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The Influence of Language on the Teaching and Learning of Mathematics

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This is to certify that the doctoral study by

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2017

Abstract

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by

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MSc, Walden University, 2011

BEd, University of the West Indies, 2006

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

A majority of students at the local University College of Science and Education (UCSE, pseudonym) in Jamaica do not have the conceptual understanding of mathematical principles to function in a competitive and highly globalized marketplace. In 2013 and 2014, 88% and 92% of freshmen education students scored at the lowest 2 levels on the Mathematics Diagnostic Test (MDT). The instructional language at UCSE is Standard English (SE) whereas most students speak Jamaican dialect (JD). The purpose of this study was to determine the effect that the language of instruction has on student achievement in math as measured by the MDT. Guided by Vygotsky's social development theory, the research questions focused on comparing MDT change scores between students who were taught using JD and those using SE as the instructional language. The quasi-experimental design used ex post facto data including pretest and posttest MDT scores from 40 freshmen of whom 20 were instructed in JD and 20 in SE. The results of an independent sample *t* test showed that the difference in the MDT change score was significant. The JD students had a higher improvement score. Consequently, it is recommended that math instructors use JD to instruct freshmen education students whose native language is JD. A professional development session for math teachers was created that demonstrates how to teach in JD while simultaneously scaffolding the instruction in a way that students can learn SE and be prepared for the following year at UCSE. If students understand the math concepts in their freshman year, they are more likely to continue their college education and to become productive members of Jamaica's economy which is dependent on employees that are proficient in math.

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Dedication

I am dedicating this project study to my colleagues Eloise Douglas, Phostine Brown, and Donna Thompson.

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I would like to acknowledge the guidance, assistance, and suggestions of the chair of my committee, Dr. Cathryn Walker White and the URR Dr. Laura M. Siaya throughout the writing of this investigation. Your patience and guidance is unrivaled and is the reason I have made it this far! Thank you.

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Section 1: The Problem

Introduction

The problem that I investigated in this study was the low mathematics competency scores of freshmen at the University College of Science and Education (UCSE, a pseudonym) in Jamaica. Specifically, results from the Mathematics Diagnostic Test (MDT) for the 2013-2014 academic year show those students who speak the Jamaican dialect (JD) obtained an average score of approximately 40% with the passing score set at 50% (Ministry of Education, Jamaica, 2014). The mean score on the MDT for students who speak Standard English (SE) was 70% (Ministry of Education, Jamaica, 2014). The scores indicate that a disparity exists between students who speak the JD and students who speak SE and their competency in mathematics. The Registry at UCSE stated that students who speak SE obtain an average score of 72% in the semester-based math examination while students who speak the JD had an average score of 40%; these scores also show a disparity in achievement between SE-speaking students and students who speak the JD.

JD is the language used by the majority of Jamaicans, but SE is the official language of the country (Nero, 2015). Teachers are mandated by the Ministry of Education to carry out instruction in SE; however, this does not match the cultural identity of most students (Nero, 2014). In the Jamaican education system, official recognition of the JD is absent and is a politically combative issue (Fairclough, 2014). According to Nero (2014), the majority of students use the JD as their medium of communication. From the UCSE college administrator's perspective, this means SE has

become a foreign language for most pupils, and subsequently, the majority of students are viewed as English language learners (ELLs).

More specifically, many ELLs, who use JD as their primary language, underachieve and fail to demonstrate mathematics competency determined by the MDT. Although it is difficult to attribute the students' poor performance to any one factor, researchers have demonstrated that students with limited proficiency in the English language often misinterpret mathematical principles, axioms, and theorems (Vukovic & Lesaux, 2013). Consequently, educators in Jamaica are concerned that students' lack of English language proficiency could prevent mathematics instructors from effectively teaching ELL students (Ministry of Education, Jamaica, 2014) because it could prevent students from effectively understanding the instruction and concurrently interfere with the students' ability to communicate with the instructor (Chitera, Kasoka, & Thomo, 2016). The purpose of this study was to determine the effect that the language of instruction has on student achievement in math as measured by the MDT. Creswell (2012) noted that quantitative research is useful for explaining the relationship between variables. Quantitative data also highlight the relationship between an action or event and the effect that it produces (Creswell, 2012). Therefore, sustained indication of the role that English language proficiency plays in instructing freshmen at UCSE would be beneficial (Esquinca, 2013; Greer & Mukhopadhyay, 2015; Haag et al., 2013 and as such I used a quantitative approach in this study. In the proceeding subsections, I will describe the local problem, provide the rationale for the investigation, and explain the importance and broad effect of this systematic inquiry.

Definition of Problem

In 2014 and 2015, freshman students at UCSE were required to take semester examinations using the MDT to monitor their mathematics competency. For each year more than 60% of UCSE freshmen did not pass this test. Poor performance in math by ELL students is not unique to UCSE; it represents a major problem in all colleges in Jamaica as many ELLs underachieve on the mathematics competency test (Ministry of Education, 2014). The Ministry of Education submits an annual report on the performance of the students in the Annual MDT to UCSE, and this information is made available to all members of the mathematics and computer science department. Analysis of the data sent from the Ministry of Education from 2013-20014 academic year (AY) and 2014-2015 AY show that the students were performing poorly in the MDT (see Appendices D and E). Information collected from the Ministry of Education of Jamaica (2014) revealed that 40% of all JD students at all tertiary-level institutions were failing mathematics (i.e., had obtained < 50% on the standardized mathematics test).

The UCSE registry indicated that students who failed the semester-based mathematics exam obtained a grade of C in English language in the yearly Caribbean Secondary Education Certificate (CSEC) examination. To attend a tertiary-level educational institution in Jamaica, students must pass a minimum of five subjects on the CSEC examination (CITE). Acceptable grades earned in each subject should range from I to III, or the equivalent of A to C. Data collected from 2001–2012 revealed that 23% - 45% of all students taking the examination attained Grade I-III proficiency in mathematics (Ministry of Education, Jamaica, 2015). Consequently, the majority of the

students for the 2001-2012 years did not reach Grade I-III proficiency in mathematics, and, according to the UCSE college administrator, this failure rate concerned the Ministry of Education and college administrators.

To combat this, the Jamaican government, through the national mathematics coordinator, rolled out some initiatives to address the low mathematics achievement among students, particularly in respect to students speaking the JD; however, low attainment in mathematics is still a problem (Ministry of Education, Jamaica 2014). The average marks obtained in the semester-based examination is < 45% (Ministry of Education, Jamaica 2014). This is a concern across the country as low attainment in math has contributed to Jamaica lacking science-based professionals that can help spur innovation and economic group (Ministry of Education, Jamaica, 2015).

It is necessary for all mathematics instructors in Jamaica to have an understanding of the language that students take to the mathematics classrooms and be capable of supporting their language identity during math lessons. This strategy may help to improve attainment in mathematics for all JD students. The high mathematics failure rate is a concern to college administrators because of its close association with dropout rates. Many mathematics teacher education students are starting college but are leaving without completing their course of study (Ministry of Education, Jamaica, 2014).

Rationale

Evidence of the Problem at the Local Level

The results obtained from the 2013 and 2014 MDT administered by the Ministry of Education highlight the poor performance of first-year students in mathematics,

particularly among those students who speak the JD. This low level of achievement, especially with various initiatives in place that were designed to raise mathematics achievement, has caused great concern among government officials, university administrators, and parents (Ministry of Education, Jamaica, 2014). These data from the Ministry of Education show that 69.23% of the students exhibited profound deficits in their content knowledge and needed intensive support. These data (see Appendices D and E) also show that the education students' average performance in algebra, measurement, numbers, geometry, and statistics was less than 50%. Analysis of the information in Appendix D reveals that all the students displayed a deficit in math content knowledge. Ideally, all students are expected to perform at Level IV on the MDT.

The Ministry of Education categorizes the students who take the MDT. Level IV students exhibit a minimal deficit in their content knowledge. At Level III, the students show moderate gaps in their content knowledge and need general support; students at Level II exhibit severe deficit in their content knowledge and need remediation, while students at Level I exhibit profound deficits in their content knowledge and need intensive support. None of the students at UCSE were performing at Level IV, and only 11.5% were achieving marks at Level III. Given the poor performance in all the areas tested in the MDT, it is reasonable for me to focus on the effect of language on mathematics achievement in this study. Kanno and Cromley (2013) noted that the linguistic background of students is an important factor that can be used to predict access to and attainment in college education. As students enter university with a given language preference, the concern becomes how to most effectively instruct students in mathematics

and what language of instruction to use for students who native language is not SE, the standard language of instruction.

Students at UCSE must pass the mathematics examination in order to graduate. If students fail to graduate, it deprives Caribbean nations of graduates who are prepared to assume leadership roles in agriculture, science, and education (Ministry of Education, 2014). Table 1 shows the average score of USCE education students and the difference in the freshmen education student score compared to 50% passing standard on the 2013 and 2014 MDT. Further, Table 2 depicts the diagnostic data of students and their MDT performance by Standards I (Profound Deficit), II (Severe Deficit), and III (Moderate Deficit) and demonstrating that the majority of students who took the MDT during the years 2013 and 2014 demonstrated need for mathematics support by scoring in the profound to moderate need range. In 2013, 52 freshmen education students took the MDT, and in 2014, 33 freshmen education students took the MDT.

Table 1

MDT Average Percentage Score for Freshmen Education and Difference in Average Score Compared to Proficiency Standard of 50%

Year	Average Score	Difference
2013	40.55	-9.45
2014	33.24	-16.76

Note. (2013) $N = 52$ and (2014) $N = 33$

Table 2

Number of UCSE Freshmen Education Students Scoring on MDT Diagnostic Levels of Performance

Year	Deficit Level I	Deficit Level II	Deficit Level III	Total Students
2013	26	20	6	52
2014	19	13	1	33

Note. Data from National MDT 2013 and 2014 see Appendices D and E

Students in the Level I and II areas, which comprised the majority of the students who took the exam in 2013 and 2014, required additional mathematics support from the college mathematics department to continue their education degree program (Ministry of Education, Jamaica, 2015). No freshmen education students scored, in either 2013 or 2104 at the Level IV range which indicates minimal deficits (See Appendices D and E). To address this issue, the Government of Jamaica offered professional development (PD) courses for instructors in mathematics (Ministry of Education, Jamaica, 2014); however, these programs did not adequately address the language proficiency needs of students to comprehend mathematics taught in English. According to the MDT data for college freshmen education students for 2013, the overall minimum score obtained was 29.85%, compared to an average score of 40.55% for all students. Findings from the MDT data for college freshmen education students for 2014 showed that the overall average minimum score was 20.75%, compared to a score of 33.24% for all students. Therefore, for the years 2013 and 2014 there were deficits of 10.7% and 12.49% respectively when comparing the performance of college freshmen education students and all other

freshmen students who took the MDT (See Appendices D and E). The college administrators were not clear about the effectiveness of the PD intervention as it was designed (J.Vonkuster, personal communication, July 6, 2016).

Aud, Wilkinson-Flickers, Nachazel, and Dziuba (2013) discussed the disadvantages of not considering students' language proficiencies when teaching mathematics. Aud, Wilkinson-Flickers, Nachazel, and Dziuba (2013) demonstrated that ELLs are at a disadvantage when their instructors do not consider the influence language may have on the understanding of mathematics instruction. The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. Teaching students who speak the JD to comprehend and solve mathematical word problems is a challenge for most instructors because in many instances the words used to describe the math problems are different from the JD language used in their cultural setting, which is the predominant language used. Consequently, when the language of the student is not SE, teaching students using SE in math courses has been found to be challenging in that students have difficulty understanding math content using SE as math courses have math-specific vocabulary, which uses words that are not in the students' native language and has resulted in poor math performance for student (Agirdag, Houtte, & Avermaet, 2012).

Using culture-based terminology, or teaching in the students' native language, has the potential to increase the number of students who pass the standardized examination. The results reported in Turner et al.'s (2012) study support this assertion, in that they demonstrated unequivocally that scores earned on the mandated semester examination

improved when students were taught mathematics using the students' native language for word problems. Difficulties encountered by ELL students seem to be associated to language anxieties and not necessarily mathematical tasks (Alt et al., 2014). Menken and Solorza (2014) performed studies in bilingual education that demonstrated that ELL students who were instructed in their native language outperformed ELL students instructed in English.

Despite the results of studies demonstrating an improvement in mathematics performance when students are taught using their native language, these results were not obtained at the target site with the interventions as designed (see Appendices D and E). The administrators contended that many mathematics instructors were unable to integrate the JD used by most ELL students into their classes because they were not adequately trained to do so or were not proficient at using the JD. Cervetti, Kulikowich, and Bravo's (2015) findings supported the claim that many mathematics instructors are not capable of integrating the language of ELL students into their teaching of mathematics.

The college administrators at the target site determined a mathematics intervention was needed to address the mathematics deficiencies by freshmen students entering the education program. This intervention divided students into groups based on the MDT score and level performance. Instructors received copies of the MDT assessment so that instruction could be individualized to meet the student needs. The instructors were directed to use manipulatives, real life scenarios, and emphasize problem solving and written and verbal skills in English (See Appendix B.) The college

administrators also developed interventions to support the college instructors responsible for teaching the JD students with low mathematics performance scores.

College administrators also proposed targeted professional development (PD) for instructors of ELLs to supplement the use of culture-based terminology to teach mathematics. The goal of the PD was to provide instructors with additional mathematics language skills to support the JD student to master the mandated curriculum prepared by the Ministry of Education. The hope was that this intervention of PD for teachers and students would support the development of JD students' English language skills in order to demonstrate proficiency in the mathematics curriculum.

Evidence of the Problem from the Professional Literature

Teaching mathematics effectively is difficult even for experienced instructors (Riccomini, Smith, Hughes, & Fries, 2015). According to Sleeter (2012), instructors should understand that teaching mathematics in the native dialect of students might be insufficient. Mathematics instructors also need to explore creative ways of using the language to enhance the teaching and learning process (Riccomini, Smith, Hughes, & Fries, 2015). In general, communicating using the language of mathematics requires a strong background in mathematical content and pedagogy, a good command of the English language, well-developed number sense, and the ability to think critically (Riccomini, Smith, Hughes, & Fries, 2015). Quinnell, Thompson, and LeBard (2013) noted that identifying and understanding the barriers that prevent students from learning mathematical concepts would allow more students to learn mathematics and be able to transfer their knowledge to other subject areas. An excellent instructor of mathematics

should seek to (a) expand inherent qualities of mind and character, knowledge, and practices in students to support the enhancement of their mathematical thinking and (b) integrate students' cultural, linguistic, and everyday lived experience in the classroom (Turner et al., 2012).

Competency in the language of instruction is a necessary requirement for understanding the concepts being taught. Phakiti, Hirsh, and Woodrow (2013) stated that in universities where instruction is carried out in English, a student's ability to master the English language is a critical aspect of academic success. Haag, Heppt, Stanat, Kuhl, and Pant (2013) asserted that academic language differs from run-of-the-mill discourse; therefore, the language of the instructor will influence both the instruction and erudition of mathematics for ELLs. According to Haag et al., the more scholastic language features that a math item contains, the more challenging it will be for ELLs to understand the problem. Pina, Fuentes, Castillo, and Diamantopoulou (2014) noted that language is linked to performance on mathematical tests with high language exigencies. The researchers suggested mastery of the language of instruction influences performance in mathematical problems that require detailed and accurate understanding of the concepts tested.

Semantic features of language can be confusing if the language of instruction is not the students' native language (Chitera, Kasoka, & Thomo, 2016). This has been found to be critical in mathematics due to the vocabulary that accompanies mathematics instruction (Chitera et al). Kanno and Cromley (2013) noted that ELLs' performance in academic subjects is inferior to that of students who are proficient in using the English

language. The results of their study also indicated that learning challenges for ELLs entering higher education are common to many English-speaking countries, including the United States.

In this study, I focused on how to provide academic and linguistic support to first-year education students who are enrolled in courses taught by instructors using SE with students who speak the JD. To maximize ELL students' learning, mathematics instructors should try to align teaching, learning, and the language of the students (Chitera et al., 2016). Therefore, it was critical that students' mathematics performance on the MDT and the gap in practice related to the freshmen education students and all other entering freshmen students at the target site be explored to determine a course of action to address the performance and potential gap in practice (see Appendices D and E). The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT.

Definition of Terms

Before I can begin to introduce any theories or findings, it is important for the reader to understand the nuances of terms associated with this research. Terms associated with this research study are defined as follows:

Bilingual: A person who has the capability of using two languages with equal or nearly equal fluency (Kempert & Hardy, 2015).

Culture: The arts, family relationships, communication styles, and other manifestations of human intellectual achievements regarded collectively (Meidl & Meidl, 2013).

Culture-based terminology: Words used in a structured way in teaching and learning that are relevant and responsive to the languages, literacies, and cultural practices of students (Paris, 2012).

English language learner (ELL): A student whose main language is the JD and is in the process of learning SE (Nero, 2015).

Jamaican dialect (JD): The JD is a language developed in Jamaica that is peculiar to the Jamaican society (Sebba, 2014). The language was developed out of the language of African slaves interacting with English slave owners and a small amount of Spanish; it has become the mother tongue of successive generations of Jamaicans and is also known as Jamaican Patois.

Language: A system of sending or receiving information, which is either spoken or converted in written or signed form; its ease of use aids people in rational thoughts (Alt, Arizmendi, Beal, Nippold, & Pruitt-Lord, 2014).

Language minority students: Students who do not speak English or live in an environment where the English language is present and influential (Hodara, 2015).

Standard English (SE): The conventional style of the English language accepted as the typical correct form (Fairclough, 2014). English, which is characterized by idiom, vocabulary that is regarded as correct and acceptable by educated native speakers (Collins English Dictionary, 2016).

Tertiary education: Education at a level beyond that provided by secondary schools (Ministry of Education, Jamaica, 2015).

Tertiary mathematics students: Students studying mathematics at the college level (Ministry of Education, Jamaica, 2014).

Significance

Poor performance in math could lead to an insufficient number of people with the required science and math skills needed in the workforce in Jamaica (Ministry of Education, Jamaica, 2014). The insufficiency of workers with math and science skills could affect the competitiveness of Jamaica and Jamaican workers on the global stage. Additionally, a report from the Programme for International Student Assessment (PISA; 2013) showed a strong correlation between increases in students' attainment in mathematics and the gross domestic product (GDP) of several countries. In the United Kingdom, 10% of all jobs and 16% of total GDP was a direct result of mathematics. In the 2013-2014 census, the Ministry of Education showed that only 207 of the 1,784 mathematics teachers at the secondary level in Jamaica were qualified to teach mathematics up to Grade 11 standard.

The Ministry of Education and the administration of UCSE are concerned with the poor performance of the students in mathematics and the implications for national development. With no formative or summative data to establish if there is a relationship involving mathematics instruction using JD and student achievement in mathematics, it is unclear if this is a strategy that could help solve this problem. Based on research findings from this study, the Jamaican Ministry of Education could decide to facilitate and support further research in this area. My main goal with this research was to determine the effect the language of instruction has on student achievement in math. The findings from this

study provide an understanding of how math educators could support the enhancement of students who speak the JD and the students' knowledge of mathematics as well as alterations in the teaching approaches of the math instructors. Results from the study indicate that improvement in performance in math for students who speak the JD could be achieved through the provision of support to lecturers; such support should be designed to increase their academic knowledge on how the verbal expressions used in the classroom influences the instruction and learning of mathematics for students who speak the JD. The results from this study also indicate that using the language of the students as the medium of instruction contributes to improved performance in math. As accountability for academic performance increases and more focus is placed on academic achievement through standardized tests, the findings of this study may have a positive influence on teaching practices of math instructors as well as policy decisions to be considered by the college administrators.

Research Question and Hypotheses

In quantitative investigations, researchers use quantitative research questions and hypotheses, to outline and focus the purpose of the study. Quantitative research questions inquire about the relationships among variables that the investigator seeks to be aware of through investigation. Quantitative hypotheses are forecasts the researcher makes about the expected associations among variables (Creswell 2012). The local problem identified is set in USCE; a college with students who predominately speak JD and are struggling with performance on the MDT and the demonstration of mathematics proficiencies. The problem is evidenced by MDT scores from the years 2013 and 2014. Despite

interventions by the college administrators, the scores have not improved. Therefore, the results of the performance data coupled with findings and suggestions from the literature might lead one to examine the language of instruction as all students at the college do not speak SE as their first language. Therefore, to address the lack of mathematics performance in USCE, this research was critical for examining the association between the use of JD to instruct students in mathematics and the performance of USCE students on the MDT. Therefore, in order to address the lack of mathematics performance in USCE, this research was critical for examining the association between the use of JD, and the performance of USCE students on the MDT.

