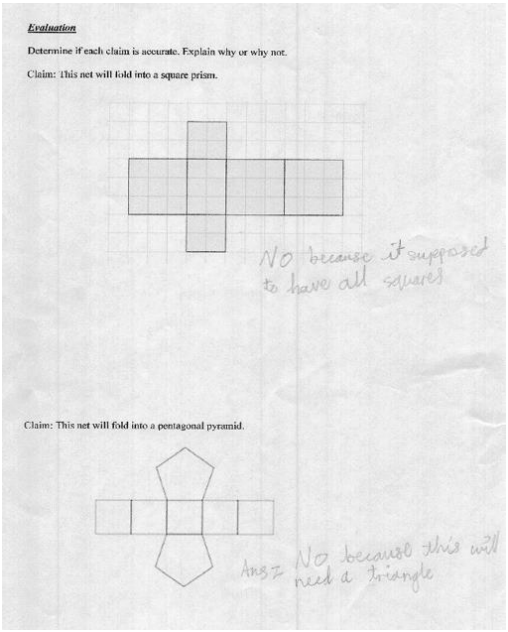

Figure 6. Student response #6

Teacher's third critical incident

Lesson 2: Multiplication of Fractions

The television was playing in the background as I got ready for another day at school. Interestingly enough, the movie was "The Man Who Knew Infinity", about the mathematician Srinivasa Ramanujan, who was self-taught. At first, I wasn't paying attention to the flick. It was just keeping me company as I dressed for school but because I had never heard of the name before, I did a quick google search. Ramanujan had no formal training in the field of pure mathematics but was able to make substantial contributions to the analytical theory of numbers and worked on elliptic functions, continued fractions, and infinite series. This was inquiry-based learning at its highest level. I was pumped, excited to think that there might be a Ramanujan in my class, someone who would not only grasp the concept of the lesson but also become so inspired with mathematical theories that they would go on to do great things!

Almost two hours later, I was ready to collect the student responses and send the students out for a much-needed break. The problem was that they had not yet finished the task that I had set before them. After my teaching multiple units of work

on fractions, there were still some students who did not grasp the concepts. They were struggling with this task too and it made me feel that I needed a break. I stopped them and told them that we would continue the exercise another time as they were saturated and I was exasperated.

First author's analysis of third critical incident

This reflection identifies the issue of dealing with mixed ability students in the class during IBT implementation (Mumba et al., 2015). In this instant, the teacher recognized the need to bring the experience to an end, given the lack of progress and the frustration that became evident. She reflects that both she and the students were overwhelmed at that point. This is a valuable incident because it shows that it is important to know when to throw in the towel or to stop and refresh rather that push forward to complete the lesson without meaningful engagement or outcomes.

Teacher's fourth critical incident

By day three of this exercise, I was ready to give up. After discussing the conundrum with my colleagues, I realized that I was transferring my feelings of frustration onto my students even before the lesson began. Also, I was focused on them getting the right answer and I really was not paying attention to the process, their learning and their discussions. I realized then that the students had no idea really what it was like to be a mathematician; so it was difficult for them to be expected to act like one. Ramanujan spent his time testing out theorems and creating connections.

First author's analysis of fourth critical incident

The focus of the reflection here is on product rather than process and how the wrong focus can undermine the inquiry-based learning process (Gutierez, 2015). This critical incident revealed that teachers implementing IBT also need to be keenly aware of their emphasis (Ireland et al., 2012) in order to avoid such mistakes. The incident showed that the teacher was also self-aware and able to make meaningful links about her metacommunication of mathematics to her students. Teachers need to always relate what they are doing to the bigger picture of what they are trying to communicate or establish, and this is determined by their beliefs (Furtak & Alonzo, 2010). They must also be keenly aware of the tendency to drift backwards to the default teaching mode when there is difficulty using contemporary approaches or strategies.