For the purposes of this research, the class that was taught in the JD was named *JD Group 1*, and the class taught in SE was named *SE Group 1*.

Research Question: What is the difference in MDT mathematics change scale scores between students who were instructed in JD (JD1) and students who were instructed in SE (SE1) for semester?

RQ Null Hypothesis (RQ-NH): There will be no significant difference between the mathematics scale scores of students receiving mathematics instruction using JD (JD1) and the mathematics scale scores of students receiving mathematics instruction in SE (SE1) as measured by the pre-post test scores of the MDT for the semester.

RQ Alternative Hypothesis (RQ-NH): There will be a significant difference between the mathematics scale scores of students receiving instructions using the JD (JD1) and the mathematics scale scores of students receiving mathematics instruction in SE (SE1) as measured by the pre-post test scores of the MDT for the semester.

The literature review that follows adds much to the understanding of the research problem and questions, places the findings into historical perspective, and leads to suggestions for further research.

Review of the Literature

Theoretical Foundation

Vygotsky's sociocultural theoretical framework guided this study. Mathematics educators in Jamaica are concerned about how poor language skills are preventing students from learning mathematics effectively. According to Darhower (2013), "the sociocultural theory operates on the assumption that human cognitive development is highly dependent upon the social context within which it takes place" (p. 251). Vygotsky (1962, 1978) noted that, "development occurs as the result of meaningful verbal interaction between novices and more knowledgeable interlocutors such as parents, peers, or teachers" (as cited by Darhower, 2013, p. 251). Closely linked to the Vygotskian view of cognitive development is the concept of shared view. Darhower (2013) suggested that, "engaging in collaborative discourse requires a shared communicative context" (p. 253). Speakers who have the same kind of experiences and social circumstances can readily share their lived experience. Outcomes are easier to interpret using sociocultural theory because such a perspective reflects the effect of language and related socioeconomic, cultural, and pedagogical elements that affect the lives of students and instructors (Darhower, 2013). In the research, I used a sociocultural theoretical framework to investigate social and cultural circumstances of how language influences mathematics scholarship.

Henry and Baltes (2014) have shown that language effects the teaching and learning of mathematics. Sociocultural theory encourages the teaching of mathematics around students' cultural identities, which makes mathematics accessible to those who have traditionally had difficulty learning the subject. If math reforms in Jamaica and other jurisdictions are to benefit students who are linguistically and politically different from the majority, research should be carried out that will assist in understanding the relationship between human communication and mathematics learning (Chitera et al., 2016). I combined current views of mathematics scholarship with current thinking on how to use classroom communication, mastery in more than two languages, and written or spoken communication about instructors' experiences while teaching ELLs. Poor English language skills are likely to exacerbate poor mathematics performance (Weinburgh et al., 2014). If their language challenges are not removed, it is unlikely that ELL learners will be able to fully grasp the concepts taught in a math lesson (Weinburgh et al., 2014). Vygotsky's sociocultural theory suggests that the acquisition of knowledge or skill occurs with social communication and comprehension is the result of socialization (Florentino, 2014). The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. Vygotsky's sociocultural theory, which highlights the need to incorporate the language of students into the instruction and erudition of mathematics, guided the study.

Review of the Broader Problem

This section is an appraisal of the relevant literature. The goals of this review include establishment of understanding of the key concepts, terminologies, ideas, theories

and, methods used to teach mathematics to ELL students. Establishing the state of knowledge in the field of mathematics education for ELL students is also an intention of the literature review.

The review is organized under five broad themes: (a) theoretical framework of the research study, (b) mathematics discourse, (c) influence of language on the profession, (d) mathematics instructors' education, (e) and language proficiency and attainment in math. These themes are explored in this appraisal of the literature with the intention of placing the local issue in the broader context of the educational domain.

The review of literature incorporated a variety of research strategies, including physically obtaining research documents from UCSE and the Ministry of Education in Jamaica. A comprehensive database search that included books, studies, and articles checked by experts in the particular branch of study was carried out through various library databases, including Google Scholar, Web of Science, ERIC, ProQuest, JSTOR, and Thoreau Multiple. Key search terms included *English language learners*, *JD*, *limited proficiency in English*, *bilingualism and academic performance*, *teaching mathematics to language minority students*, and *diversity*. Evaluating the literature highlighted the key issues that were relevant to the investigation, thereby helping to shape and provide a focus for this project study. The proceeding subsections provide a critical review of the broader problem associated with the influence of language on mathematics pedagogy.

Mathematics Discourse

Poor academic performance in mathematics is an important issue, as many college students struggle with grasping important mathematical concepts that they are being

taught (Ministry of Education, Jamaica, 2014). Language is a critical element of teaching and learning (DiCerbo, Anstrom, Baker, & Rivera 2014). It is the medium through which information is conveyed and through which an instructor is able to determine whether or not students grasp the concepts and skills taught. Communication is one of the key factors in building understanding in the mathematics classroom of the 21st century. Star and Stylianides (2013) stated that conceptual understanding and procedural knowledge are the foundations of mathematical reasoning. Teaching techniques would therefore benefit from a widening of the range of mathematics discourse to include conceptual knowledge and procedural understanding.

Alt et al., 2014 noted that the more complex the language in math problems is the lower ELL students' performance will be. Items written in the unique vocabulary of mathematics cause performance disadvantages for ELLs. Haag et al. (2013) noted that linguistic complexity influences ELL students' accomplishments on standardized attainment tests in math. Greer and Mukhopadhyay (2015) noted that mathematics only makes sense when it becomes fixed firmly in historical, cultural, social, and political contexts. Cho, Yang, and Mandracchia (2015) stated that emerging teaching strategies for teaching ELLs include sheltered instruction, an experiential approach, and purposefully commissioned tuition in English. Brantlinger (2014) suggested that math discourse involving explanation, argumentation, and defense of mathematical concepts should be a defining feature of a quality mathematics classroom experience for ELLs because academic language can increase the difficulty of math items for ELLs.

New teaching strategies may enable ELLs to learn mathematical concepts and ensure that educators do not compromise the knowledge base of students' English proficiency level. More specifically, new teaching strategies may support students' ability to exchange information or ideas, involve them in vigorous activities, and provide favorable circumstances for using English. Mathematics instructors should acknowledge that an underlying demand in mathematics pedagogy is helping tutees move from trying to use everyday vernacular to formulating knowledge in scientific ways that are imperative for success in learning math and science (J.Vonkuster, personal communication, July 6, 2016). (See Appendix B.). Bunch (2013) noted that in multicultural classrooms, there is a demand for greater proficiency while using the English language in academia. Developing instructors' comprehension of communication issues can be the basis for preparing them to give assistance and support ELL learners in mathematics classrooms. Many terms used in mathematics are unique to the subject area. Furthermore, many symbols for ideas are used in the study of math. The meaning of a word in mathematics is often influenced by culture and the context in which it is used (Solano-Flores et al., 2013).

In the field of mathematics education, there is still much uncertainty concerning the most effective teaching techniques for instructing ELLs (Cho, Yang, & Mandracchia, 2015). Many researchers have, however, confirmed that the wording used by both students and instructors in mathematics discourse influences the learning of mathematical principles (Weinburgh et al., 2014). Understanding the language of instruction is essential to effective math instruction. Students are required to understand math-specific terms as

well as perceive the specialized mathematical meaning of a word and other definitions of the same word. Mathematics instructors should therefore develop an awareness of the time it takes ELLs to learn academic English. Such awareness is important, given that Choi et al. (2013) showed verifiable evidence of possible language biases in mathematical worded problems at the postsecondary level that placed ELLs at a disadvantage. Esquinca (2013) suggested that ELL students learn to think mathematically through participating in mathematics discourse in classrooms. Mathematics is best learned through discourse; discussion gives students the opportunity to explore mathematical concepts and develop understanding of concepts that otherwise might be abstract to them. Instructors should continue to advocate for integrating numeracy and literacy in the teaching and learning of math; this would include calling attention to the meaning-making resources used to construct mathematical understanding (Bunch, 2013).

Influence of Language on the Teaching and Learning of Mathematics

Vukovic and Lesaux (2013) stated that language affects how students interpret mathematical ideas. Results from this study showed that method of human communication, knowledge, and skills gained over time are essential for mathematical development regardless of language. These findings indicate that ELL learners need more thorough and focused opportunities for developing an understanding of mathematical principles and concepts of pivotal importance. Zhu, Chen, Moyzis, Dong, and Lin (2015) suggested that language proficiency is an important aspect in educational accomplishments; additionally, mathematical competence is fundamental to educational attainment.

Many instructors have little or no training related to teaching mathematics to ELL students; consequently, many instructors struggle to equalize instruction in both literacy and content knowledge (Bunch, 2013). Kanno and Cromley (2013) suggested that ELLs enter tertiary education at a disadvantage, due mainly to lack of competence in the English language and their instructors' absence of knowledge of their culture. In many classrooms, ELL learners' opportunities for learning mathematics are being limited through poor classroom instruction (Waxman, Diaz, & Padrón (2013). Guglielmi (2012) noted that there has been much discussion on how best to educate English language learners; the integration of the students' mother tongue in the instruction and learning of math will cause an improvement in academic achievement for ELLs. DelliCarpini and Alonso (2014) noted that in mathematics, content cannot be taught if the pupils do not have the ability to understand the English language. Adding to the challenges of mathematics educators is the fact that the student body in Jamaica is multicultural and widely varied academically. Sarama, Lange, Clements, and Wolfe (2012) suggested that students who live in poverty and who belong to linguistic and ethnic minority groups clearly showed lower levels of academic achievement. In Jamaica, educational institutions are experiencing difficulty in executing reform programs without sufficient financial and PD support (Williams & Staulters, 2014). According to Bunch (2013), the classrooms of the 21st century place greater language demands on instructors as a result of academic expectations. Constructing math educators' comprehension of communication could be used as the argument for making them ready to involve and support ELLs in the mathematics classroom as they try to develop mathematical

understanding. Valle, Waxman, Diaz, and Padrón (2013) noted that in consideration of the linguistic heritage of ELL students, mathematics instructors should incorporate teaching techniques to create a teaching and learning environment that is conducive to their learning styles, thereby promoting math proficiency. Instructors need to dismiss the misconception that mathematics is a universal language and instead promote policies that will contribute to greater achievement in math for all ELL learners.

Instructor Education

Roofe and Miller (2013) stated that there are many difficulties involved in instructor preparation, and this idea has continued to dominate discussions on students' educational achievements. Math problems requiring an understanding of the English language are known to prevent language minority learners from fully grasping the concepts taught and hence from giving a practical exhibition and explanation of ideas tested. Students who exhibit mastery of the English language, on the other hand, are more likely to understand worded math problems that require the analysis of ideas (Haag et al., 2013). As suggested by Stronge et al. (2013), there is a strong correlation between student learning outcomes, instructor quality, and instructor education. According to Cortes, Goodman, and Takako (2015), the competence of instructors is one of the influences that contribute to the accomplishment of ELL students. ELLs require special enrichment activities while they are taught mathematics; the significant increase in the ELL school population makes the need for immediate intervention urgent. The joint board of teacher education (2012) stated that in Jamaica, the duration of teacher training is 3 years in universities and 4 years in teacher colleges. Teacher training courses expose

students to elementary education, content and pedagogical knowledge and supervised teaching practicum at different stages of the curriculum. The primary goal of teacher training in Jamaica is to educate instructors who can give a virtual exhibition and explanation of their area of specialization as well as suitable pedagogical skill or knowledge and an understanding of their role as educators. The teacher-training curriculum does not include provisions for training instructors on how to teach ELL students (Levis, Sonsaat, Link, & Barriuso, 2016). Ross (2013) reported that mathematics educators' involvement in PD on ELL instruction was connected to their profound belief in their capacity to teach ELLs.

The linguistic needs of ELL students and the inadequate preparation of teachers to support the mathematical requirements of these students have highlighted the need for math instructors to improve their knowledge about language. According to Bunch (2013), in some jurisdictions, it is not certain what concepts of language or language development should be promoted in academic settings to prepare instructors to teach ELLs. Kibler, Walqui, and Bunch (2015) noted that a lack of clarity on language instruction for English language pupils has led to the promotion of an range of language-related knowledge and skills that have not resulted in an improvement in mathematical understanding for ELLs. Supporting ELLs' mathematical knowledge through an emphasis on language requires mathematics instructors to involve their pupils in activities that develop conceptual understanding of mathematical concepts simultaneously with language. Math instructors should understand that academic language is different from

daily dialect in terms of vocabulary and the arrangement of words and phrases to result in the creation of well-formed sentences (Haag, Roppelt, & Heppt, 2015).

The PD of instructors in relation to instructing ELL students is a practical approach for reducing scholastic problems in the traditional mathematics lecture room. Coady, Harper, and De Jong (2015) stated that the absence of cooperation between math and language lecturers and the need for continued professional growth for both groups of instructors also negatively influence ELL students' ability to grasp mathematical concepts. Such findings highlight the need for ameliorating instructional practices in the mathematics lecture room to combine and amplify content and communication skills for English language learners. ELLs' mathematical performance will be enhanced when math instructors provide clear instructions in a language that the students understand. According to Ottmar, Rimm-Kaufman, Larsen, and Berry (2015), many instructors are ill equipped to teach mathematics efficiently in widely varied classrooms. Proficient mathematics instructors for ELL students will advance knowledge, assist in influencing students' inherent qualities of mind and character, and build on pupils' mathematical thinking as well as their culture (Turner et al. 2012). Kim, Wang, and Michaels (2015) emphasized the significance of linguistics in the instruction and learning of math; their investigation gave credence to the idea that the lack of mastery in the instructional language will hinder pupils' understanding of the procedures needed to solve math word problems. Rubinstein-Avila, Sox, Kaplan, and McGraw (2014) suggested that meaningful mathematical discourse for ELL students may be expected to take place when they are involved in discussions and when they are permitted to ask open-ended

questions. Purposeful mathematical discourse also occurs when ELLs solve problems using different strategies and provide good explanations for their solutions in a systematic way to their assembled teachers and classmates. Bunch (2013) noted that instructors of ELL students should evaluate their teaching strategies as well as the language they use while teaching mathematics. Linguistic issues associated with the teaching of mathematical ideas include the use of more than one system of studying signs and symbols and their use. According to Ottmar et al. (2015), the unique vocabulary of math as well as its logical structure and its grammatical features must be incorporated into lessons planned for ELLs. Linguistic issues associated with the teaching of mathematical ideas include the use of more than one system of studying signs and symbols and their use. The unique vocabulary of math as well as its logical structure and its grammatical features must be incorporated into lessons planned for ELLs. Mathematics educators should recognize that using language in a rigorous environment is determined by both instructors and students. Using the same mathematical terminology as defined by the rigid observance of rules or conventions and choice of language, pronunciation, and grammar, in addition to building mathematical understanding from real-life experiences leads to the comprehension of math concepts (Warren & Miller, 2014). Instructional strategies used by instructors to address lack of English proficiency while highlighting mathematical content have positive results among ELL students (Cervetti, Kulikowich, & Bravo, 2015). Math instructors at UCSE should seek to be part of an effort to clarify the contents of the math curriculum and instructional strategies necessary for ELLs to meet the standards outlined by the Ministry of Education in Jamaica.

The attributes, dispositions, skills and habits of thought necessary to become an valuable mathematics educator include knowledge of mathematics, persistence, positive attitude towards the subject of math, the state or quality of being ready for change and a reflective inclination or tendency (Ministry of Education, Jamaica 2014). The content courses offered during the training of mathematics instructors should therefore, play an important role in helping prospective educators acquire the knowledge they need for teaching ELLs (Masingila, Olanoff, & Kwaka, 2012). According to Solano-Flores et al. (2013) ELL students are to be provided with the opportunity to improve their language skills; multiple pedagogical approaches are necessary to develop ELLs' mathematical thinking and computational fluency before they can start to show improvement in mathematics attainment. Toll and Luit (2014) noted that the capacity to measure language-related variables in test items and to relate those measures to student performance is imperative to effectively evaluating the effect of language factors on students' performance in mathematics. Roofe and Miller (2013) suggested that there is a correlation between the quality of teacher preparation and student achievement. The problem of instructor preparation for teaching ELLs continues to occupy academic discussion; there seems to be agreement on the need for reform in the way in which mathematics instructors are educated (Sparapani, Perez, Gould, Hillman, & Clark, 2014). Sparapani et al., 2014 have suggested that in the preparation of teachers, opportunities should be provided that will enable them to examine the ethnic setting of instruction and learning and how it influences academic achievement. Maguire (2014) suggested that reforming teacher education remains a priority; the diversity of the classrooms of the

twenty-first century has placed more demands on math instructors. The difficulty being encountered by teacher training institutions is how best to design teacher education programs that will assist instructors to support the diverse needs of the multicultural classrooms.

Language Proficiency and Attainment in Math

The nature of the interdependence between language mastery and achievement in mathematics by ELL students is among the primary research concerns of this study. Findings from a study conducted by Ercikan, Chen, Lyons-Thomas, Goodrich, Sandilands, Roth and Simon (2015) in Australia, Canada, the United Kingdom, and the United States specified an established interdependence between language mastery and attainment in mathematics. Prevoo, Malda, Mesman, and IJzendoorn (2015) stated that ELL students' academic achievements often show less favorable school outcomes compared to their monolingual peers. Chen and Chalhoub-Deville (2015) suggested that language demand contributed to the significant difference in achievement between ELLs and non-ELLs in mathematics attainment. Such findings give credence to the argument that language influences performance in mathematics Chen and Chalhoub-Deville (2015) suggested that language demand contributes to the significant difference in performance involving ELLs and non-ELLs in mathematics attainment. In many Jurisdictions, ELL's performance in math is consistently inferior to students who are proficient users of the English language (Mullis, Martin, Foy, & Arora, 2012). Such findings give credence to the argument that language influences performance in mathematics.

One of the essential constituent elements affecting mathematics pedagogy in multicultural schools is the language of the instructors. According to Vukovic and Lesaux (2013) language competency is important for students' mathematical development. Many of the students are English language learners, and, therefore, this will affect their conceptual understanding of mathematical problems in a context where instruction is in English. Instructors are presently mandated by the Government of Jamaica to teach their students in English. All mathematics lecturers are required to have a least a master's degree in math and complete English proficiency course is an integral part of the instructor training curriculum (National Mathematics Policy, Ministry of Education, 2014). Also, the government employs mathematics teachers whose curriculum vitae shows that their official language is English and that they studied at universities where class instruction was conducted in English (Policy document, Ministry of Education Jamaica, 2013). Many mathematics lecturers find it challenging to integrate, the language of ELL pupils into the teaching of mathematics (Riccomini et al. 2015). Rubinstein-Avila, Sox, Kaplan, and McGraw (2014) suggested that Mathematics instructors need to be aware of the relationships between mathematical capabilities and particular features of linguistic ability; in particular, attention has to be directed towards the unique vocabulary associated with math. Many mathematics instructors in Jamaica do not have the ability, quality or characteristics nor the requisite teaching skills and experience necessary for addressing the idiosyncrasies of their multicultural pupils (Ministry of Education, Jamaica, 2014). Math instructors should consider the cultural resources that ELL students bring to the classroom. Results from this study should

provide support for instructors in the development of mathematics lessons for ELL students. Such Lessons should be focused on the five strands of mathematical proficiency: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition (Ministry of Education, Jamaica, 2014). Investigating the influence of instructor's language on attainment in mathematics for ELL students might provide the ability for math instructors to understand the relationship between language and mathematics as well as identifying reasons for poor academic performance in math. Findings from a study done by Ercikan et al. (2015) in Australia, Canada, the United Kingdom, and the United States, "indicate a strong relationship with reading proficiency accounting for up to 43% of the variance in mathematics and up to 79% in science" (p. 153). Such outcomes indicate the important differences in academic performance in math and science evaluation, thereby giving credence to the argument that language influences performance mathematics.

Vukovic and Lesaux (2013 noted that there is convincing evidence to support the notion that linguistic skills are involved in solving mathematical problems. According to Solano-Flores (2014) during the procedure of developing or reviewing test items, the linguistic features should be examined about the attributes of the content and the nature of the target population; this is important because some circumstances or factors that are necessary to address adequately language problems or difficulties are sometimes not met. Henry, Baltes, and Nistor (2014) stated that standardized mathematics assessments written in English for ELL students complicate the learning experience and contributed to

poor attainment in mathematics. Results from this study further suggested that there is a correlation between math scores and English proficiency.

Implications

The number of ELLs in Jamaican education system needing academic and linguistic supports is growing (Preece, 2015). Mathematics teachers of ELLs need to be trained in how to effectively support the needs of Jamaican ELL college students. Jamaican math instructors should be advocates for their ELL students by providing the critical supports to ensure their successful academic achievement. The year one students at UCSE, have potential, but need linguistic and strategic academic support from the college administrators and lecturers. By providing mathematics educators who can engage students in rich mathematical discourse will ensure that ELLs could attain success in the mathematics classrooms resulting in additional prospects for advancement.

One possible project direction might be to support PD of education practice at the local site by educating instructors how to structure mathematics questions that are not culturally biased as well as identifying teaching methods that will assist ELL students learn mathematics. Another possible project direction may be to sensitize all the stakeholders in the form of a white paper that most Jamaican students are ELL learners and to recommend appropriate strategies for teaching mathematics in a globalized environment. Anticipated findings and data analysis may influence me to investigate if the JD has the structure necessary for imparting mathematical knowledge.

A large segment of the Jamaican school population is made up of ethnically and lingual diverse students. The necessity, therefore, exists for teacher education programs

in the universities and colleges to incorporate strategies into their instructor training programs that address the needs of English Language Learners (ELL). The project study can help to design or recommend activities that can improve instructors' knowledge of the learning challenges that ELL learners encounter when they are involved deeply in English, a language they do not fully comprehend. According to de Oliveira and Shoffner (2016) all educators should be adequately trained to work with ELLs. Knowing how to support the needs of ELL students is vital because much emphasis is now being placed on relationships, mathematics amalgamation, and communication (Ministry of Education Jamaica, 2014). All mathematics educators should, therefore, be prepared to assist ELLs in meeting their learning needs as it relates to imparting mathematical knowledge. Equipping mathematics educators with the essential skills and capabilities required to teach ELLs has the potential of improving the academic performance of these students.

Summary

Section 1of this project study incorporates several resolutions. First, mathematics educators at UCSE need to understand the relationship involving mathematics and language to be better able to deal with the shortfall and the educational implications related to specific language deficiency. Second, mathematics pedagogy for students ranging from the primary to tertiary levels is in need of change (Aronson & Laughter, 2015). Third, strategies used for the instruction of mathematics in many educational institutions is characterized by instructors not recognizing that harnessing students' native language is an excellent teaching strategy for improving the academic achievement in mathematics. Fourth, incompetent instructors and a lack of teaching aids and not enough

emphasis placed on teaching for conceptual understanding. The primary stakeholders at UCSE have stated that they want to see a decrease in mathematics achievement disparities between year one students who are competent in English language and year one students who are not efficient users of the English Language (Ministry of Education, Jamaica, 2014).

The focus of the study is the situation at UCSE, but it provides data that could be of interest to colleges in other jurisdictions. Many schools and colleges have similar or related issues regarding equipping mathematics teachers with the pedagogy necessary for instructing ELL pupils and also in what way to deal effectively with other social challenges encountered by ELL students. Language minority students seem to have problem with mathematical principles because of language constraints. One outcome is clear; ELL students who face a demanding task with language are at a disadvantage compared with their peers who are proficient with language as it relates to acquiring mathematical competency. The mathematics classroom of the twenty- first century has increasing linguistic demands associated with teaching and learning and, therefore, the language used by the instructor could serve as the foundation for teaching math to ELLs. All mathematics educators should consider the role that language plays in instruction in mathematics. Vukovic and Lesaux (2013) noted mathematics instruction depends primarily on oral explanations. Specifically, inferior performance in mathematics by ELLs may be exacerbated by poor English language skills.

In a body of knowledge about the influence of language on the instruction and acquiring of mathematical competence, it is essential to comprehend the social

circumstances that are of central importance. According to Alt et al., (2014) success in college depends on pupils' comprehension and use the academic language of instruction to learn; there is, however, much to know about how language influences academic performance in mathematics for students who use JD as their primary language. In Section 2 of this project study, I described the Methodology used to collect quantifiable data that ascertained the association between freshmen students' English language proficiency and their performance on the Mathematics Diagnostic test at UCSE. I also describe the Research Design and Approach, setting and sample Instrumentation Materials, Assumptions, Limitations, Scopes and Delimitations and Setting and Sample.

Section 2: The Methodology

Introduction

The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. Administrators at the target site recommended the implementation of a mathematics intervention to address the mathematics deficiencies indicated by MDT scores in 2013 and 2014 for freshman education students whose primary language was JD. Although administrators recommended and implemented PD for the college instructors responsible for teaching JD students with low mathematics scores, indicating that this PD should be focused on language strategies for teaching mathematics to JD speakers, MDT scores remained low.

College administrators sought to discern the effect of teaching ELL students using JD whose primary language was JD. An intervention that involved teaching students in JD who did not score at the proficient level in 2013 and 2014 on the MDT had been attempted, but no formative or summative data existed on the effect of teaching JD students using JD rather than SE. College administrators wanted to discern whether instructing students in JD yielded results that would affect performance.

Within Section 2 of this project study, I discuss the methodology used to determine the findings to the research question. I employed a quasi-experimental design. Using the quasi-experimental design approach allowed me to determine the effect between teaching students in JD rather than teaching students in SE at the target site.

Research Design and Approach

A quantitative methodology was useful for describing the difference between the variables and, as such, was the approach chosen for this study. Quantitative research is used to describe and to test the ways in which people or things are connected; it facilitates examination of relationships between variables while strengthening the probability of generalizing and replicating a study (Creswell, 2012). Through the analysis of numerical data representing the various constructs and variables in this study, it was possible to address the research question.

The quantitative design chosen for this study involved obtaining pretest as well as posttest measures. Creswell (2012) noted that when researchers use similar instruments for both pretest and posttest, they minimize instrumentation threats. Using a quasi-experimental design, I was able to examine the change between the pretest and posttest scores of the treatment group and control group to determine whether the difference between the two groups was statistically significant.

Quantitative methodology also allows hypotheses to be tested statistically to indicate similarity or dissimilarity between experimental and control groups (Creswell, 2012). Rather than facilitating induction, a quantitative approach allows findings to be generalized based on the analysis of data. With the use of a quantitative design, it was possible to measure differences in performance on standardized tests between students being taught using JD and students being taught in SE.

In contrast to quantitative research, the intent of a qualitative study is not to generalize the findings, but to develop an in-depth exploration of a fact or situation

(Creswell, 2012). The aim of this study was to generalize from the sample to the general population of JD students; therefore, a qualitative methodology was not considered. Specifically, the purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT.

Justification for Research Design

A quasi-experimental research design was used to understand the effect that the language of instruction has on student achievement. MDT scores were used to measure student achievement in mathematics. I established a treatment and a control group. All participants were students whose primarily spoken language was JD. Participants in the control group were taught in the traditional style, which included instruction in SE. The treatment group consisted of students who were taught using JD.

This design used pretest and posttest measures. The pretest was given to both the treatment and control groups. All study participants completed the posttest at the end of the semester. At the close of the semester, an analysis was carried out using the change scores of students who were taught using JD and those who received instruction in SE.

A quasi-experimental research plan was ideal for this investigation because random assignment of participants to the experimental and control groups was not practical. Many quasi-experimental studies are conducted in situations in which the setting prohibits the formation of groups and the researcher has to use existing classes and designate one of them as the experimental group and the other as the control group. The quasi-experimental methodology gave me the opportunity to use existing student groups at the local site; the participants were willing to be part of any group to which

they were assigned. The effectiveness of this research design also emanates from the ability to control threats to internal and external validity while permitting generalization to other similar settings if warranted (Creswell, 2012). Another reason for choosing quasi-experimental design is that it is very efficient for discovering significant differences between groups in an educational setting. The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT; the quasi-experimental design was well suited to this aim.

Consideration was given to both correlational and experimental research designs. As Creswell (2012) noted, correlational studies only explain the nature of relationships that exist, and a true experimental study involves observation and monitoring for a particular purpose, typically to test cause-and-effect connections between variables under strict scientific conditions. In the present study, I did not have the authority or resources to assign the participants to random groups, and I did not seek to test for cause-and-effect relationships. Further, a true experimental design requires random sampling, which was not possible in this situation. Thus, correlational and experimental approaches were not appropriate for the current research.

Creswell (2012) described quasi-experimental research as including the use of systematic observation as well as the manipulation and regulation of facts or situations that are observed to exist to determine if they influence an outcome (i.e., dependent variable). I determined that a quasi-experimental design was the best means to address the problem identified and answer the research question regarding whether the difference

in change scores on the MDT was significant for students taught using JD versus those taught using SE.

How Design Derives Logically from Problem

The problem that I investigated in this study was the low mathematics competency scores of freshmen at the University College of Science and Education (UCSE, a pseudonym) in Jamaica. The design best suited for acquiring the information needed for this study was quasi-experimental research. Using this methodology, I sought to determine the difference in MDT change scores between students who were instructed in JD and students who were instructed in SE for semester term of 4 months. I attempted to ascertain whether the difference in these change scores was significant. Specifically, I wanted to determine if the difference in these change scores were significant.

Past studies have demonstrated the role that language proficiency plays in learning mathematics (Esquinca, 2013; Greer & Mukhopadhyay, 2015; Haag et al., 2013; Henry & Baltes, 2014; Kanno & Cromley, 2013; Menken & Solorza, 2014; Solano-Flores et al., 2013; Turner et al., 2012; Weinburgh et al., 2014). There was a need for this study to establish the effect of using JD to support mathematics instruction for students whose primary language was JD, in that this study would provide data for college administrators to determine a course of action to address mathematics deficits in the freshman education population.

This study's research question and hypotheses concerning the effect of teaching students in JD versus teaching students in SE were as follows:

Research Question: What is the difference in MDT mathematics change scale scores between students who were instructed in JD (JD1) and students who were instructed in SE (SE1) for semester?

RQ Null Hypothesis (RQ-NH): There will be no significant difference between the mathematics scale scores of students receiving mathematics instruction using JD (JD1) and the mathematics scale scores of students receiving mathematics instruction in SE (SE1) as measured by the pre-post test scores of the MDT for the semester.

RQ Alternative Hypothesis (RQ-NH): There will be a significant difference between the mathematics scale scores of students receiving instructions using the JD (JD1) and the mathematics scale scores of students receiving mathematics instruction in SE (SE1) as measured by the pre-post test scores of the MDT for the semester

Setting and Sample

The local setting selected for this project study was a year-round multidisciplinary college located in Passley Gardens, Portland, Jamaica. The college was established under the Education Act of 1981. Under this legislation, the Ministry of Education is the legal owner of the institution. The Ministry appoints a board of governance whose primary duties include setting and monitoring the strategic direction of UCSE (Students' Handbook UCSE 2015). The college is the only tertiary institution in Jamaica dedicated to training students in agriculture and allied disciplines. The organization is required to provide education of the highest quality in science, teacher training, and agriculture. The college has three campuses in the parishes of Saint Catherine, Clarendon, and Saint Ann. The University Council of Jamaica carries out accreditation of the programs offered by

the college. The college has Departments of Science, Agriculture, and Education, which are led by academic deans that, in turn, manage the faculty and report to the vice president of academic programs (Registry UCSE, 2015).

Approximately 97% of the students are enrolled full time, with the student population being 60% male and 40% female (Registry UCSE, 2016). For the period 2012-2016, the aim of the administration at UCSE was to have an overall completion rate for programs of more than 60% (Registry UCSE, 2016). Evaluation of the quality of students' work occurs through a mixture of coursework and written examinations. Quality assurance falls under the purview of the Assurance Committee, a standing committee on the Academic Council.

The study took place at UCSE, which is located in suburban Jamaica and has an enrollment of approximately 1,700 students. The college is the property of the people of Jamaica and is operated by the Ministry of Education, with additional support coming from the Ministry of Agriculture. UCSE is mandated to develop skilled and competent practitioners in agriculture, science, education, and allied disciplines who will serve with distinction in Jamaica and globally. The focus of this study was consistent with the goals of the Ministry of Education in Jamaica for improving the teaching of mathematics to Freshmen education students. As noted in the problem section of this study, the majority of education students were not meeting the minimum requirement established by the Ministry of Education for all prospective education students, which was determined by scoring at Level I (profound deficit) or Level II (severe deficit) on the MDT. As a result, the majority of Freshmen education students had to take additional math coursework and

then complete another qualifying exam before accessing the math courses in the teacher education program (Registry UCSE, 2015). Therefore, to determine the effect the language of instruction has on student achievement in math achievement was critical to stakeholders at the college and the Jamaican economy by producing educators who could enter the education course of study by establishing their mathematics proficiency.

Sampling Strategy and Size

A nonprobability sampling approach was used to select the participants because nonprobability sampling represents an approach that helps the researcher to select a subset from the population that they are interested in studying (Creswell, 2012). A distinguishing feature of nonprobability sampling approach is that samples are selected based on the personal judgment of the investigator, rather than random selection based on probabilistic methodology. The Purposive sampling strategy used in this quasi-experimental study was made up of 40 freshmen teacher education candidates who scored poorly on the Mathematics Diagnostic test, which is administered by the Ministry of Education in Jamaica. A nonprobability sampling technique was used to carefully choose the participants because this sampling approach allowed me to select a group of students from the population that I was studying. Of the Purposive sample *(n* = 40), 20 were male and 20 were female. The racial/ethnic origin categories represented were East Indian *n* = 2) and Black (*n* = 38). Data shows that in 2016, the year of the study, 53 student teacher education candidates took the MDT (Registry UCSE, 2016). A sample of 40 teacher education students was possible for this study and this resulted in G Power analysis with α error probability $= 0.05$ and Power (1-β error probability) $= 0.8$.

Selection of the students was based on demographic data from the college registry. The aim of this quasi-experimental research was to be able to apply findings obtained among variables to the general population of all JD teacher education students at UCSE; therefore, it was important that the selection and size of a sample was representative of the population. This sample size is necessary for a statistical procedure so that the sample is a good estimate of a feature or quality of the population. The aim of quasi-experimental research is to be able to apply findings obtained among variables to the general population and so it is important that the selection and size of a sample are representatives of the population.

Sample Eligibility Criteria

Not all members of the general first-year student population pursuing courses in teacher education are required to take the MDT; therefore, the eligibility criteria for this study indicated that only freshman education students pursuing a course in mathematics would be included in the sample. Participants were recruited based on their completion of the annual MDT that is administered by the Ministry of Education in Jamaica. The inclusion criteria for the participants in this study included: (a) being a freshman teacher education student, (b) having taken the annual MDT, and (c) having scored at level I or II on the MDT. The total number of students eligible for this research project was 53, but only 40 students accepted the invitation to participate in the study.

Recruitment of Participants

Prior to initiating the study, I received Walden University Institutional Review Board (IRB) permission to conduct the research. The IRB approval number for this study

is 10-10-16-0187568. Official permission for faculty members to provide instruction using the Jamaica dialect for the treatment group was obtained from College administration as a teaching and learning strategy that would be aligned with the national mathematics program for making better the instruction and learning of mathematics (personal communication with the head of the mathematics and computer science department, UCSE, October 2015). Access to invite participants to engage in this project study was approved following communication with the dean of the Faculty of Science and the head of the Mathematics and Computer Science department at UCSE. A letter of cooperation was obtained from the head of the Mathematics and Computer Science department verifying the permission given by UCSE to support this research.

An invitation letter to participate in the study was distributed to all freshmen teacher education students who participated in the annual MDT. The email introduced me as the researcher in my role as a doctoral student and also as an instructor at UCSE. It included information about the degree program and Walden University. It included the purpose of the study, a description of the procedures to be used in the study, the topic of focus, and the time commitment for the study. It also included any part of the research that might cause risk or inconveniences to participants. The email closed with an explanation of how the study would benefit students and teachers in our college. The email included the steps that would be taken to maintain confidentiality during the study, a reminder that participation was voluntary, and information about how to reach my advisor or Walden University's Institutional Review Board if there were questions about their rights as a participant of the study.

Informed consent protocols were attached, and all letters of consent were collected by hand; all teacher education students live on the UCSE campus, and it was requested that potential participants complete their consent form and return it to the director of research at UCSE. I obtained all student consent forms from the director of research for UCSE.

Characteristics of Sample

This sample for this study included 53 freshmen education students at UCSE who took the MDT. Student targeted for the study included students performing at the Level I and Level II levels thus demonstrating profound to severe deficits on the MDT. Both the control and treatment groups had similar student demographics by race, gender, grade level, and were freshmen that were taking the MDT for the first time. The invitation to participate in the study were sent to sample of freshmen education students however only 40 students consented to participate in the study, therefore 20 students were randomly assigned to the treatment and control groups respectively.

Instrumentation and Materials

Description of Instrument

Standardized math examinations that are administered every semester in all Teachers' Colleges in Jamaica are designed to measure students' ability to justify and clarify why a mathematical principle is true or false and explain why mathematical assumptions such as axioms, postulates, and theorems are used to describe ideas. Students' ability to compute accurately is important, as it will help in the improvement of problem-solving skills; therefore, conceptual understanding, computational fluency, and

problem-solving skills are critical for learning math and performing well on standardized tests that are used to collect data.

The MDT, developed and administered by the Ministry of Education in Jamaica, focuses on assessing the skills, processes, and concepts in mathematics that freshmen students in all Jamaican colleges should know (Ministry of Education, Jamaica, 2013). The diagnostic tests are conducted through the mathematics and computer departments of each teachers' college in Jamaica under strict guidelines from the National Mathematics program.

Data showing the performance of students from all publicly owned teacher-training institutions in the annual MDT are collected and analyzed by the Ministry of Education every year. The National Mathematics coordinators use this information to outline principles and define standards for the teaching and learning of mathematics in Jamaica. The information garnered also helps to guide the intervention programs that contribute to improving the quality of mathematics pedagogy in the colleges (National Mathematics Policy Guidelines, Ministry of Education, 2013).

Concepts Measured by the Instrument

The MDT measures concepts in trigonometry such as conversion of angles measured in degrees to radians and vice versa, students' ability to use the six ratios for acute angles regarding the length of sides of similar right-angled triangles. The instrument was used to measure number concepts (place value, number sentence), parts of algebraic fractions (numerator, least common denominator), types of numbers (whole numbers, rational and irrational numbers, integers), vectors and matrices, geometry, and

trigonometry. Some of the concepts measured by the instrument include visual representations, mathematical language and terms unique to the field of mathematics. Visual and textual forms of representation of information have an effect on each other (Solano-Flores et al., 2013). Visual representation describes shapes and their location or orientation. Visual representations measured by the instrument included linear and quadratic graphs, pie charts with shaded areas representing ratios and proportions and mathematical shapes such as polygons. Concepts in trigonometry and college algebra are also tested.

Calculation of Scores Using the Instrument

The administration of the test occurs under strict examination conditions. The test contains 60 multiple-choice questions, each with the options A, B, C and D. Pupils are expected to answer all questions without the use of a calculator in two hours. One mark is awarded for each correct response. Scores obtained by each student are collated and sent to the Ministry of Education for further analyses. The flexibility of the test items makes them suitable for each pupil by steadily increasing the difficulty for each subsequent question answered. The MDT for prospective student teachers is administered at the start of each academic year to assist lecturers and guidance counselors in determining individual student competence in math. Administrators and instructors can therefore, follow students' improved performance from testing period to the completion of the each semester when they are mandated to take a final examination.