Teacher's fifth critical incident

Reflecting on this movie made me sad to think that even I did not understand fully what it was like to be a mathematician. I was teaching in a similar manner to how I was taught. I still believed that my role as the teacher meant that I had to give information to the students and hope that somehow they would remember it and use it sometime in the future. The new changes in the SEA exam, however, challenge students to synthesize many of the mathematical concepts that they would have learned previously and apply them to problems as they think about mathematics on a deeper level.

More often than not, students see their role as that of gatherer. They get as many facts as they can and then apply these facts to the problems that they are assigned in class. They are, by and large, happy just getting a good enough grade on their tests without ever fully understanding or grasping the fundamental reasoning of why the math they learned works. Don't get me wrong, many of them are successful in the short term but when they progress and as they move forward they never really understand mathematics. The subject becomes a chore.

The response that I hoped to get:

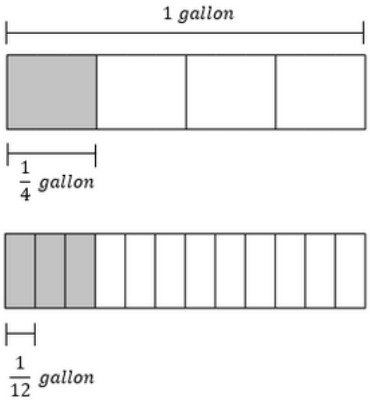

Figure 7. Expected response #2

The responses I actually got:

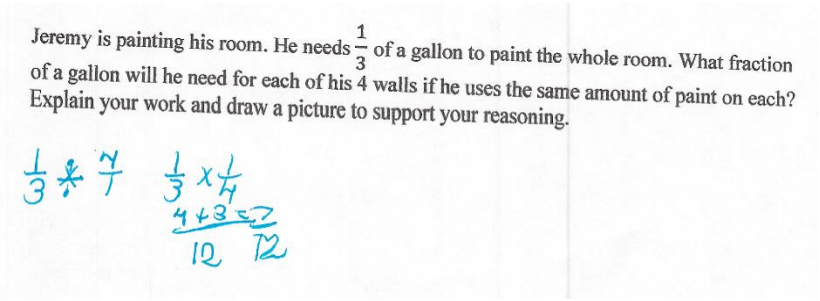

Figure 8. Student response #7

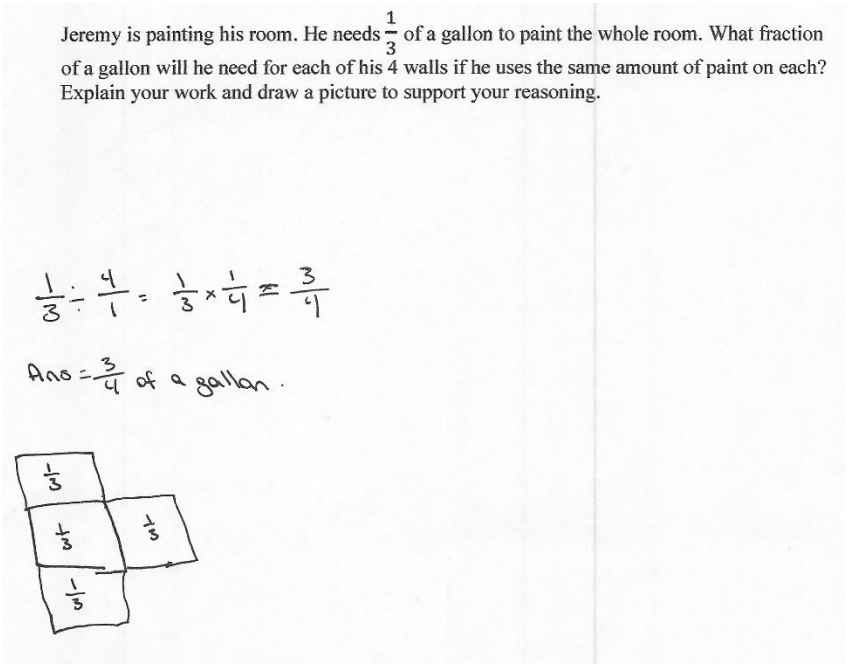

Figure 9. Student response #8

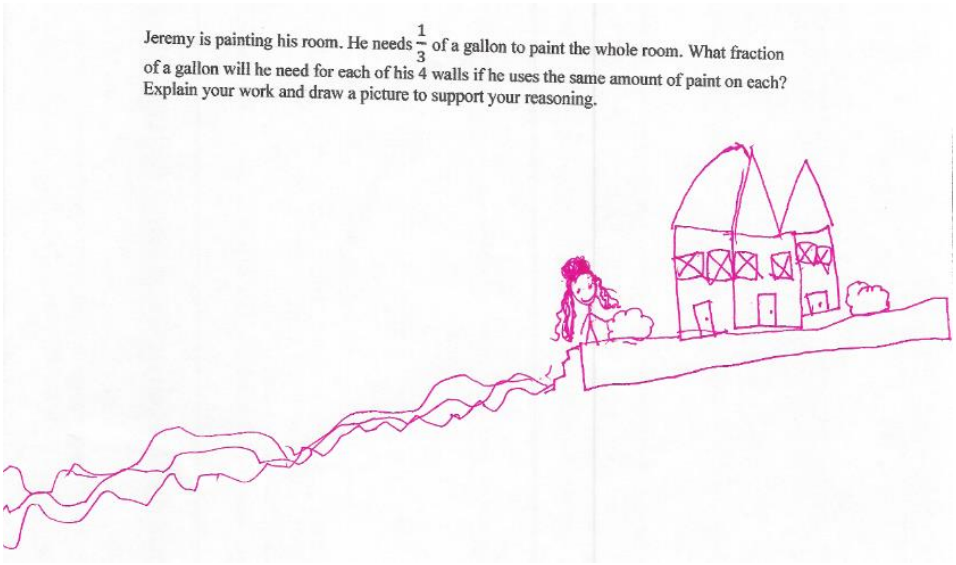

Figure 10. Student response #9

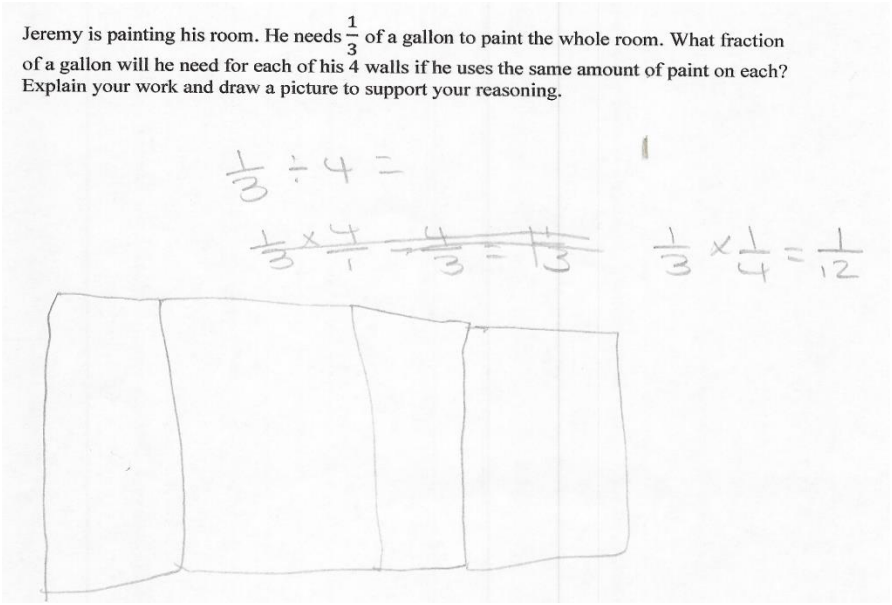

Figure 11. Student response #10

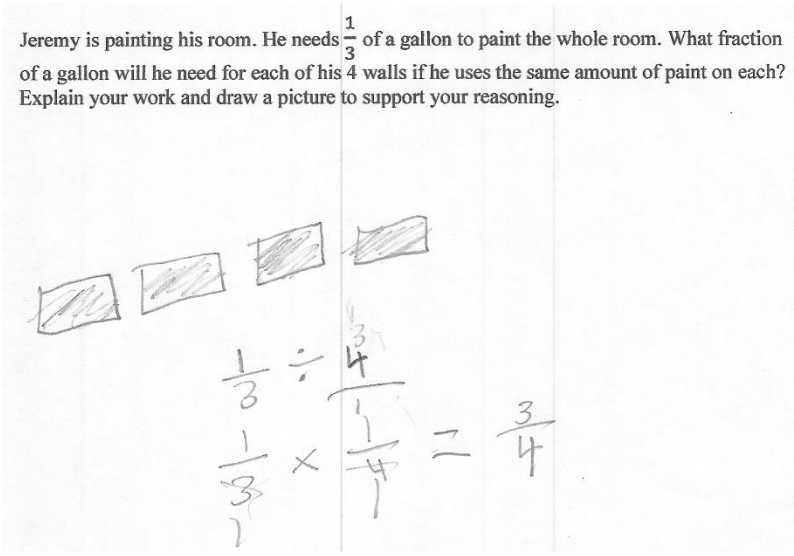

Figure 12. Student response # 11

According to the old saying, "one swallow does not a summer make". By that I mean that the students will not gain insights in a few days or even in a few weeks or after a few lessons. It will take an entire mindset shift to fully brace the inquiry-based method in schools, especially with the proposed changes to the SEA exam. The following setbacks were discussed with my colleagues about implementing the curriculum changes that we were mandated to adopt. In an attempt to be unbiased, I have matched each drawback with a possible solution.

The potential effect on SEA results. *At the Standard four and five levels, students and teachers are actively preparing for the SEA examination. The very nature of this exam makes it imperative to cover all aspects of the curriculum. In the case of inquiry-based learning, it is not a guarantee that students will discover or happen upon all the topics that they may need in order to be prepared for their examinations. As a result, teachers are reluctant to use inquiry-based learning with their students. On the other hand, the teacher's role is crucial in inquiry-based learning. It is up to the teacher to ensure that connections are made by employing effective questioning techniques so that they guide their students to the relevant areas of the curriculum. Once done properly, students can have a more enriching experience with each topic and feel as though they are in charge of their learning experience.*