The Joint Board of Teacher Education (JBTE) in collaboration with the teachers colleges of Jamaica provides a table of specification as well as the grading plan for each

standardized test. Scores obtained from the instrument are calculated and used by the JBTE to measure the competence of individual students in mathematics. Scores are sent to each college from the JBTE and distributed to individual students through the Registry at the colleges. The JBTE, located on the Mona campus of the University of the West Indies, has been involved in quality assurance in teacher education since 1965 (Ministry of Education, Jamaica, 2014). Over this time, the JBTE has formally tested or confirm over 50,000 teachers across the Caribbean.

Reliability and Validity

Creswell (2012) stated that a desired result of research is to have measures or observations that are reliable. Reliability for quantitative studies suggests consistency in test dispensation, scoring, and results from past uses of the instrument. An instrument should be chosen that gives individual scores that are valid and reliable (Creswell). Factors that can affect the reliability of an instrument include questions that are not clearly stated, administration of the instrument that is not systematized, and, according to Creswell, "participants that are fatigued, are nervous, misinterpret questions, or guess on tests" (p. 159). The ideal is for the instrument to generate results that are both consistent and valid.

Creswell (2012) noted that validity is the extent to which a tool or implement points to the intended interpretation of what it is supposed to measure and performs its functions as it should. Validity is normally measured in degrees because it is unusual for an instrument to be 100% accurate. The most suitable situation is to have an instrument that is both valid and reliable. According to Creswell reliability can be attained by using

any of the following procedures: “test–retest reliability, alternate form reliability, interrator reliability, alternate forms, and test-retest reliability and internal consistency” (p. 160). The goal should be to have an instrument that shows evidence of internal and external validity as well as internal reliability. The validity and the reliability of this instrument were found in previous studies commissioned by the Government of Jamaica and conducted by the National Mathematics coordinator (Ministry of Education, Jamaica, 2013).

The government of Jamaica made the policy decision that all students entering teacher education programs are required to take the MDT, a standardized diagnostic math test commissioned by the Ministry of Education, Jamaica (2013). The administration of UCSE took the decision that all year one students pursuing courses in which mathematics is a component would have to take the annual MDT. The MDT is regarded by the all educational institution in Jamaica as being both valid and reliable as its development was commissioned by the government of Jamaica and its use to provide reliable data validated by the Ministry of Education; it is used to test the mathematics competency of all prospective candidates for entry into instructor training programs in all publicly owned colleges. The Ministry of Education in Jamaica has been using this instrument for over 5 years, and it has developed a history of reliability and validity in the tertiary sector of the Jamaican education system. This instrument was used to collect data for the project study research. The Walden IRB also sanctioned the use of this instrument to collect the relevant data for this research. The MDT developed by mathematics educators employed by Ministry of Education includes open-ended questions that are diagnostic in design so

that they can identify gaps and misconceptions in the understanding and knowledge of the potential student. The instrument aims to measure students' achievement in mathematical concepts and skills based on standards set by the National Mathematics program and are a part of the National Mathematics policy guidelines (Ministry of Education, Jamaica, 2014). The Ministry of Education trains instructors administering the diagnostic test through the National Mathematics Program with guidelines from the National Mathematics coordinator.

The capability to measure language-related variables and to relate those measures to student performance was critical to the validity of this study and, by extension, correctly evaluating the influence of language on the teaching and learning of mathematics. Creswell (2012) stated that *threat to validity* refers to the reasons why researchers may be incorrect when they make inferences in an experiment. Establishing and supporting the intended points or claims of this research was restricted to the trustworthiness of the instruments used, and so care was taken to guarantee that the inferences drawn were correct. According to Creswell, the goal of thorough research is to have measures that are reliable. A comparison of the score gaps between both groups of students and the pattern of marks obtained attributable to the intervention was done. The mean scores obtained by ELLs and non-ELLs by type of item for both pretest and posttest were also analyzed; this strategy allowed me to observe the score differences between linguistic groups and across both pretest and posttest for each item tested.

Data Collection and Analysis

For the purposes of this study, I sought to determine the effect the language of instruction has on student achievement in math as measured by the MDT. I collected student assessment scores on the MDT at the end of the 2016 term. I collected these scored from both the control and treatment groups, which included both the SD and JD student groups respectively. The assessment scores were on an interval continuum and were derived from the MDTD analyses conducted including the marks obtained by each student assigned to the treatment and control groups.

I carried out the independent sample *t* test to compare the two groups. According to Triola (2012), categorical variables represent discretely separate groups or categories; therefore my predictor variable was categorical, exactly, a nominal scale of capacity. Triola (2012) noted that it is desirable to have a higher level of measurement rather than a lower one. The specific inferential analysis used to answer the research question and hypotheses is described in the following section.

t test Analyses Used to Address the Research Question/Hypothesis

During the semester, one group of students was taught in SE (SE Group 1) and the other group in the JD (JD Group 1). Both groups were examined on their retention of mathematical concepts taught during the semester. To ensure the two groups were equivalent and to reduce the potential for a Type 1 error, a Levene's Test for Equality of Variances was conducted using the data from the MDT. The results indicated that the groups did not differ significantly as $p>.05$.

To determine if the treatment, in this case the use of the JD in mathematics instruction, made a difference in student mathematics achievement, an independent samples *t* test was performed using MDT test scores at the end of the semester (year). An independent samples *t* test was conducted on the post test scores and the treatment group showed a significant difference from the control group with $p<.05$ in that the difference in scores between the JD group and the SD group was significant. Students assigned to the JD group, those students instructed in JD, demonstrated a significant difference between the score at the beginning of the term and the end of the term compared to the students assigned to the SE group, those students instructed in SE.

An inferential statistical test was most suitable for examining the data for the research question. Through a *t* test, groups mean scores were compared to determine if a significant difference exists between the two groups. The *t* test compared whether the two groups have significantly different mean scores. From a statistical perspective an independent data item is categorical and the dependent variable continuous, analysis of both population means was used to determine an answer to the research question. An independent sample *t* test eliminates bias and measures the significance of the difference between the means of two groups and therefore, was a suitable analytical strategy to use in this study.

To perform the independent sample *t* test six assumptions must be true.

Assumption 1: The dependent variable must be measured on a continuous scale performance. In this case it was measured from 0 to 60.

Assumption 2: The second assumption is that the independent variable consists of two categorical independent groups. In this study our independent variable takes on the values of treatment or no treatment.

Assumption 3: Both groups are independent of each other. In this investigation the scores of the JD students have no effect on the scores of the SE students.

Assumption 4: The fourth assumption is that there are no significant outliers in the difference between the treatment and control groups.

Assumption 5: Assumption 5: The fifth assumption is that the distribution of differences in the dependent variable is approximately normally distributed for each group.

Assumption 6: There needs to be homogeneity of variances. The Levine's F-Test shows p= 0.61; this is greater than .05 therefore, the assumption of homogeneity of variance has been met, the variances are the same.

Hypothesis testing is a method for testing a claim about a measurable characteristic in the population, by using the *t* test to measure data in a sample. One dependent variable and one independent variable exist in this project study, further justification for using a *t* test. According to Creswell (2012) the purpose of the independent sample *t* test is to establish if there is a significant difference in the means of both the control and treatment groups. The significant value of the test was taken to be 0.95; therefore, the *t* statistic was determined to be statistically significant if it was less than 0.05. Levels of confidence make it easier for the researcher to decide what statistical

investigation is appropriate for the values that were allocated. The ratio level of measurement is appropriate for this study because a *t* test on the data will be conducted.

Assumptions, Limitations, Scope, and Delimitations

Assumptions

In this quasi-experimental study, the math instructors were volunteers and the participants in the treatment group genuinely engaged in all aspects of the investigation involving the language of instruction. The assumption was made that the math instructors involved in the extended instruction were all competent mathematics educators who knew the JD. An equal amount of time was spent on the treatment of all participants. Members of the experimental and control groups were alike as it relates to their academic competence in the MDT; the mean of the control and treatment group were 11.9 and 11.7 respectively. Students are ordinarily assigned to their classes in a random manner; therefore, this assumption was justifiable. Findings from a study by Kanno and Cromley (2013) showed ELL students' capability in academic subjects is inferior to English-proficient students and other monolingual English-speaking students in college admission and completion. I, therefore, assumed that students who speak the JD performance in mathematics would be inferior to students who speak SE. Scherdin and Zander (2014) noted that complying with a collection of expectations help to focus the investigation effort in the accumulation of knowledge.

Limitations

The study was limited to freshman teacher education students at UCSE who were pursuing mathematics courses that were a component of teacher curriculum therefore;

there might be difficulties with generalizability of the findings. Results may not apply to other colleges with a smaller ELL population or an ELL population that is more widely varied. Also, the sampling of the study could decrease the generalizability of the findings because the students from which the treatment group was selected may differ in their linguistic ability from students from other colleges. Since a sample of 40 students was taken from the general teacher education students this could be viewed as limitation. In drawing conclusions about the outcomes, the probability exist that some of the other components mentioned can influence students' accomplishments. Increasing the generalizability of this study may involve, incorporating the underlying structure of pertinent literature and analytical abstractions about successful techniques for teaching mathematics to the ELL students at UCSE. Simons (2014) noted that the aim of every study is to generalize beyond the tested sample; however, the conclusions from this study cannot be generalized outside the current setting, because the assessment is applicable only to UCSE. Additional research would be necessary to allow for generality.

The difficulties in teaching math to ELLs highlighted in the review of literature that produced the research question came from an extensive conversation about the influence of linguistic on the instruction and learning of math. Solano-Flores et al. (2013) stated that other influence or facts effect the teaching and learning of mathematics; however, the investigation will emphasize the results of a very specific instructional strategy for teaching ELLs. If any extraneous variable becomes apparent from this research that cannot be calculated, it will be regarded as a limitation of the investigation. Solano-Flores et al. (2013) noted that restricted competence in the language in which

mathematics tests are given is a considerable threat to the validity of measures of academic performance for English language learners.

Scope and Delimitations

According to Creswell (2012) suppositions and delimitations narrow the scope of a study. Focus of this research study will be to investigate the association between the JD and performance in mathematics, as measured by the Prospective Student-Teacher Mathematics Diagnostic Test; administered by the Ministry of Education in Jamaica. Probabilistic sampling procedures that will be applied in the study will decrease the generalizability of the findings because there are courses offered by the college where students take mathematics, and they are not majoring in education, mathematics, technology or the natural sciences. The study was delimited to the demands for fulfilling the language needs of ELL students in the area of mathematics. Also, as is the case with most educational research, there will be uncontrollable external variables such as the demographics of the students and the effects of their general negative attitude towards the teaching and learning of math.

Protection of Participants' Rights

The safety of the participators in this research was an integral part of the study. Researchers conducting studies involving human beings should institute human research safeguard programs to maintain the integrity and well-being of research members and satisfy all ethical and regulatory requirements (Tsan & Tsan 2015). Several potential ethical issues may arise throughout this study. As the researcher, I have over 20 years of teaching experience and am a certified mathematics educator. I am an instructor at the

college; however, I did not instruct the students who were the participants in this study. I did not administer an instrument or collect data on students who I teach since this would have been a conflict of interest. The instructors who provided extended instruction were also certified math teachers who all have been teaching for more than 15 years. The roles of the instructors in the study did not affect the data collection process because instructors at the UCSE can collect data from the college registry. No coercion or ethical issues were created the focus of the study was to evaluate the implementation of a quasi-experimental intervention by the target site.

The project study was implemented using ethical, professional, and confidential principles that will ensure that the treatment of the participants was governed by established moral principles as required by the Walden University Institutional Review Board (IRB). The IRB approval number for this study is 10-10-16-0187568. A letter of invitation was given to the students inviting them to join in the investigation. I completed the NIH Web-based training course "Protecting Human Research Participants" on January 01, 2015. Certification Number: 1662441.

The students' information was kept confidential to protect the participants from harm or injury by guarding their anonymity, through allocating to each member a unique code designed by the researcher. Upon the culmination of this study, and before issuing the findings, all data about the students will be held in the strictest of confidence. All identifying information is kept in a locked cabinet stored in the college registry; that will be for at least of five years after which shredding of the information will take place.

Data Analysis Results

Research Question and Hypotheses

The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. After data collection, a brief statement of the main points of the data analysis results concerning approval or refusal of each null hypothesis and non-directional alternative hypothesis (Creswell, 2012) was offered. The findings, as they correspond to the research question, are discussed in the ensuing sections.

The analysis of findings for this study was based on the research question. The null hypothesis stated that there will be no significant difference between the mathematics scale scores of students receiving mathematics instruction using JD (JD1) and the mathematics scale scores of students receiving mathematics instruction in SE (SE1) as measured by the pre-post test scores of the MDT for the semester. Data analysis was carried out using the independent sample *t* test; the results showed that there was a significant difference between the math scale scores of the treatment group and the control group in the posttest, therefore, it was concluded that using JD to teach students whose native language is JD could possibly influence student performance on the MDT. The maximum test score for the treatment group in the posttest was 39 and the minimum score was 23. The mean score was 30.25. Table 6 shows that the score for the control group on the posttest ranged from a low of 7 to a high of 23 out of a possible 60 points. Analysis of these data show that 13.3 was the average score for the group. Furthermore, the Levene's test of equality of error variances ($p = .61$) was greater than .05, which

signifies the error variance of the dependent variable is equal across both groups; therefore, I rejected the null hypothesis. A statistically significant difference was found between the students who were instructed in SE and those that were instructed JD, therefore the null hypothesis was rejected.

The data analysis of this research included an independent sample *t* test to address the research question by comparing the means of the treatment and control groups. The treatment group involved students who received mathematics instruction in JD whereas the control group involved students who received instruction in SE. The research question and hypotheses that guided this study included:

RQ: What is the difference in MDT mathematics change scale scores between students who were instructed in JD (JD1) and students who were instructed in SE (SE1) for semester?

RQ Null Hypothesis (RQ-NH): There will be no significant difference between the mathematics scale scores of students receiving mathematics instruction using JD (JD1) and the mathematics scale scores of students receiving mathematics instruction in SE (SE1) as measured by the pre-post test scores of the MDT for the semester.

RQ Alternative Hypothesis (RQ-NH): There will be a significant difference between the mathematics scale scores of students receiving mathematics instruction using JD (JD1) and the mathematics scale scores of students receiving mathematics instruction in SE (SE1) as measured by the pre-post test scores of the MDT for the semester. The results as they correspond to the research question are discussed below by providing a sequential analysis of the results of the treatment and control groups. Following a

presentation of the data in Tables 3 through 7, a Discussion of the Findings in relation to the research problem and research question and potential project deliverable will follow in addition to the resulting project deliverable of a PD project.

Table 3

Performance of Control Group in Pretest

Scores	Frequency	Percent	Valid Percent	Cumulative Percent
7	3	15.0	15.0	15.0
8	2	10.0	10.0	25.0
9	2	10.0	10.0	35.0
10	1	5.0	5.0	40.0
11	2	10.0	10.0	50.0
12	1	5.0	5.0	55.0
13	2	10.0	10.0	65.0
14	2	10.0	10.0	75.0
15	1	5.0	5.0	80.0
16	1	5.0	5.0	85.0
17	1	5.0	5.0	90.0
18	1	5.0	5.0	95.0
19	1	5.0	5.0	100.0
Total	20	100.0	100.0	

As can be observed from Table 3 the performance involving the control group in the pretest test was poor; the scores ranged from a lowest value of seven to a maximum of 19, the maximum score is 60.

Table 4 shows that the performance involving the Treatment group in the pretest was poor; the scores ranged from a lowest value of six to a maximum of 19. The test was marked out of 60. Summary statistics for the performance of the control and treatment groups in the pretest indicate that both groups are similar. The Levene's test shows they

are similar as the purpose of the Levene's test is to test whether the variances of the groups are homogenous.

Statistics from the pretest of the performance of the Treatment group is shown in Table 4.

Table 4

Performance of Treatment group in pretest

Scores	Frequency	Percent	Valid Percent	Cumulative Percent
6.	1	5.0	5.0	5.0
7.	2	10.0	10.0	15.0
8.	2	10.0	10.0	25.0
9.	2	10.0	10.0	35.0
10.	2	10.0	10.0	45.0
11.	1	5.0	5.0	50.0
12.	2	10.0	10.0	60.0
13	1	5.0	5.0	65.0
14.	3	15.0	15.0	80.0
16.	1	5.0	5.0	85.0
17.	1	5.0	5.0	90.0
18.	1	5.0	5.0	95.0
19.	1	5.0	5.0	100.0
Total	20	100.0	100.0	

The statistics in table 5 indicate there was a significant enhancement in the performance of the participants from the treatment group in the posttest. Scores ranged from a minimum of six in the pretest to a maximum of 19; however, in the posttest, the minimum score obtained by the participants was 23, and the maximum mark was 39.

Summary statistics for the performance of the control group in the posttest are shown in Table 5.

Table 5

Performance of Treatment group in Posttest

	Frequency	Percent	Valid Percent	Cumulative Percent
23.00	3	15.0	15.0	15.0
26.00	2	10.0	10.0	25.0
27.00	1	5.0	5.0	30.0
28.00	1	5.0	5.0	35.0
29.00	4	20.0	20.0	55.0
31.00	1	5.0	5.0	60.0
33.00	2	10.0	10.0	70.0
34.00	1	5.0	5.0	75.0
35.00	1	5.0	5.0	80.0
36.00	3	15.0	15.0	95.0
39.00	1	5.0	5.0	100.0
Total	20	100.0	100.0	

The statistics from the posttest indicate that there was a significant enhancement in the performance of the participants from the treatment group. The minimum score moved from six obtained in the pretest to 23 in the posttest; the maximum mark moved from 19 obtained in the pretest test to 39 in the posttest.

A simple independent sample *t* test was conducted to determine if a significant difference existed between the scale scores of students on the MDT who were receiving instruction in JD1 and those students receiving instruction in SE. The independent sample t test assumes homogeneity of the variance; the Levene's test for equality of variance test

whether the variances of the groups are homogenous. The Levine's F-Test shows p = 0.61; this is greater than .05 therefore, the assumption of homogeneity of variance has been met, the variances are the same. Further analysis of the independent sample t test showed that with 38 degrees of freedom (df) with p = 0.00 there was a substantial difference in attainment in the posttest between the control and the treatment groups. A 95% level of confidence adds further reliability to the conclusion that the difference in the test scores is statistically significant.

Statistics from the pretest and posttest of the performance of the Treatment group is shown in Table 6.

Table 6

Findings for Treatment Group in pretest and Posttest.

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Pretest	20	6.00	19.00	11.7000	3.85391
Posttest	20	23.00	39.00	30.2500	4.83273
Valid N	20				

The statistics indicate that there was a significant enhancement in the performance of the participants from the treatment group in the posttest; this further suggests that the treatment was effective. Scores ranged from a minimum of six in the pretest to a maximum of 19; however, in the posttest, the minimum score obtained by the participants was 23, and the maximum mark was 39. Figure 1 highlights the performance of both groups in the posttest.