For Lesson 1 on geometry, inquiry-based learning was successful, as the scope of this topic was not very extensive. The questions that are based on this topic in the SEA exam normally do not vary. As such, I was confident that students would be able to

achieve the objectives that were set out before the lesson. For Lesson 2, however, the students seemed daunted by the task. The models helped me as the teacher to explain the concepts and to be confident in my delivery; but the students were not able to achieve all the objectives that were set out. I felt at one point as though the students were not going to grasp the concept, and I reverted to pushing them to reach the objectives rather than ensure that they came upon the information themselves. This reflection suggests that expedience might be another reason that would explain why a teacher might revert to traditional over contemporary approaches.

Unwilling students, *With inquiry-based learning activities, students are required to be immersed in the activities presented so that they are able to respond appropriately. Right away, the students who are not strong public speakers are at a disadvantage. The students who may need more time to process information and therefore would not have a readily available response are also at a disadvantage. Students with learning disabilities and weak comprehension skills would also be at a disadvantage.*

Generally, reluctant students need extra support. Teachers can mitigate some of these disadvantages by asking questions in the initial stages of the lesson that everyone can answer. By focusing mainly on open-ended questions, the teacher can engage even the most reluctant participant. What may be entirely useful is to form small groups where the struggling student is able to share ideas with friends. In this way, students would feel comfortable since such a lesson design takes student interest, ability and pace into consideration.