Figure 1

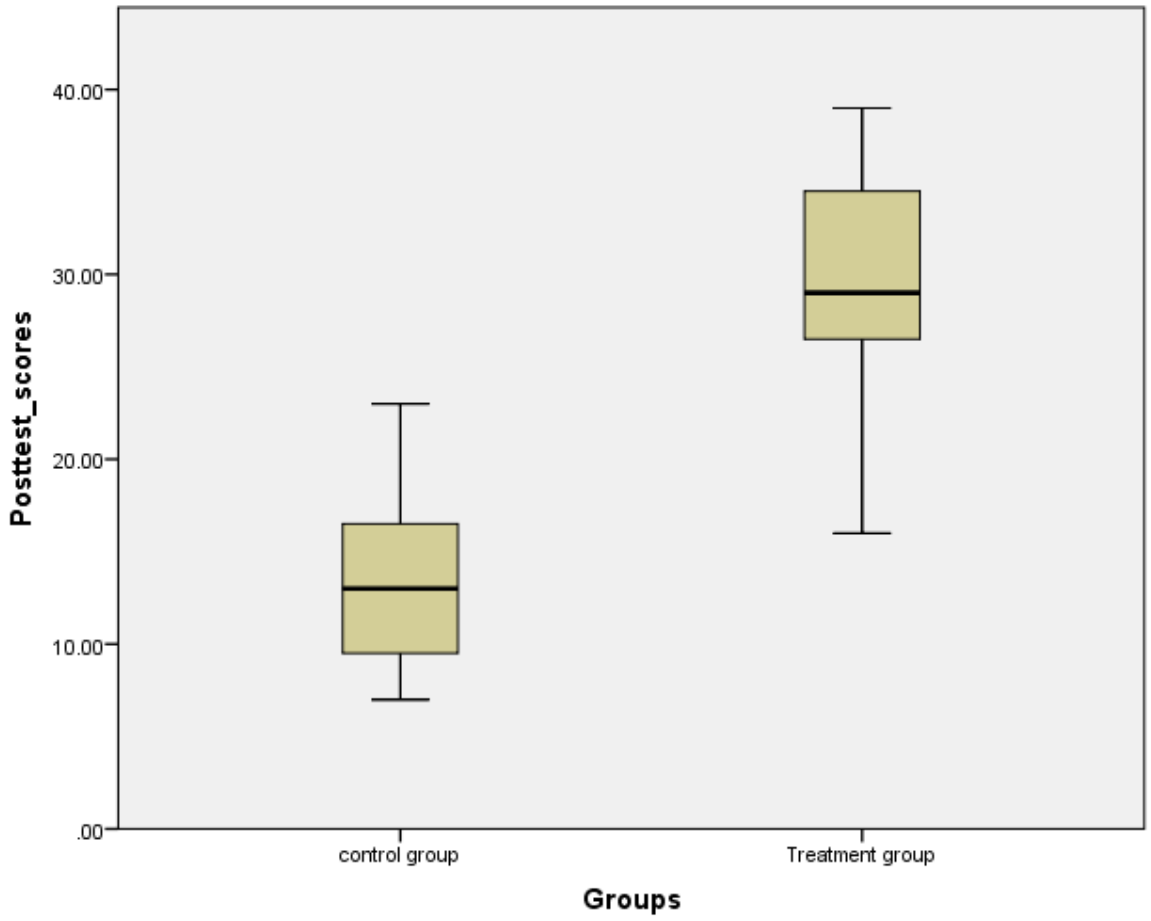

Figure 1. Boxplot showing change in test scores for students in both treatment and control groups after intervention.

The first graphic represents students' scores from the control group, and the second graphic represents students' scores from the treatment group.

Summary statistics for the independent sample *t* test and confidence interval confirm the experimental group tested higher than the control group. This outcome may have been the result of the intervention. As shown in table 7 the mean score for the

control group was 13.3 in the posttest and table 6 shows that the mean score for the treatment group was 30.25.

Statistics from the pretest and posttest of the performance of the Control group is shown in Table 7.

Table 7

Findings for Control group in both pretest and posttest

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Pretest	20	7.000	19.000	11.90000	3.809959
Posttest	20	7.00	23.00	13.3000	4.62374
Valid N	20				

These data indicate that the students who did not receive the treatment had a mean score moving from 11.9 in the pretest to 13.3 in the posttest; this level of attainment is of a poor standard at the tertiary level.

Discussion of Findings

The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. Bishop-Clark and Dietz-Uhler (2012) stated that the findings of a study should be presented in a methodical and informative manner. After the collection of data, a brief statement of the main points as it relates to data analysis results about acceptance or rejection of the null hypothesis and non-directional alternative hypothesis (Creswell, 2012) was given. The conclusions reached as a result of the inquiry, as they correspond to the research question, are discussed in the following sections. The research question addressed the influence of

instructors' language for the instructional delivery and how it affected the ELL students' ability to learn mathematical concepts as measured by the MDT. The findings of this study will help to guide the development of a PD project that might create a social change in knowledge that will influence pedagogical shifts in the teaching of math to ELLs. Another benefit that may accrue from the findings is that it will make possible better conveyance of information and cooperation between ELL students, management and academic staff of UCSE as they apply procedures that might lead to an improvement in mathematics proficiency for freshmen education JD students in mathematics at the college.

Findings were also appraised within the perspective of the current literature. Evidence from these data as well as from the educational literature suggest that instructing students in their native language could contribute to an improvement in academic achievement. Improving freshmen at UCSE performance in math is an undertaking that requires innovation and support from all stakeholders. Hodara (2015) noted that ELL college students need to strengthen their math competency to meet the demands of science and technology for the twenty-first century.

In answering the research question, consideration was given to the statistical significance while comparing the observed values with the theorized values. Based on the observed values (see Tables 1, 2, 3, 5), the Null Hypothesis was rejected, as in all cases there was a statistically significant difference in the academic performance of the ELL students that were instructed using the JD when compared to those that were instructed using only SE as measured by the MDT. Data from this study show that the language

used by instructors might influence mathematics performance for ELL students at the local level in terms of their performance on the MDT. The findings further suggest that the strategy used by Jamaican instructors to teach ELL students in SE could affect students' conceptual understanding of mathematical principles and concepts however no cause and effect judgement can be drawn from this project study. The findings from this study might provide an understanding of how math instructors could enhance JD students' knowledge of mathematics, students' performance on the MDT and use specific teaching approaches with students whose native language is JD. Results from the study indicate that improvement in ELLs' performance in math could possibly be achieved through the provision of support to lecturers; such support should be designed to increase instructors' academic knowledge on how the verbal expressions as demonstrated through the use of JD or SE, in the classroom could influence instruction and learning of mathematics for ELLs or students whose native language is JD. The statistics showed that there was a significant statistical difference between the mean scores of the students that were taught using JD and the students that were taught using the SE (see Tables 4, 6). For this study, the null hypothesis was rejected with 95% confidence based on the *t* test results.

Research Question: What is the difference in MDT mathematics change scale scores between students who were instructed in JD (JD1) and students who were instructed in SE (SE1) for the semester? The independent –sample *t* test indicated that the mathematics scale scores of students who received instruction using the JD were higher than students receiving instruction in SE. These results appear consistent with other

researchers' findings that to maximize ELL students' learning, mathematics instructors should try to align teaching, and student learning by using the native language of the students (Chitera et al., 2016). I concluded that if students who speak the JD are taught mathematics by instructors using JD, it could contribute to an improvement in academic the performance of the students because the results showed there was a significant positive association between students being instructed in JD and their respective MDT scores. The data analysis of this research involved an independent- samples *t* test that addressed the research question by comparing the means of the treatment and control groups. The treatment was delivered consistently to the treatment group by the teachers who participated in the study. The control group was taught using the traditional method of instructing the freshmen education students using Standard English.

Conclusion

A quasi-experimental study met the necessary requirements to gather data to determine the association between freshmen students' English language proficiency and their performance on the MDT at UCSE. The results of the study were reviewed in the context of Vygotsky's sociocultural theoretical framework; a premise of the theory is that social interaction using language is a requirement for cognitive development. Mathematics educators in Jamaica are encouraged by the Ministry of education to place greater emphasis on the social interaction between students and teachers in the mathematics classrooms (Ministry of education, Jamaica 2014). Attention should not only be placed on the texts used to instruct students but also on the language instructors use as this study established that language of instruction could have a positive influence

on the mathematics proficiency scores as measured by the MDT for students whose native language is JD. It is now widely accepted that mathematics has its unique vocabulary; therefore, the spoken discourse of mathematics in the classrooms must be carefully monitored, especially in a context where the students' primary or native language of communication is not the language of instruction.

Findings of the study were concomitant with the literature and were, therefore, expected, Haag et al. (2013); (Cho, Yang, and Mandracchia, 2015); Rubinstein-Avila, Sox, Kaplan, and McGraw (2014); Kibler, Walqui, and Bunch (2015) and Bunch (2013). Comparing the results of this investigation with those mentioned above and other similar studies shows that the findings of this research are consistent with their findings and confirm that the language of instruction does influence attainment in mathematics.

The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. For this research, it was appropriate to use a quasi-experimental design, as a small sample of 40 ELL pupils took part in the study. One goal of this research was to inform stakeholders at UCSE regarding instructional delivery and design to build instructors' capacity to support JD students who were failing to demonstrate math proficiency on the MDT at UCSE. Another goal of the study was to inform the administrators at UCSE regarding possible interventions and procedures to provide support for JD freshmen education students. The desired result of this research is that the application of the knowledge derived from this study may contribute to an improvement in the teaching strategies used for instructing students who speak the JD and ultimately contribute to an improvement in

mathematics attainment and enable students to remain enrolled in the education program by demonstrating proficiency on the MDT. Demonstrating proficiency on the MDT could lead to more education students graduating from UCSE and entering math and science fields to support the Jamaican and global economies.

In Section 3, I describe the resulting project, a PD genre for assisting in the enhancement of ELL students' knowledge of mathematics as well as advancement in the teaching approaches of the math instructors. The PD will be guided by the quantitative findings that will be shared with: the Ministry of Education, the administration of the UCSE, parents, instructors, and students.

Section 3: The Project

Introduction

In this of section of the study, I describe the project in detail. An explanation of the project is given, an appraisal of literature is presented, and a discussion of the project takes place. Section 3 is the concluding part of this research; it brings all of the components to totality. In this part, the objectives of the project are discussed. A rationale is given as to why this particular project type was preferred. Additionally, reflections of the data analysis in Section 2 are included. Also enclosed in this section is an evaluation of the literature on the PD of mathematics teachers. A thorough description of the project is presented that includes the project's purpose, goals, learning outcomes, and targeted audience. The section closes with a dissertation on the possible future effects on social change. Furthermore, the project's importance to mathematics educators, the local community, and all affiliated stakeholders is analyzed.

Rationale

The project that I planned is one that involves professional development. A PD plan with units for an afterschool program was the preferred genre for this project study because it was the best option for the local site to assist in the enhancement of ELL students' knowledge of mathematics as well as advancement in the teaching approaches of the math instructors. No formative or summative data exist at the local site to establish the to which the language of instruction has on student achievement in math as measured by the MDT for JD students This study will provide USCE administrators with a PD plan to build capacity using JD to instruct students whose native dialect is JD thereby

creating positive social change by enabling JD students' access to instruction resulting in proficiency of required mathematics skills to graduate from USCE becoming productive members of Jamaica's economy.

PD seminars are planned for not only ELLs and their instructors, but also the administrators of UCSE. Kennedy (2016) stated that PD fosters teacher learning and alterations in teaching practices, thereby making a significant difference in student achievement. Amendum and Fitzgerald (2013) noted that the more support educators receive for their learning from each other and experts, the more their learning is scaffolded. Desmonte and Garet (2015) suggested that a theoretical structure for producing a desired result in PD is focused on four main components: alert and lively learning, consistency, sustained duration, and shared participation. The PD is therefore structured around these four elements. Planning PD programs for ELL instructors make sense because findings from this study showed that the when students are instructed in their own language it contributes to improved attainment in mathematics. Altering procedural classroom behavior takes less time than improving the content knowledge of the teachers or administrators; this is another good reason for a PD program. The PD of math educators can be efficient and sustainable when planned correctly. The PD of math teachers is attracting much attention as society demands more accountability from them in terms of ELL students' attainment in mathematics.

One of the purposes of this PD project is to support ELL math educators in planning instructional strategies so as to maximize the time they use to help ELL learners build understanding of mathematical concepts. PD would also enhance college

administrators' knowledge of what to expect when they visit an ELL mathematics classroom. When administrators understand the process of second language acquisition and what it means to teach for equity, they are better able to make decisions that affect ELL programs and curriculum development. Additionally, when administrators are given the opportunity to understand the five strands involved in mathematical competency (i.e., concrete understanding, technical fluency, planned competence, adaptive thinking, and productive temperament), they are able to make informed decisions about professional standards for teaching math. Furthermore, Ross (2014) suggested that continuing education for ELL instructors is a worthwhile strategy to reducing academic challenges for ELL students in mathematics by creating better prepared teachers. Instructors' involvement in PD on ELL teaching and learning is positively linked to their sharp sense of effectiveness (Ross, 2014). Another benefit for math instructors participating in PD is that it will promote collaboration among all stakeholders who are responsible for educating students with JD. PD of teachers should be planned carefully; however, educators should also have a vision for their professional growth that will influence them to be actively involved in their development as teachers.

Review of Literature

This segment comprises an appraisal of literature related to the PD of instructors and administrators accountable for the instruction of ELL students. The goals of this review include developing an understanding of the range of career development opportunities accessible to teachers and administrators of ELL students. Establishing an understanding of instructors' acquisition and use of knowledge acquired as a result of

attending PD seminars is critical to the state of information in the field of PD for ELL educators and as such was a goal of this formal assessment of literature. The findings in Section 2 of this investigation are consistent with the outcomes of other researchers who investigated the influence of language on the instruction and learning of math (DelliCarpini & Alonso 2014; Dong & Lin 2015; Sarama, Lange, Clements & Wolfe 2012; Valle et al., 2013; Vukovic & Lesaux 2013; Zhu et al., 2015). The evaluation of the results of this study and similar studies indicated that the studies agreed with the outcomes of this one and therefore influenced the review of literature in this section.

An extensive database search that included the examination of books, studies, and articles checked by scholar-practitioners in the particular area of study was carried out through several library databases, including Google Scholar, Web of Science, ERIC, ProQuest, JSTOR, and Thoreau Multiple. Relevant search terms included, but were not restricted to, the following: *design of professional development*, *development of teachers' mathematical thinking*, *educational reform*, *changing instructors' practice*, *teaching mathematics to ELL students*, *teaching for equity*, and *effects of PD on teachers, students, and educational administrators*. The review is structured under five broad themes: (a) how PD improves teaching, (b) PD in tertiary education, (c) best practices in teachers' professional development, (d) PD for mathematics instructors, and (e) PD to support ELL learners. Topics explored in this review of the literature were selected with the intention of establishing PD that has significant, positive effects on mathematics teachers' knowledge and place professional development/training curriculum in the broader context of the educational sphere.

How PD Improves Teaching

The academic community at UCSE has accepted the position that as educational research evolves, as new technologies emerge, and as a vast amount of information becomes more accessible, instructors must continually increase their knowledge and hone their skills through PD if they are to continue to be relevant in the classrooms of the 21st century (Registry, UCSE, 2015). PD of educators can contribute to improvement in teaching and learning. Teacher quality is associated with student achievement, yet many instructors enter classrooms unprepared. PD activities are therefore used to inform the teaching and learning process. Kennedy (2016) suggested that career development can assist in identifying a significant problem of practice and devising teaching strategies that may help instructors overcome some of the extenuating challenges that they have to deal with on a regular basis in their classrooms. Nasser, Kidd, Burns, and Campbell (2015) noted that educators have determined that teaching is a constant learning process that continues in the classrooms in the form of PD long after formal college training. Mathematics instructors should reflect on their strengths and weaknesses while teaching ELLs and administrators are obliged to create PD opportunities for these teachers to help them address their deficiencies. With ongoing professional development, teachers' competence will improve, and students will be equipped to meet the problems of the 21st-century global environment.

PD is associated with excellence in teaching and high-quality education to better student performance. Whenever educators are a part of professional development, they will be motivated to take time to investigate the work their students are doing and

develop teaching strategies that target the deficiencies in their students' learning (Stewart, 2014). Educators who participate in PD earn the skills of scrutinizing data on student performance, analyzing students' work, choosing effective teaching approaches to facilitate learning, writing and executing good lesson plans, and developing student-centered classrooms.

Sun, Frank, Gallagher, and Youngs (2013) asserted that PD could influence change in teaching strategies by promoting the sharing of instructional expertise among education professionals. Teachers involved in career development will learn new strategies from other professionals to support the diversity of different educational background found in ELL schoolrooms; these educators will learn how to make accommodations and modifications for all of their students. Engagement in PD will ensure that the participants learn more about their practice and develop an improved understanding of the relationship between teaching and learning in practical ways (Stewart, 2014). De Vries, Jansen, and van de Grift (2013) noted that greater instructors' participation in PD leads to more student-oriented teachers. Providing high-quality math education for ELL students should be a priority; it is important that administrators encourage the PD of their teachers, as the training may motivate them to develop ownership and personalize their teaching and learning. Thus, there is no uncertainty in the literature regarding the potential of PD activities to help educators in improving their existing skills and in obtaining new ones.

PD in Tertiary Education

Trede, Macklin, and Bridges (2012) stated there is a shortage of research articles on tertiary education that carefully investigate or discuss the development of professional identity through advanced education. Instead of concentrating on focused development, the few materials available focused largely on topics pertaining to professional thinking, bounds of human knowledge, integration into the teaching profession, and teaching philosophies. Garson, Bourassa, and Odgers (2016) suggested that combined changes in pedagogy and curriculum provide evidence that well-planned, theoretically grounded, multicultural PD for faculty can promote long-lasting benefits for both instructors and their ELL students. PD is a useful technique to use in educating instructors at the tertiary level to understand that they may have to change their teaching strategies if they are to be effective in educating their students; this may include ongoing learning conducted formally or informally.

Gomez et al. (2015) emphasized the need to develop a greater understanding of how mathematics instructors learn about students' language and literacy needs and ways in which they may influence language to support mathematics teaching and learning. One method of resolving this problem involves improving instructors' capacity to buttress students' language and literacy needs through PD and consequently improving student achievement (Gomez et al., 2015). ELL instructors at the college level should be aware that PD practices are shifting toward collaborative training; individual practices are in many cases deficient in preparing instructors to incorporate the educational skills that students need if they are to excel in a college environment (Stewart, 2014). PD at the

college or university level is beneficial when instructors engage keenly in instructional analysis in the context of supportive professional communities focused on improvement in lecturers' teaching approaches and student achievement. Robinson, Strauss, and Reed (2014) suggested that PD opportunities that use a model that incorporates a wide-ranging, adaptive, cohesive, developmental approach should be encouraged. Such findings support the view that there is improvement in teaching and learning for teachers and students whenever teachers are exposed to significant professional development.

The education system of the 21st century is changing to an agreed level of attainment for what students must comprehend and be able to do in today's world; consequently, career development becomes essential to the successful application of standards. The application of the standards is contingent to a large extent on the professional improvement of educators (Marrongelle, Sztajn, & Smith, 2013). As suggested by Marrongelle et al. (2013), PD should be (a) rigorous, constant, and linked to practice; (b) centered on student education, addressing the teaching of precise concepts; (c) aligned with college development priorities and objectives; and (d) designed to build solid working connections among faculty. Reavley, Ross, Killackey, and Jorm (2013) noted that social and economic circumstances of many tertiary educational institutions, including their history, geographic location, and method of financing, were among the factors constraining or supporting quality teaching and the uptake of PD opportunities. Instructors at UCSE should therefore advocate for a policy wherein PD is an integral part of the college curriculum, and provisions should be made for instructors to attend PD seminars.

PD for mathematics instructors ought to take into account current data about successful methods to shape learning episodes for math educators. Gerken, Beausaert, and Segers (2016) asserted that higher education administrators should nurture the professional growth of their academic staff by motivating exchange of data and using response with co-workers in a proactive manner; this approach would contribute to improvement in the pedagogical approach of the instructors in relation to educating ELL students. Carney, Ng, and Cooper (2016) stated that the future of faculty development might rely in part on fostering PD to promote both scholarly efficiency and pedagogical success. Results from this study also showed meaningful relationships between PD features, teachers' content knowledge, teachers' perceptions, and instructional practices. Allen and Penuel (2015) emphasized the necessity for PD to engage educators in sustained sense-making activities around issues of apparent confusion so as to strengthen teachers' emerging comprehension of specifications and advance the probability of implementing instructional practices aligned to benchmarks.

Best Practices in Teachers' Professional Development

Concern for the PD of instructors regarding expanding their content knowledge and improving their educational skills to continue working effectively with students from multicultural backgrounds is one of the primary goals of teacher development. It is necessary for administrators to plan PD seminars for faculty members rather than engaging in lengthy discussions about what the educational institution hopes to accomplish and establish guidelines by which the goals are measured. There should also be evidence indicating the successful implementation of PD programs. Guskey (2014)

suggested that many educators consider outcomes to be synonymous with results; however, the desired result should be where the planning process for PD starts. To facilitate the PD of educators, a community of practice is an essential structure. Within a community of practice, teachers with similar interests or shared objectives collaborate to share resources, develop best practices, and engage in problem solving so as to strengthen the quality assurance of the institutions they work with (Tseng & Kuo 2014). Guskey (2014) noted that the accomplishments of any PD for instructors are reliant on how well it is structured. The suggested structure of a PD should be as follows: (a) pupils' learning outcome, (b) new training to be applied (c) needed administrative backing, (d) anticipated educators' awareness and skills, and (e) model learning events. The involvement of teachers in PD is critical, in that it is a significant predictor of teachers' pedagogical content knowledge (Glover, Nugent, Chumney, Ihlo, Shapiro, Guard, & Bovaird, 2016).