First author's analysis of fifth critical incident

The teacher's emotional intelligence comes to the fore in that they are able to read and respond appropriately to student differences in personality even when engaged in a new approach to teaching. This is vital to success because practitioners can easily be caught up in the elements of delivery and forget that the most important factor in the context is the students. Interactional awareness and insight are therefore crucial to success when communicating content that might take some students out of their comfort zone. The role of teacher self-efficacy with the new method in this high stakes environment is also brought into view and underlined as critical (Cartwright et al., 2014).

Preparedness and mindset of the teacher

Inquiry-based learning techniques rely heavily on the preparedness of the teacher. Some teachers who do not wholeheartedly embrace the concept of inquiry-based learning would find some difficulty in designing a lesson that engages students at a deeper level.

It is critical for the teacher to guide and facilitate all students during the inquiry-based lesson. By providing timely and formative feedback, the teacher can ensure that the objectives are met and that each student is on the right track. If any student is left up to their own devices, the lesson stands a good chance of being unsuccessful.

The fact remains that teachers, including myself, believe that a good mathematical performance means that the student would be able to score high marks on a test. For me, this would be the ultimate evidence that the student has understood the concepts that were taught. My mindset about what constitutes good mathematical instruction is therefore coloured by this view. Inquiry-based learning, though, asks that the teacher help students come to the point where they understand fully why mathematics works. As a direct result, I am transferring to the students all the misconceptions that I have about "doing mathematics".

Again, we see here the teacher's ability to not only be frank and honest in reflection but also to be able to identify the possibility of misconception transfer. This type of acknowledgement is essential for any meaningful change in approach or philosophy to occur (Eggen & Kauchak, 2015).

How ready are the students for this?

At the SEA level, we expect that students have matured enough to inquire and make decisions on their own. Some students are not completely ready to take charge of their own learning in this way. As a result, being unprepared and ill-equipped, many students are not comfortable with working in (what may seem to be) an unstructured environment (Magee & Flessner, 2012).

Using the inquiry-based approach at the SEA level in the primary schools of Trinidad and Tobago means that skills related to the inquiry process would have to be taught. While it can be acknowledged that all learners have the capacity to ask questions and make judgements about tasks set before them, for many of them, these skills do not come naturally. Teachers will definitely need to scaffold student learning so as to ensure that learners are properly supported along the way (Blair, 2014).

In the lesson on geometry, I was able to help students by guiding them to uncover the information that they came to the class with and use this information to make connections to the task set before them. In the second lesson on division of fractions, however, I stopped short of telling them exactly how to find the answer. The questions did not seem to be enough to help them to use the previous knowledge that they had to find the correct responses. The importance of student readiness and their prior knowledge and how to facilitate both in the learning processes cannot be overestimated

(Gutierez, 2015). The reflections in this section demonstrate this most clearly. Practitioners would do well to be like-minded when implementing IBT.

Assessing

Traditional methods of assessment are not easily used with inquiry-based learning. As a result, it almost seems as though we are blindsiding students when we teach using one model and then subject them to an assessment of an entirely different nature.

Although the problem of assessment can be solved by the teacher using different methods to gather evidence that concepts are grasped, the fact remains that the learner still has a high stakes exam to write at the end of the period. As SEA teachers, we want that our students will have the very best chance at success and so we rely heavily on drills to ensure that our charges are comfortable with the format of the exam. Using the inquiry-based method to teach and then using the process of drills to assess creates a definite mismatch. With inquiry-based methods, formative assessments would provide valid information as to whether learners are developing skills in higher-order thinking. Having students voice their responses and observing as they complete tasks would definitely give the classroom teacher the insight needed to determine whether the students are engaged actively in their learning.