PD planning should begin with learning outcomes for learners. As an alternative, many college administrators and professional organizations defer to such things as results from needs assessments, or the availability of presenters on a particular date. PD is progressively utilized to advance instructors' expertise and knowledge in connection to the teaching and instruction of math. Career growth for teachers has the potential to produce a moderate effect on development excellence and a large effect on operational quality (Markussen-Brown, Juhl, Piasta, Bleses, Højen, & Justice, 2017). The need for quality assurance from the globalized community and the need for educational institutions to work well in global measures of educational efficacy ensure that many educational administrations continue to invest in teachers' career development as a means

of enhancing students' academic performance and teachers' ability to deliver content effectively (King, 2014). For sustainability of practice, math educators need to have conceptual knowledge, computational fluency, and problem-solving skills related to practice; such competencies can be developed through PD seminars where best practices are demonstrated. King (2014) suggested that PD provides instructors with devices necessary to guide pupils to excel in a world characterized by increasing complication, rapid change, and a guarantee of quality performance.

According to Glover, Nugent, Chumney, Ohio, Shapiro, Guard, and Bovaird, (2016) instructors who spent more time engaged in PD have greater pedagogical content knowledge thus giving credence to the notion that there is a relationship between teacher performance and professional growth. Loughran, (2014) stated that there is growing awareness of the significance of the professional improvement of educators as the qualities of teacher training progressively come under analysis. Nasser, Kidd, Burns ,and Campbell (2015) stated that teachers who are involved in PD garner valuable knowledge that enhances their teaching, get opportunities to network with colleagues, and encounter mentors whose positive interaction support their learning. The approach taken by instructors to adopt best practices in their classrooms during the development of their knowledge and skills is vital. Irrespective of the organization and offerings of an educational institution PD of the academic staff, will only be effective in meeting individual and institutional needs if it approached as a collaborative, community work within and outside the institution (Austin & Sorcinelli, 2013). Flynn, Lissy, Alicea, Tazartes, and McKay (2016) suggested that PD interventions might have the capacity to

make better educators performance and classroom management practices that reduce suspensions and behavior incidents acknowledged to be unfavorable to learning attainment.

PD for Mathematics Instructors

Mathematics educators have over the past decade integrated more social and cultural perspective into their ways of understanding and measuring teaching (Gutiérrez 2013). Jacob, Hill, and Corey (2017) suggested that PD is planned to advance teachers' mathematical knowledge and aid them in stimulating critical student thinking and reasoning during mathematics lessons. PD for math instructors must be focused on assisting them (a) acquiring more mathematics knowledge, (b) understand how students develop conceptual understanding of mathematical concepts, (c) use formative assessment to enhance pupils learning and (d) select activities that allow students to use problem solving strategies to understand and solve math problems (Jacob et al. 2017). In many instances, mathematics is taught in an unsatisfactory manner emphasizing rote learning and algorithms instead of relating the math to or based on mental concepts; it is necessary to provide PD seminars where effective strategies for teaching math to overcome weakness in mathematics pedagogy, is demonstrated by mathematics specialists.(Francis & Jacobsen, 2013).

Mathematics education reform demands that math instructors create equal opportunity for all pupils to learn irrespective of their ethnicity. Math instructors should use standards-based teaching techniques, which exemplify the criteria set by the Ministry of Education. To adequately support teachers' application of standards-based curriculum,

career improvement opportunities must be provided that meets instructors' needs. The specialized development programs planned for math instructors should focus on the implementation of standards-based mathematics curricula (Jacob, Hill, & Corey, 2017). Kutaka, Smith, Albano, Edwards, Beattie, and Stroup (2017) noted that the prevailing assumption held by society that teachers acquire the knowledge they need to know before they start teaching had been dismissed and PD is now the strategy that is used to improve academic staff development and school development. The removal of teachers' fear of mathematics and their desire not to teach math are the desired outcome of professional development. Qablan, Mansour, Alshamrani, Aldahmash, and Sabbah (2015) suggested that providing educators with continuous PD practices is necessary to improve the quality of teaching and learning. Polly, Neale, and Pugalee (2014) indicated that professional improvement for teachers has an extensive positive effect on their mathematical knowledge as well as their pedagogical skills; there was also an increase in their use of student-centered instructional practices and views about the way students learn mathematical concepts. Useful mathematical development seminars should ensure that instructors develop pedagogical content mastery and be able to establish and maintain classrooms that will guarantee effective teaching and learning.

Competent instructors of mathematics should have a strong knowledge base on which to build their professional practice; their knowledge should include awareness of the mathematics content and how to teach for mathematical proficiency (Ministry of Education, Jamaica, 2014). The professional standards for teachers of math can be achieved through carefully planned and executed PD seminars. PD seminars will also

contribute to math instructors displaying levels of integrity and professionalism because they have an obligation to the students, parents/guardians and all other stakeholders (Ministry of Education, Jamaica, 2013). According to Willemse, ten Dam, Geijsel, van Wessum ,and Volman (2015) teaching professionals must make normative professional decisions of what is educationally desirable as they go about the task of educating students; the quality of the decisions made can be improved through professional development. Good quality professional improvement should result in advances in educators' knowledge and instructional practices and result in better-quality student learning (Masuda, Ebersole, & Barrett, 2013).

Forte and Flores, 2014 stated that educators involved in PD gain new ideas by being more reflective in their professional practices. Also, instructors develop positive attitudes towards their work that aids them in becoming more effective with their students. Policy makers should ensure that there are policy guidelines in tertiary institutions that will assist administrators in supporting the PD of all categories of staff; this should result in improved performance for students. Khong and Saito (2014) noted that an institutional hindrance for ELL teachers is insufficient PD notwithstanding the significance of preparing instructors to work with ELLs. According to Khong and Saito, roughly 60% of the head of a university faculty or department acknowledged the absence of adequate or acceptable attention on PD for educators.

PD to Support ELL Learners

Masuda, Ebersole, and Barrett (2013) suggested that in most ELL classrooms exchange of ideas need improvement and instructors should learn how to actively engage

students to come up with explanations in their words and have the opportunity to insert new information in existing knowledge domain. Career development is essential to upgrading the quality of instruction for ELLs, the usefulness of policy changes for instructors and teaching practice, and advances in student attainment can be enhanced by high level of PD (Pehmer, Gröschner, & Seidel 2015). The push for mathematics education reform in the Jamaica has grown increasingly more urgent as the student population has become rapidly more diverse while there is a decline in achievement in mathematics (Ministry of Education, Jamaica, 2014). Moreover, the findings of this study indicated that there is a relationship between the verbal expressions of instructors and attainment in math for ELL students. Many math educators have proposed that capacity building for teachers with skills specific to ELLs' instructional needs is necessary to address the learning challenges these pupils encounter on a daily basis. Loeb, Whitney, and Wyckoff (2016) suggested that ELL-specific instructional strategies are linked with higher academic attainment for ELLs. Further results from the project study corroborate the view that all teachers can develop valuable ELL-specific instructional expertise

Cervetti, Kulikowich, and Bravo (2015) stated that recognizing and endorsing ELLs' native language produces a more favorable language and content learning setting, as ELLs feel secure to rehearse their English skills, and consequently, improving their understanding of math content. As the ELL population continues to increase more attention is drawn to their academic and social needs. ELLs enter academia from home where English is not their native Language. The language of academia is harder for ELLs to learn because it is not used in the students' daily conversations. Mathematics with its

abstract symbolism poses learning difficulties for ELL students; they are required to learn content in English that they do not have equivalent words for in their innate language. Thus, it is clear that additional support is needed for ELL students to help them attain higher levels of success. Administrators in schools and colleges will have to structure PD courses for math instructors to inform the teaching and learning of mathematics to ELLs. The need to address these challenges

According to Burstein, et al (2014) many teachers do not have the necessary training on how to adjust their instructional methods to fit in with the needs of the varied cultural and linguistic circumstances of ELL students. One strategy to overcome this problem is to use Language Muse, a web-based application designed to offer teacher PD on the writing of lesson plans for content-area teachers (Burstein, et al). The objectives of the Language Muse are to improve instructor's awareness of the challenges that ELLs face in learning academic English and making available to instructors strategies for adjusting their daily lesson plans to satisfy the learning requirements of students with different levels of capability in the use of the English language. Research-based PD is necessary for instructors to be able to provide quality math education for ELL learners. Mathematics educators should recognize their obligation towards their profession and understand that they should make every effort to pursue professional development.

Jacob, Hill, and Corey (2017) noted that PD would enhance practice in the mathematics classroom. PD includes engaging in research that will inform the teaching and learning of math and collaboration with colleagues in using their knowledge of mathematical concepts and principles to design learning activities and material suitable

for the teaching and learning of math. Instructors who attended PD seminars are more likely to be able to apply the new knowledge, skills, and attitudes learned to improve the instructional content and boost learning for ELL student learning in math. "The variability in mathematics content and pedagogy warrant continuous teacher PD to maintain and strengthen competencies for fostering successful math programs" (Henry et al., 2015, p. 98). PD opportunities for ELL mathematics instructors should be a central component of efforts to support increased student achievement for linguistically diverse students.

PD that focuses on improving instructors' quality, changing ELLs' assessments strategies, might increase English Language learners' mathematics achievements while reinforcing their steadfastness to pursue upward social mobility through a college diploma. Ross, (2014) noted the importance of providing mathematics instructors with PD appropriate for teaching ELL students.

PD should be provided to math instructors and if designed as school-based, continuing learning opportunities, instructors would gain access to PD as a job embedded function resulting in improving practices for ELLs with an aim of improving pupils' attainment in mathematics (Ministry of Education, Jamaica, 2014). Researchers support career development activities that concentrate on learning criteria that will make change to strategies that are intended to improve instructor content knowledge, demonstrating effective teaching practices, endorsing teamwork for PD, and providing expertise or skill that will ultimately cause improvement in academic performance for all categories of students (Elfers & Stritikus, 2014). Guzey, Tank, Hui-Hui, Roehrig ,and Moore (2014

indicated that most teachers who participate in PD were able to efficiently implement science, technology and engineering design lessons in their classes signifying that the instructors' ability to apply effective teaching strategies were closely related to their involvement in PD seminars. Another positive feature of PD concerns the acknowledgement and discernibility of instructors' work.

Project Description

Needed Resources and Existing Supports

The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. The findings of my study have shown that the language of instruction does affect the teaching and erudition of math to ELLs. Therefore, a PD project that will promote best practices for teaching mathematics to English Language Learners and build capacity of UCSE mathematics instructors using JD to instruct students whose native dialect is JD has been developed. The PD project is designed for the instructors of ELLs and members of the administrative staff of UCSE; this influenced the resources that will be needed for the PD plan. Resources required for this PD project include access to a tutorial room with computers and Internet access from 3:00 p.m. to 5:00 p.m. for 2 days per week. All instructors that teach mathematics to ELLs at UCSE, the vice presidents for academics, as well as human resources and 4 other members of the administrative staff, will be invited to attend the seminars. One of most valuable resource necessary to the success of the program is an instructor who is conversant with the needs and learning styles of ELL students and is knowledgeable about effective teaching strategies for instructing them.

The presenters at the seminars must be knowledgeable about the National Mathematics Policy Guidelines (Ministry of Education, Jamaica, 2014). Additional resources required include a laboratory technician to assist with setting up the technology lab (laptops, white board, sound system, ensure internet is working), printed material for the discussions, copies of the Jamaica Education act and the National Mathematics Policy Guidelines.

The college library on the west campus is ideal for conducting the seminars; instructors, members of the administrative staff and students will have access to the other college library on the east campus and will, therefore, not be inconvenienced. The room has large tables and comfortable chairs that are easily organized for group work. The library has air conditioning, is well ventilated and the lighting is good. Other existing supports for the program include the National Mathematics Coordinator, the Dean of the Faculty of Science, Guidance counselors, the college research coordinator and the head of the Mathematics and Computer Science department.

Barriers

Finding facilitators who have competence in demonstrating how math should be taught by instructors to enable ELLs may be problematic as there are not many math educators in Jamaica who are competent at explaining how to teach math to ELLs so that they can develop conceptual understanding and problem-solving skills. A minor obstacle might be to get a qualified facilitator to travel to Eastern Jamaica without having to pay them a high salary. Other possible barriers to the success of this project include instructors and administrators who may not want to attend the seminars after they have stopped working for the day. Some of the participants will have difficulty in getting

transportation to go to their various destinations after the end of the sessions. UCSE students and all categories of staff encounter problems getting transportation after 6 p.m. UCSE lie outside the regular public transformation route.

Another obstacle for this professional improvement project is the perception of the instructors. Many instructors often see PD as a top-down process usually run by the college administration. It might be a challenge to educate the participants to realize that the objectives of the in-service training is about their personal development and not just for the benefit of the college and the ELL students.

Implementation

After completing Walden's necessary conditions, my aim is to share the report giving information on the findings in person with the stakeholders. Interested parties would include the Board of Governors of UCSE, the Ministry of Education in Jamaica, the Joint Board of Teacher Education, the Mathematical Association of Jamaica and the Board of Directors of Teachers Colleges of Jamaica. My vision is to work with the Math Department at UCSE and the National Mathematics Coordinator to inform them about the results and suggestions as to the recommended course of action based on the findings of this study. All recommendations will be presented by way of a white paper at organizational team meetings at the start of the next academic year so that some of the recommended teaching strategies may be implemented throughout the school year. A formal introduction of the white paper would give administrators and instructors time to deliberate about the data and decide on the most appropriate time for implementing the strategies. It is desirable that a presentation is made to the Regional Director in the

Ministry of Education throughout the summer so that there will be a permanent account of the information before the white paper is posted on the Ministry of Education internet site. Also, the white paper would be presented at the annual PD seminar hosted by the UCSE before the start of the next academic year. Finally, I would request permission from the President of the College to present the findings and recommendations at faculty conferences at the commencement of the academic year. The results would confirm the effective activities taken on the part of cooperating instructors to promote positive social change locally by improving ELLs' attainment in mathematics; this should help set the platform for a successful implementation of the recommended teaching strategies

Roles and Responsibilities

I will be working with the Mathematics and Computer Science Department and the vice-president responsible for human resources at UCSE to organize the PD seminar for the math instructors and administrators. My responsibilities throughout the ELL PD seminars include: acting as facilitator throughout the seminars, introducing the presenters and initiate discussions, assist in the formation of groups and aid in the structure and presentation of demonstration lessons. Technical support will be provided by computer laboratory technician.

The Head of the Mathematics Department will evaluate examination of the teaching techniques that are presented by the presenters. He will also use the National Mathematics Policy document as a guide to ensure that the information delivered to the participants are in keeping with the national policy for the instruction and acquiring of mathematical competence. The vice-president for human resources will collaborate with

the director of human resources to: find a sponsor for the PD workshop, provide lunches and snacks for the participants, pay the presenters and finance all other cost associated with hosting the seminar.

Project Evaluation Plan

The process of determining the effectiveness of the white paper requires an evaluation. According to Earley and Porritt (2014) evaluation of PD by educators and policy-makers is still unfocused and anecdotal. It is against this background that objective-based, proficiency-based, in-process, and cumulative assessments were considered. Youker and Ingraham (2014) noted that an objective-based appraisal estimates a program's effectiveness against precise, measurable goals or aims. Mikasa, Cicero and Adamson (2013) suggested that outcome-based evaluation is necessary when evaluating student mastery of course objectives. Formative assessments provide immediate feedback thus enabling the educators to gain insight into the quality of the intervention resulting in an improvement in the action taken to correct the problems (Nieveen & Folmer 2013). Hoover and Abrahams (2013) suggested that summative evaluation assesses the final product thereby helping teachers to identify deficit areas in students' learning. I chose to use a formative evaluation to implement the PD designed for instructors of JD students.

Justification

To gain insight into the quality of the PD seminars and their structure and to obtain empirical data about effective strategies for teaching math to ELL students at UCSE a formative evaluation is necessary. Also, adjustments may become necessary to

achieve the intended goals for instructors' success. For these reasons, a formative assessment will be a vital feature of the PD designed. Results of the formative evaluation may give credence to the results of the research and help to bring about an improvement in the teaching techniques of ELL instructors at UCSE. The purpose of the formative evaluation is to aid in the improvement of practice (Venable, Pries-heje, & Baskerville 2016). In these PD seminars, formative evaluation should assist in the immediate recognition of any limitations of the suggested teaching strategies and generate ideas for improving them.

Goals of the Project

The general goal of this PD is to present content in the form of knowledge and strategies to support ELL student learning and to provide instructors responsible for teaching mathematics to JD students with strategies and techniques to improve teacher effectiveness and self-efficacy as well as student learning in mathematics while incorporating the National Standards for teaching Mathematics in Jamaica. The PD goals for the project include:

Goal 1: Teachers will be able to identify effective instructional strategies for teaching and assessing mathematics lessons for ELL students who speak JD.

Goal 2: Teachers will demonstrate an understanding of reading and linguistic support for ELL students who speak JD.

Goal 3: Teachers will demonstrate the ability to combine the use of JD and SE for instructing ELL students who speak JD

Goal 4: Teachers will demonstrate the ability to design math lesson plans that emphasize problem-solving, computational fluency and conceptual understanding using the strategies presented in the PD.

Evaluation of the PD Project

One of the overarching goals of this project is to determine the effectiveness of the recommended teaching strategies for teaching ELLs and where it might be necessary to make adjustments to the teaching techniques that contribute to instructors' efficacy in teaching ELLs who speak JD while incorporating the National Standards for teaching Mathematics in Jamaica. Another objective of the formative evaluation is to be able to make a recommendation to the various stakeholders on how to develop National Standards for the teaching of mathematics to ELLs in Jamaica. Collaboration between the various stakeholders is desirable. The Standards should provide math instructors clear guidelines in supporting ELLs as teachers develop conceptual understanding of mathematical principles for instructing ELL students who speak JD.

The participants will be placed in collaborative small groups to plan and execute demonstration lessons that will incorporate effective approaches for teaching math to ELLs. Such a strategy will enable the presenters to answer questions regarding the effectiveness of the strategies presented. Therefore, participants will reflect on and evaluate the strengths and weaknesses of the presentations and lessons designed to support instruction of ELL students. At the end of the seminars each day, and after the participants complete evaluation forms, the data will be analyzed, and a determination made if there is the need to organize subsequent PD or review specific PD content

presented. These data will be used for subsequent PD targeted for instructors of ELL students who speak JD.

The formative evaluation of the goals of the PD seminars will provide data to refine future PD seminars to support teachers in the Mathematics instruction of ELLs. In addition to obtaining formative feedback regarding the PD seminars, I will continue to collect formative evaluation data from teachers at the end of each teacher term to support the evaluation of the PD seminars. Teachers will also be asked to evaluate the overall perceived effectiveness of the knowledge and skills applied while designing and presenting lessons at the end of the semester term in addition to reporting on their perceived sense of self-efficacy in providing instruction to ELL students who speak JD. Student MDT data will be analyzed following implementation of the strategies by teachers. This formative data will be presented to the college leadership and be used in the annual PD seminars to support instructors in teaching Mathematics to ELL students who speak JD. The formative data will be shared with the college stakeholders at the end of each term with formal recommendations made for booster PD sessions during the year and the annual PD seminar for the upcoming year.

Stakeholders

Stakeholders in this project that will be influenced by this project evaluation include the math instructors, the college administration, the faculty and the mathematics community in Jamaica as a whole. The teachers and management of the college will be able to use the information garnered to serve the ELL students better. The math instructors will benefit as a result of the evaluation as they will be able to contribute

formative input that may advance the program for the ELL students who should improve their performance in mathematics. Also, the PD seminars may lead the Ministry of education in Jamaica to mandate mathematics instructors at UCSE and other colleges to implement some of the recommended changes arising out of the project evaluation.

Project Implications

Findings from this research have the potential to influence positive social change in the Jamaican education system. One expected social change implication resulting from the career development seminars is an improvement in the instructors' knowledge of current theories and principles about math instruction and learning for ELLs or students who speak JD. The likely changes will occur over a period. The implementation of the strategies presented in this project study has the potential of improving both human and social conditions for both ELL students and instructors.