Teaching-learning and assessment mismatches occur all too frequently in academia. The teacher here reflects how it undermines the process of IBT and what could be done to correct this problem if it happens. For the lesson on Geometry, the students were assigned pre-tasks before the final evaluation. This was in an attempt to have them warm up to the idea of learning the material in a different way. For the first task, one of the responses was this:

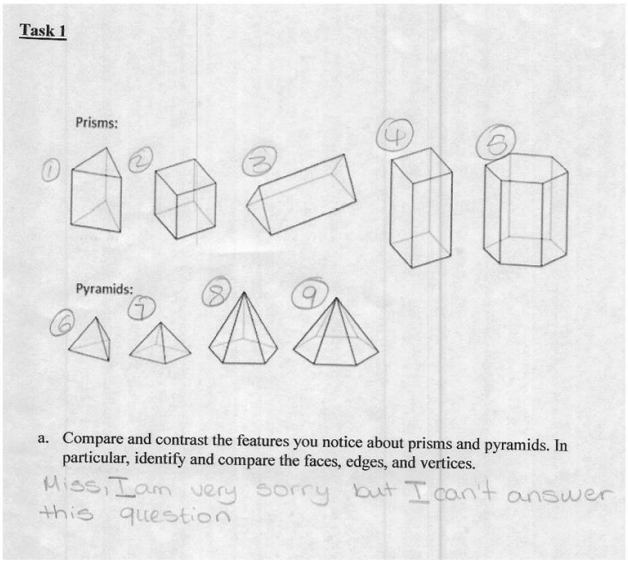

Figure 13. Student response #12

It signalled to me that this group of students had already given up and I was able to sit with them and help them to work through the task. For the second lesson, however, task 1 took so long that I did not even bother to go on to task 2. I felt defeated as there was only one group who came even close to the answer. The assessment spoke loudly and clearly on its own – "Go back to the drawing board"!

Questioning

The inquiry-based model, as the name suggests, is all about questioning. Many teachers find themselves stuck when it comes to knowing what would be the correct questions to ask. Preparing beforehand is certainly a way teachers try to maintain confidence and to keep the lesson on track. However, in situations where the lesson seems to be going down the wrong road, teachers simply fall back into the pattern of asking closed, content-specific questions that would lead students in the direction needed to achieve the objectives. When this is done, the whole idea of authentic inquiry is lost.

Of course, once teachers are able to identify the essential understandings and deep concepts of a topic rather than just what is on the surface, then they are able to fluidly question students in order for them to achieve a greater understanding of the topic at hand. In this context, learners would be able to understand and explore the content in ways that would make learning more meaningful for them.

Questioning is tricky in any situation and for any lesson. For both lessons cited here, I planned the questions assiduously. I knew what I wanted to ask, and I knew that I was

guiding the students in the right direction to achieve the desired outcomes. Of course, just as with live television, the classroom is not scripted. I did not cater for the expressions of hopelessness that students articulated at every juncture. I found myself asking the same questions over and over to groups and individuals when I had imagined that I had given the questions as a guide to the entire class. Sometimes when the questions I asked resulted in a blank stare, I had to think quickly of another way to phrase the questions without allowing the lesson to be transformed into a series of instructions. In the geometry, lesson for example, one of the guiding questions was:

"How many pentagon faces does a pentagonal pyramid have"?

The responses were anything but encouraging:

> "Oh God, Miss, yuh go kill we"!
>
> "What that mean"?
>
> "Miss, yuh know that is ah good alliteration. All yuh could say that fast"?
>
> "Way boy. All yuh thought maths was hard all de time. Look how it get harder now"!
>
> "Miss, all this talk, talk, talk. Why you just doh tell we what to do and we go do it".

The guided questions for the geometry lesson assisted greatly in encouraging students to participate. One boy commented that the questions seemed easy enough to answer and that the manipulatives assisted him in responding with confidence to the questions that I asked. In both lessons, the more outgoing students were the ones who responded bravely and voluntarily. The more reserved students really had no outlet to express their thoughts and I was not entirely sure that they were grasping the material as the lessons progressed. Whilst open-ended questions were asked in both lessons, I noted that it was an extremely difficult task. At the back of my mind, I was always wondering if the questions were too vague or if they would move the lesson away from the objectives that I had set out to achieve. In hindsight, I should have collected evidence of their learning during the lesson rather than assess their responses at the end.

And that, right there, was the problem. My students had grown accustomed to the teacher being at the steering wheel all along and so it was difficult and scary for them to now take charge of their own learning. Of course, the few voices of reason were drowned out by the distractors and getting the class to focus again took some more time. I was tempted to go back to the drill method because I knew if I just told them what to do, they would have done it. I understood why they needed to fully grasp concepts and why they needed to hone their reasoning skills. At the same time, I understood that for five out of seven years of their school lives, they were basically spoon-fed by teachers; so the majority of them were unable to truly work independently, no matter how well the questions were

structured. I was able to use the opinions of a few of the boys who fully grasped the content to continue my questioning in an effort to move the discussion along.

For the second lesson on division of fractions, the guided questions did not help.

> "Why is this a division problem?"

There was complete silence. I tried again.

> "Why shouldn't we just add? Wouldn't that bring us to the correct answer"?

Still, there was no response. I tried again.

> "How come we cannot simply move some numbers around? What does this problem have in common with other division problems that you have done before? Let's talk about what division means and then decide why this problem has to be a division problem".

It was like pulling teeth, requiring perseverance and physical strength. All the other questions and tasks that I had prepared on this topic were quickly abandoned because I knew that there was no way I could have taught this particular topic without giving students more practice in dividing and in problem solving in general.

Learner portfolios

SEA teachers are challenged when it comes to the time needed to manage learner portfolios. These portfolios serve as effective ways to gather evidence of student learning and facilitate the assessment process because students are able to work at their own pace and level. Providing ongoing feedback is crucial in the inquiry-based lesson and portfolios provide the opportunity for this kind of feedback. Because the whole idea of using portfolios is time-consuming, SEA teachers, more often than not, revert to traditional summative assessments.

In order to deal with this problem, teachers can concentrate on collecting evidence of student learning as it relates to specific objectives throughout the unit. In this way, teachers can provide formative feedback rather than wait for the summative tests at the end.

CONCLUSION

Teaching in a high stakes environment carries stressors of its own. When it also includes the implementation of a new curriculum along with new or unfamiliar contemporary pedagogy, the challenges are multiplied. This study set out to determine the challenges

of, and insights that can be derived from, the implementation of IBT to teach mathematics in a high stakes learning environment such as the SEA examination in Trinidad and Tobago. This study has shown that this particular teacher's experiences as represented in the critical incidents found resonance with extant literature, but also went beyond it. The findings also mirrored the issues related to teacher-oriented interpretation of what is meant by IBT as a key influence determining implementation. It was also found that different students in the same class or class sub-grouping may reflect different skill competency levels and readiness for IBT. The latter adds value to the discourse on contemporary pedagogy because while student maturity is often emphasized, readiness for student-centered approaches is much more critical for success.

The findings here, like others, identified cognitive and pedagogical challenges in delivering content through IBT. But this study goes further because the emotions experienced during different IBT phases were highlighted, as well as the affective transition from failure to success in implementation. This factor highlights the level of self-awareness that teachers may need to have as it can impact their self-efficacy and motivation levels when attempting new teaching methods. Student voice as identified in the dialogue selected is an important dimension not discussed previously but extremely vital in getting a 360-degree view of the IBT encounter from those at the core of it.

The consequences and challenges of drifting back to traditional modes of pedagogy or integrating the same are new and interesting findings in this study. While these regressions to default mode are not counterintuitive in themselves, they do provide new insight into why, how and when they occur as well as how a balance may be struck between utilizing old pedagogies while implementing new ones. Another major finding of this study is the value of teacher-mindfulness throughout the entire process so as to not only see and note when things are working well but also when major mistakes or philosophical shifts have occurred. The teacher's reflective analysis of the critical incidents reveals the importance of personal reflection while at the same time keeping focus on the students as the most important factor in the paradigm of teaching/learning, even if the framework is a high stakes one such as in this study. This means progressing only as fast and as far as is reasonable for all students to enjoy a meaningful learning experience.

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