Local Community

Potential social change implications as a result of the project include improved opportunities for ELL students to develop conceptual understanding of mathematical principles as well as improvements in their capability to relate mathematical concepts to real life situations. Other benefits that will accrue for ELL students include the instructors' incorporation of JD language into the teaching of math. Also, instructors at UCSE as well as the administration of the college will become cognizant of the challenges of ELLs as they try to learn math; likewise it is envisioned that instructors will develop an understanding of the importance of language in the development of mathematical knowledge for students whose native language is JD. Ross (2014) noted PD

for instructors has the potential of reducing academic problems for ELL students in conventional mathematics classrooms by helping math instructors demonstrate procedural fluency while teaching their students. The content and strategies presented in the PD seminars should assist instructors to understand that communicating mathematically with ELLs involves the use of appropriate terminology that is understood clearly by the students. The potential for increasing students' understanding of how mathematical ideas can be represented and communicated is convincing as it will possibly lead to improved performance of freshmen education students on the MDT thereby resulting in the required development of math skills to graduate from USCE becoming productive members of the Jamaican and global economies.

Far Reaching

In a larger milieu, math instructors at UCSE will be empowered to develop a sound knowledge base on how to build their professional practice as it relates to teaching ELLs. Mathematics teachers will be provided with teaching strategies that enable them to challenge students' thinking, arouse their interest and involve them in the teaching and acquisition of knowledge in a meaningful way. According to Riccomini et al., (2015) to advance students' mathematical performance, instructors should recognize the importance and use of research-validated instructional techniques to communicate mathematical vocabulary. Math educators will be empowered to make a change positively to the learning attainment of all ELL students pursuing courses in mathematics; this will include attention to the needs of ELLs by making accommodation and modification to a given assignment at each step of the lesson. Another benefit to

instructors is that they will learn to address the differences in the varied abilities in their math classrooms. Findings may contribute to the development of a math curriculum that is culturally sensitive and consistent with high academic accomplishment for all students. In the future, and working in collaboration with the Ministry of Education this same sequence of PD seminars could be offered to other math instructors in Jamaica who have to teach students whose language is predominantly the JD. The outcomes of this research have the potential to assist in correcting issues related to inequality and inequity in the mathematics classrooms thereby contributing to positive social change.

Conclusion

The explanation of the project provided a scholarly rationale of why the PD genre to the project was chosen and how the response to the problem will be dealt with through the project arrangements. Furthermore, an erudite literature review relating the project to the analysis of data was provided. The implementation of the project, my role and responsibilities, the evaluation plans, justification, and goals of the project are a necessary part in structuring the PD seminars. Additionally, a description of stakeholders was provided, and social change was discussed. The implications of the project to both the local stakeholders and the larger community were communicated.

The project is of significance to the local college community as well as to the people and government of Jamaica who are all stakeholders and UCSE being owned by the government of Jamaica. Moreover, it is against this background that the benefits of this plan have the capacity to influence positive social change on both the micro and macro stages. Likewise, it is significant to the larger education sector as the capability of

ELL instructors to incorporate effective strategies for teaching ELLs in their daily mathematics lessons will contribute to an increase in students' attainment.

The quintessence of this study involved collecting and analyzing data, checking specific learning needs of ELL math students, analyzing the language use by instructors and constructing a series of PD seminars that will contribute to improvement and change, specifically as it relates to the PD of mathematics instructors of ELL students in Jamaica. The information provided in the literature review gives credence to the idea that math instructors can cater to the needs of ELL students in mathematics when they successfully manage diversity and encourage inclusiveness in the teaching and learning process. PD can facilitate change and build capacity to support both instructors and students. Section 4 of this project study discusses my thoughts on the development and execution of this project and an examination of my interest as a scholar, practitioner, and project designer.

Section 4: Reflections and Conclusions

Introduction

The purpose of this research study was to determine the effect the language of instruction has on student achievement in math as measured by the MDT. In this section, I examine the project study carefully and thoroughly in terms of its strengths and limitations. A description of alternative ways of addressing the problem is presented. Additionally, I offer an appraisal of the development of the project evaluation, followed by a discussion of scholarship and leadership change. Further, I present an assessment of myself as a scholar, practitioner, and project supervisor. Afterward, I discuss the likely effect and social change that may arise from this detailed investigation and analysis as well as the resulting project. The section concludes with a discussion of the project's implications and applications for future use. Proposals for future investigation are taken into account as the significance of the work is taken into consideration.

Project Strengths and Limitations

Strengths

The PD project was designed for the instructors of ELLs and members of the administrative staff at the local site. Analysis of the project shows that it has been designed to support meeting the instructional needs of instructors and learning needs of ELLs who speak JD. First, the recommended teaching strategies should be viewed by math instructors as not only a didactic set of rules for teaching ELLs, but also as tools to help them improve their pedagogy and students' learning of mathematical concepts. The project demonstrates techniques that instructors can use to align their teaching strategies

with established National Mathematics Standards and culturally relevant and linguistically related concepts to support the development of mathematical skills for ELLs. Much emphasis can be placed on performance-based assessment, as this technique provides instructors with more information than test items that require only answers alone. Instructors can therefore embrace and become more thoughtful regarding the learning requirements of linguistically different students.

Another strength of this PD project is having administrators participate in the PD series and allowing them to recognize that effective leadership from the administrative and board levels could have an influence on ELLs' attainment in mathematics as instructors see college leadership valuing the use of the strategies by attending the PD seminars and endorsing the application of the content and strategies while teaching Mathematics to ELLs who speak JD. It is necessary for administrators to make scholarly decisions in addressing the learning needs of diverse learners. Administrators should be familiar with the guiding principles for teaching standards as well as services that support the success of culturally different learners. Bond, Cason, and Baxley (2015) suggested that it is necessary to have a managerial structure that supports academic success. Administrators will provide support and recognition by participating in the PD seminars resulting in the continued support of PD for instructors teaching ELLs and resources for instructors to apply the changes needed to support the success ELL learning of Mathematics.

The PD series highlights the importance of teaching ELLs, using JD as it promotes the attainment of math concepts including the critical skill of problem solving,

which builds conceptual understanding of mathematical concepts, but also is an effective way of promoting equitable access to instruction. Krawec, Huang, Montague, Kressler, and de Alba (2013) noted that math problem solving is an important skill to acquire, given that there is a correlation between math achievement and students' problem-solving skills. Another strength of the PD seminars is that instructors will receive information how the language of instructors influences the learning math. According to Henry et al. (2014), focusing on the language of instruction is an effective strategy to improve ELLs' mathematics attainment and support their social mobility. The PD seminars will provide the vehicle for educators to examine the benefits and consequences for instructors and policymakers regarding the support of students who speak JD. The seminars will emphasize the prominence of English as a worldwide language but will encourage the use of JD to enhance students' understanding of mathematical concepts. Creating an opportunity for ELLs to be taught mathematics using JD until they develop adequate knowledge of the SE will enhance JD students' learning proficiency in math. Unlike most justified beliefs, mathematical facts are not derived from direct sensory monitoring but from cultural practices (DeCruz & DeSmedt, 2013). One of the goals of mathematics instructors should be to confirm the validity and cultural identity of ELLs; this strategy will encourage students to relate mathematical concepts to real-life situations as well as promoting the development of collaborative skills in the math classroom. Mathematics educators can assist ELLs to develop their full mathematical abilities by acknowledging the culture of the students and how culture influences the way ELLs learn and consequently how instructors teach.

Limitations

The PD seminar designed for the project has some limitations for addressing weaknesses in instructors' teaching strategies as they relate to the teaching of linguistically diverse students. Issues influencing the execution of the project are related to time requirements; many math instructors may have difficulty committing the necessary time to learn and execute the recommended strategies because most of them are involved in teaching math in the College Center for Extra Mural Studies in the evenings. Vygotsky's sociocultural theoretical framework guided the study; a premise of the theory is that social interaction using language is a requirement for cognitive development. The difficulty that some instructors may have involves learning to teach mathematics using a combination of the JD and SE. It may be difficult to find math educators who are adept at both languages thereby making it difficult to support enough faculties to implement the new approach to the teaching and learning of math in ELL classrooms at UCSE.

The attitude of the instructors could also negatively affect the implementation of the program. Many of the senior instructors at UCSE are resistant to change and may not readily accept the new approach to teaching ELLs. According to Hernández-Ramos, Martinez-Abad, Peñalvo, Garcia and Rodríguez-Conde (2014), "attitude is the predisposition to act in a particular way on the basis of incidence of cognitive, affective and behavioral components, in such a way that each element is predisposed to influence the other" (p. 510). The project is designed to build capacity of instructors to modify their teaching by using JD to satisfy the learning needs of ELLs; it is therefore important

for instructors to approach the PD with a positive attitude. Aalderen-Smeets and van der Molen (2015) suggested that a positive and willing attitude is a first and necessary step for teachers' professional growth.

Recommendations for Alternative Approaches

There are other ways of dealing with the problem of poor performance in math by ELL students. One approach could involve acquiring English proficiency as a prerequisite for entering mathematics courses. A benefit of this approach is that instructors would be aware of the students' language level and could start teaching them at this level without having to make any accommodation or modification for lack of competence in the use of the English language. The difficulties experienced by ELLs in achieving mathematics proficiency have highlighted the issue of the effect that the language of instruction has on the development of mathematics proficiency by JD students as measured by the MDT. If PD for instructors is not used to address the local problem, it may become necessary to carry out the continuous evaluation of instructors and, where shortcomings are identified, make recommendations for the development of best instructional practices for the instruction of JD students. Additionally, steps should be taken by the administration to assist math teachers in correcting poor teaching techniques by encouraging them to attend seminars where best practices for the teaching of math are demonstrated.

Another method that could be used as an alternative approach would involve an educational policy under which all instructors would be required to use the constructivist approach to the teaching and learning of math and where measurement of mathematics

attainment would be completed through performance-based assessment. One of the benefits of this approach to assessment is that it provides the instructor with more information than a test item that requires only one response from a student. An assessment taken before the student begins the class would provide a profile of the student skills thereby facilitating individualized instruction. Ertmer and Newby (2013) suggested that the constructivist standpoint accepts that transfer of knowledge can be enabled by participation in tasks fixed in meaningful settings.

Scholarship, Project Development, and Leadership Change

Scholarship

On the course to becoming a scholar practitioner, there are many skills to acquire and engagement in a range of professional responsibilities before one can start generating new knowledge that can contribute to the development of the education sector. Ho (2014) stated that being a scholar-practitioner is academically challenging as well as demanding. The extent to which this doctoral study qualifies as an example of scholarship derives from its capacity to contribute knowledge on how instructors can incorporate the JD into the teaching of math to ELLs. There are no existing scholarly works in this area of education. It was not until I started this research that I began to understand the complex task of finding more efficient ways of addressing the needs of learners at the college level. I learned much about scholarship while conducting the research. A major challenge that I had to overcome while pursuing this project study was finding credible sources, as there is a paucity of information on the influence of the JD on the teaching and learning

of mathematics. I also discovered that existing research becomes outdated quickly and that references had to be regularly updated for the investigation to remain current.

I have learned that being a scholar-practitioner is a way of life. It is not just about conducting research; one has to be motivated to search for truth. Daily reflection on one's practice is necessary as this approach will help in providing answers to the questions that students or colleagues may ask. Primarily, at the college level, scholarship includes involvement in research and speaking the language of academia and practice.

Project Development

After carefully appraising the results of the study, it became apparent that a PD project designed for the instructors of ELLs and members of the administrative staff at the local site would give plausibility to the results of the research and be instrumental in improving teaching techniques of ELL instructors at UCSE. A PD project should be performed with great care and completeness; there must be clarity of goals, learning outcomes, and target audience. Likewise, input from the research findings will be used in the design of the PD seminars. Additionally, during project planning, the work must be original and have a solid academic base. Furthermore, all materials provided for the participants must be spelled out succinctly so that any math educator can use the materials to structure a lesson for ELLs. The primary objectives of the PD seminars include the development of teaching and learning strategies that provide cognitive stimuli, actively involve participants in the learning process, prompt interactive dialogue, and aid educators in synthesizing the new information and skills that are presented. The presenters at the seminars should also provide clear guidelines for the use of materials

and strategies presented. Finally, an evaluation of the project will be done; all findings will be compared and cross-analyzed to come to a conclusion regarding the effectiveness of the project. Researching a particular topic and developing a project based on the findings can build on existing knowledge and open the academic community to new possibilities and opportunities for learning and development.

Leadership Change

Commitment to research means putting aside one's personal agenda, becoming a leader with a particular focus within a field, and ultimately convincing one's stakeholders that the finished product is worthwhile and can contribute to positive social change. Nohria and Khurana (2013) suggested that leadership is a collective undertaking and is a combined effort and agreement to give invaluable time and intellectual effort to the accomplishment of a task. Working with my committee to satisfy the requirements of the doctoral process was a rewarding experience; it taught me patience and tolerance. There were occasions when I experienced emotional exhaustion, but my chair offered helpful criticism that allowed me to regain focus and grow as a scholar-practitioner. This activity has left a lasting impression on my mind; I have learned the meaning of perseverance and how to evaluate constructively. Going through the doctoral process has also allowed me to grow as a leader and to become a reflective educator; more importantly, though, I have grown to understand that being involved in research is a critical dimension of being a teaching professional. I am now well prepared to take a leadership role in helping other math educators to conduct research as they also try to find answers to questions that may be effecting their practice.

Reflection on the Importance of the Work

The findings emanating from this research have implications for the teaching and learning of mathematics for ELLs at all levels of the education system in Jamaica. Math educators should be aware of the finding that if instruction is carried out in students' language, it will contribute to their conceptual understanding of mathematical concepts, and ultimately to improvement in students' attainment; no longer should the language of instruction be only SE. The JD should be viewed as a teaching and learning resource. The significance of this work is that it has the potential to change the teaching practices of mathematics in Higher Education in the country. In light of ELLs' poor performance on standardized mathematics assessments nationally, the Ministry of Education in Jamaica should consider adopting policies that modify how ELLs are taught math. Many students enrolled in mathematics classes in college are struggling to learn the mathematical concepts and principles that are taught due to the language differences between instructors and students. Many students fail to complete their course of study because they are unable to complete a math course; this affects their access to upward social mobility because attending and completing college is the only way out of poverty for many students. Henry et al. (2014) stated that more than half of all jobs forecasted through 2018 would require some college training; this claim draws attention to the significance of improving ELLs' mathematics attainment.

The research and project concentrated on working within the local site to provide the skills necessary for instructors and administrators to create a learning environment where an attempt is made to attain equal outcomes for all math students. The difficulties

experienced by ELLs in achieving mathematics proficiency and the solutions coming out of this study to correct the problems have underscored the importance of this research.

Implications, Applications, and Directions for Future Research

The implicit conclusions drawn from this project study are linked to improved pedagogy for instructors and improvement in math attainment for ELLs. The gap between ELLs and non-ELLs in math achievement has remained, and quick action should be taken by the Jamaican government to correct the problem. The goal of the PD is to ensure that instructors use best practices designed to improve the teaching of math to linguistically diverse students. The recommendations are revolutionary, and as such there might be the need to offer continuous training for faculty until they are comfortable with the suggested changes; there might also be the need to make adjustments to the teaching and assessment strategies so as to guarantee the effectiveness of the program. If necessary, demonstration lessons will be done on a regular basis. Moreover, determining which of the strategies instructors find challenging to implement will be of benefit to both faculty and administrators, who can use these data to develop goals and strategies as they plan to improve the instruction and erudition of mathematics.

The PD project is structured to satisfy the training requirements of older members of staff, new teachers, and math instructors in all colleges who may be having similar challenges. It is likely that the PD program can be used as a model for implementing PD for math instructors nationally. All instructors of ELLs must understand that the individualization of the math concepts taught may become necessary and that therefore, instructional best practices designed to improve attainment for all learners must be

implemented. Teaching math through problem solving, using performance-based assessment, using the language of the students as the mode of instruction, making accommodations and modifications, offering differentiated instruction, and presenting tiered lessons are teaching strategies that are effective for teaching ethnically and diverse lingual students. The importance of the career development series to all stakeholders will be demonstrated through improvements in ELLs' achievement in math and instructors providing for learners with the requirement for special education. This plan has shown how the examination of a local problem can lead to potential solutions to satisfy the needs of students nationally. Statistics enclosed in the research support the identification of a local problem, provide data to support it, and identify a PD series of seminars that guides instructors to think about and begin to deal with the problem.

Future research on the influence of language on the instruction and erudition of mathematics is needed, especially in the local context where the JD is the main language of communication and it is mandated that instruction be done in SE. The study was significant through its examination of factors that effect the teaching of math to ELLs; however, future research will be necessary as there is a paucity of information on this important matter. Modifying instructional practices for ELLs and restructuring how math teachers are trained are medium term policy decisions that the Ministry of Education in Jamaica can make as they try to improve ELLs' mathematics achievements. Knowledge resulting from this project study can be used to close the disparity in performance between ELL and non-ELLs in math; in fact, the instructional strategies illustrated in the project study can also be useful at K-12 levels of the education system. Webb and

Thomas (2015) noted that low attainment in math for linguistically and culturally diverse student might be an indicator of the poor teaching techniques of the teachers and more importantly, the talent and skill of each instructor. Poor instructional techniques further highlight the need for the application of the findings of this study to solve a problem that is a cause for concern in our society. This study will help in guiding educational planners as they try to develop strategies that will enrich the professional experience of faculty and improves academic attainment in mathematics for ELLs.

Conclusion

The mission to complete this project study was arduous, but I was intensely motivated to determine the influence of language on the instruction and learning of mathematics and what steps are necessary for improving attainment in math for students whose principal language is the JD. The findings of this study may influence a paradigm shift in the instructional strategies of mathematics instructors at the local site. After analyzing the data, I am convinced that all colleges in Jamaica could benefit from some of the recommended teaching techniques that were used at the location for this study. In summary, it appears that the language of instruction influences attainment in math for linguistically and culturally diverse students. To this end, the method of communication used in the math classroom could be the difference between success and failure for many students.

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Appendix A: Project—ELL PD Series

ELL PD Series

Purpose: The purpose of the PD series is to improve instructors' understanding and use of instructional strategies for ELLs.

Goals: The general goal of this project is to determine the effectiveness of the recommended teaching strategies for teaching ELLs and where necessary make adjustments to the teaching techniques that may contribute to instructors efficacy. Another objective of the PD series is to be able to make a recommendation to the various stakeholders on how to develop National Standards for the teaching of mathematics to English Language Learners in Jamaica. The final goal for the after school PD program is to see whether the program will lead to a change in instructors' teaching strategies of math and an improved sense of self-efficacy in teaching to ELLs at the local site. The plan for the future is to create a quality education system at the local site which guarantees excellence in teaching by all instructors and to achieve effective integration of educational and cultural resources that will optimize learning in math for all ELLs.

Learning Outcomes: Upon completion of this series of PD seminars the mathematics instructors should: (a) know effective strategies for teaching and assessing mathematics lessons for ELL students; (b) be able to provide math, reading and linguistic support for English Language Learners; (c) be able to teach mathematics using a combination of the JD and SE and (d) be able to use the knowledge acquired from the seminars to prepare math lessons that emphasize problem-solving, computational fluency and conceptual understanding.

Target Audience The PD project is designed for the instructors of ELL students and members of the administrative staff of UCSE.

Overview: The suggested timeline for the execution of this project is 3, seven-hour sessions. On the first day of the seminar a discussion will be held on the influence of language on the teaching and learning of mathematics to ELLs. Also, on day one there will be a discussion and demonstration on how to teach mathematics equitably to English Language learners. Day two will be spent focusing on effective strategies for teaching mathematics for computational fluency, problem-solving and conceptual understanding; a series of demonstration lessons will be done. On the final day the sessions will be based on building assessment into instruction for ELLs.

Strategies Used in this Series:

The following formats will be used:

• Demonstration (presenter models activities for participants), video exploration (participants analyze a video of an instructor demonstrating the activity), and case analysis (the presenter gives the participants a case to read in which an instructor is not effectively managing the diversity in her class to promote inclusiveness in the teaching process; the aim will be to assist the participants to cultivate a stance of expertise in addressing the issues being highlighted. The emphasis will be on the participants learning through their joint, supportive work.

• The strategy of making accommodation and modification are two ways of supporting students who are English learners and who are culturally diverse. Siegel, Menon, Sinha,

Promyod, Wissehr and Halverson (2014) stated that modifications are helpful in assisting ELLs to understand, envisage and consolidate thinking, and prompt responses.

• The strategy of differentiating instruction offers different paths to understanding content, process, and products, bearing in mind what are appropriate given a student's profile of strengths, interests, and styles (Dixon, Yssel, McConnell & Hardin, 2014).

• Incorporating the students' language into the math lessons being taught. Goldenberg (2013) suggested that the language of English Language Learners plays a significant role in promoting their academic achievement. Alt, Arizmendi, and Beal (2014) suggested that there is substantial data that indicate that students who are not capable in the language of instruction are inclined to have lower academic achievement than students whose primary language is the one used by the instructors.

Faculty PD Training Program

Table of Contents

Day One

i) The influence of language on the teaching and learning of mathematics

ii) Teaching mathematics equitably to English Language learners

Day Two

Strategies for Teaching Mathematics for Computational Fluency, Problem-Solving and Conceptual Understanding.

Day 1: The influence of Language on the Teaching and Learning of Mathematics to ELLs.

i) Registration,

ii) Prayer

ii) Welcome from Head of Mathematics and Computer Science Department.

iii) Moderators remarks

Day 1		
	The Influence of language on the Teaching and Learning of Math to ELLs.	**Duration**
Objectives	i. Faculty will learn about how language impacts the teaching and learning of mathematics. ii. The difference in performance of ELL and non-ELL students in solving mathematical word problem. iii The mathematics register.	**3 hours**
Resources and Materials:	Handout on strategies for teaching English Language learners. Mathematics register. Provide participants with samples of terms that are specific to the field of mathematics and refer to mathematical concepts, including expressions and syntactical structures used frequently in the context of	

	mathematics.	
15 minutes break		
	Decisions about the choice of language of instruction.	**Duration** **90 minutes**
Objectives	i. Faculty will learn how to differentiate between academic language and content knowledge in the mathematics classroom ii. Faculty will learn that math uses carefully defined terms and concise symbolic representations expressions that may be a part of everyday language but may have the same or different meanings in a mathematical context.	
Resources and Materials:	Hand out showing mathematical symbols, their meaning and how they enable us to perform mathematical operations.	
	60 minutes lunch break	**Duration**
	Teaching mathematics equitably to English Language learners	**150 minutes**
Objectives	i. Participants will learn instructional strategies for diverse learners. ii. Participants will learn about the individualization of content for English language Learners	

	iii. Math faculty will learn how to incorporate the JD into their lessons so as to promote access for learners.	
Resources and Materials:	Handouts with strategies for teaching mathematics to English Language learners.	

Day 2: Strategies for Teaching Mathematics for Computational fluency, Problem-Solving and Conceptual Understanding.

i) Registration,

ii) Prayer

iii) Moderator's remarks

iv) Review of previous day's work.

	Strategies for teaching Mathematics for Computational fluency, Problem-Solving and Conceptual Understanding.	**Duration**

Objectives	i. Participants will learn how to teach ELLs through problem-solving. ii. Faculty will learn how to use differentiated instruction to support the needs of English language learners. iii. Faculty will learn how to make accommodation and modification to support the learning of ELLs. iv. Faculty will learn how to use tiered lesson to support English Language Learners in a math class.	**3 hours**
Resources and material.	Power point presentation on problem solving. Handouts on planning for all students.	
15 minutes break		
	Planning for all learners	**Duration**
	Faculty will be exploring the general planning steps and additional considerations for planning math lessons for ELLs.	**90 minutes**
Resources	Table displaying the planning steps and other considerations for English Language learners.	
60 minutes lunch break		
	Programmatic Breakout	**Duration**
Objectives	i. Faculty will learn how to make accommodation and modification to support the	**120 minutes**

	learning of ELLs. ii. Faculty will learn how to use tiered lesson to support English Language Learners in a math class. iii. Participants will work in groups to plan and demonstrate a math lesson showing how to incorporate accommodation and modification in their class.	
Resources and Materials:	Program specific course materials, equipment and resources. Training evaluation.	

Day 3: Building assessment into instruction for English Language Learners.

ii) Devotion

ii) Chairman's opening remarks

iii) Prior Training Review and Continental Breakfast

iv) Introduction of Presenters.

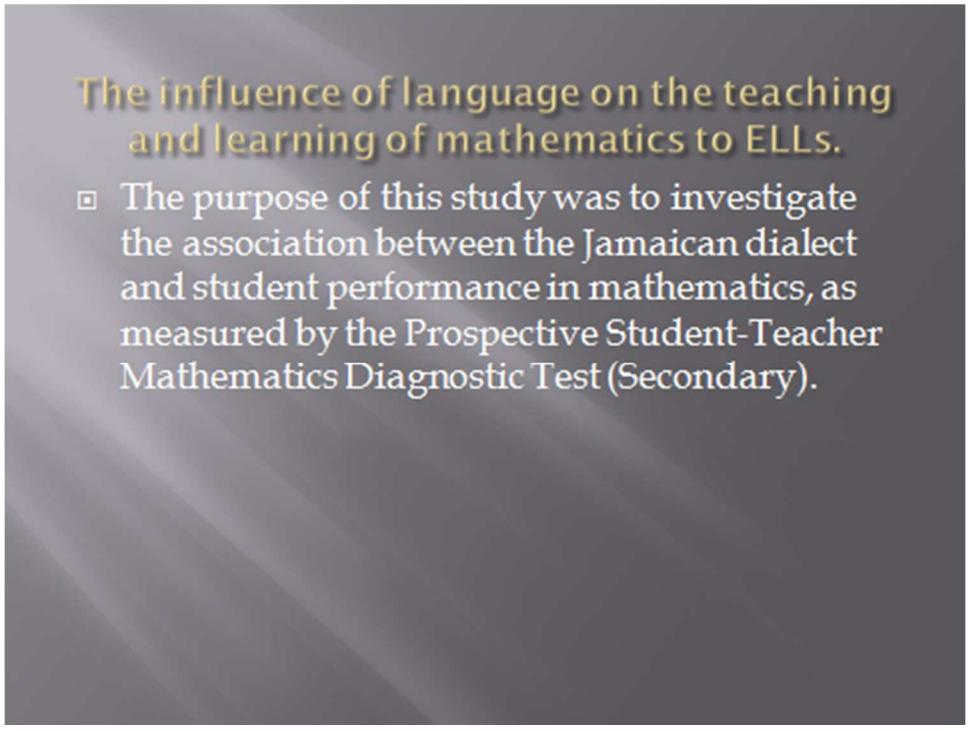
	Building Assessment into Instruction for English Language Learners.	Duration

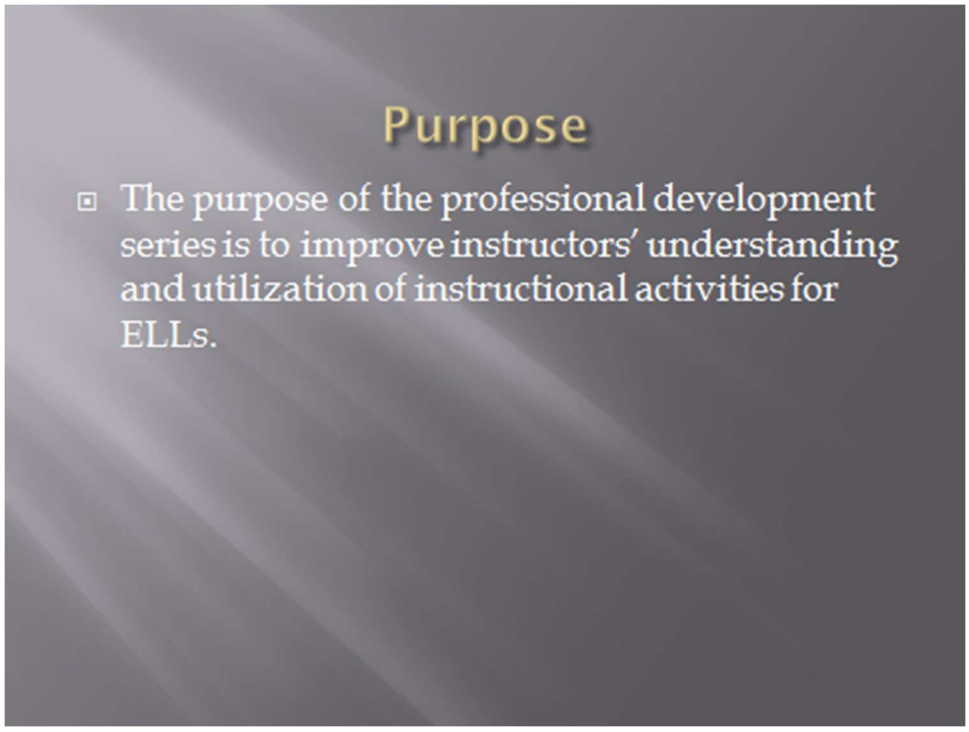
Objectives	**i.** Faculty will learn how to enable students to demonstrate skill, knowledge and attitude relevant to specific areas. **ii.** Instructors will learn how to match mathematics assessments with English proficiency levels.	**2 hours**
Resources and Materials:	Syllabus, Goal Sheet, Handouts with examples of performance- based tasks. Training evaluation.	
15 minutes break		
	Performance based Assessment for ELLs	Duration
Objectives	I. Instructors should be able to build assessment that reflects: concepts and procedures, mathematical process, problem-solving and productive disposition. ii. Participants should be able to construct performance – based assessment for students who are learning English. iii) Instructors should be able to use a range of assessment information to support student learning.	**90 minutes**
Resources and Materials:	Evaluation Template	

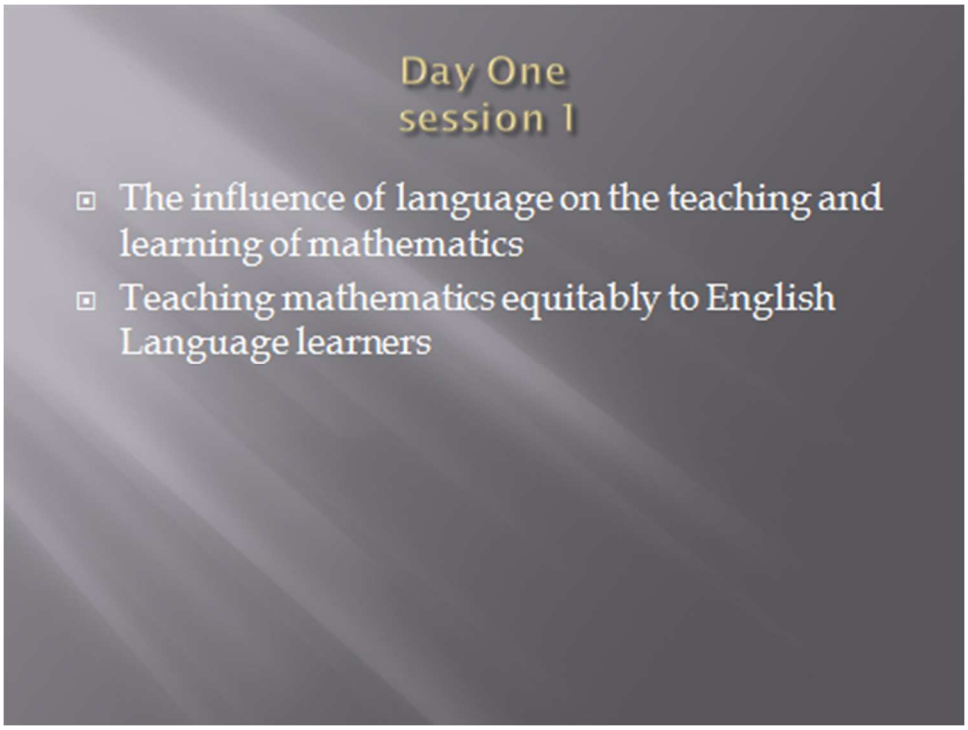
1 hour lunch break		
	Rubric and Performance Indicators.	**Duration**
Objectives	i. Instructors will be able to develop rubric for a mathematical task. ii. Instructors will be able to develop a rubric and its performance indicators.	**90 minutes**
Resources and Materials:	Syllabus, Goal Sheet	
15 minutes break		
	Setting Goals	**Duration**
Objectives	i. Faculty will discuss how they can use the recommended strategies and techniques to meet the learning needs of ELL students. ii. Administrators and Instructors will discuss their roles in eradicating inequity; creating curricula and structures that are equity-centered and personalized to meet the needs of ELL students in Jamaica. iii) De- briefing/ Questions and Answers/ Closing remarks.	**90 minutes**
Resource and material	Training Evaluation	

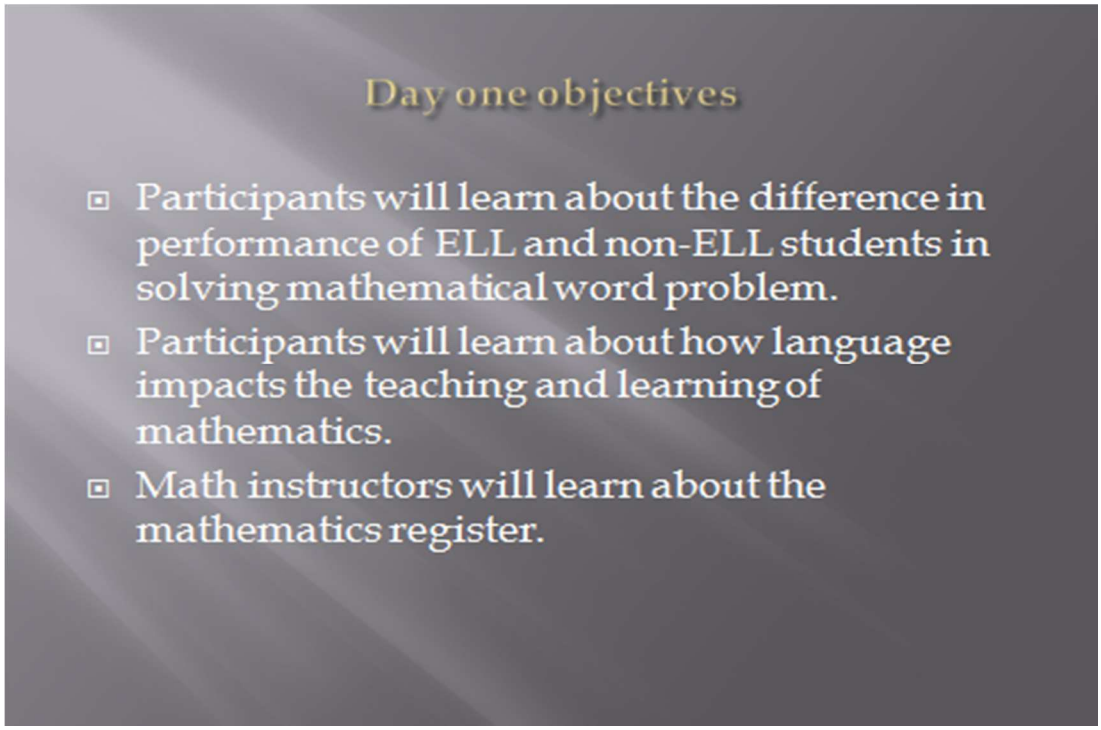
The expectation is that the PD seminars while achieving the goals set out will make the cooperative job of highlighting the learning challenges of ELLs and providing ideas for the administrators of the college that will make the education of the math students at UCSE less daunting and more meaningful for all concerned.

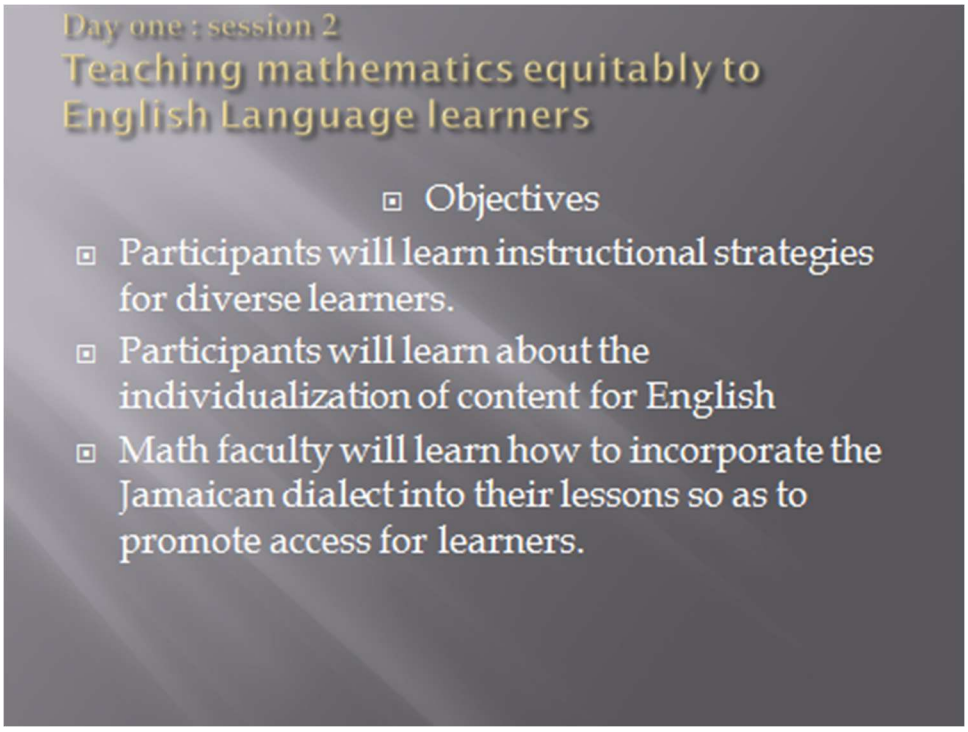
PD PowerPoint Slides

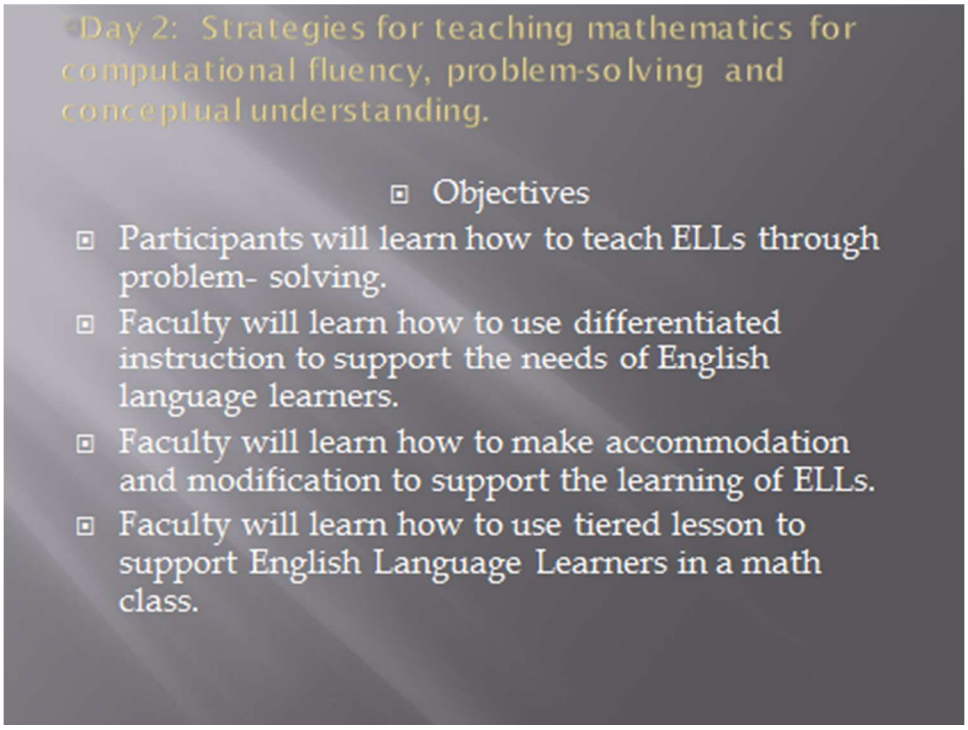


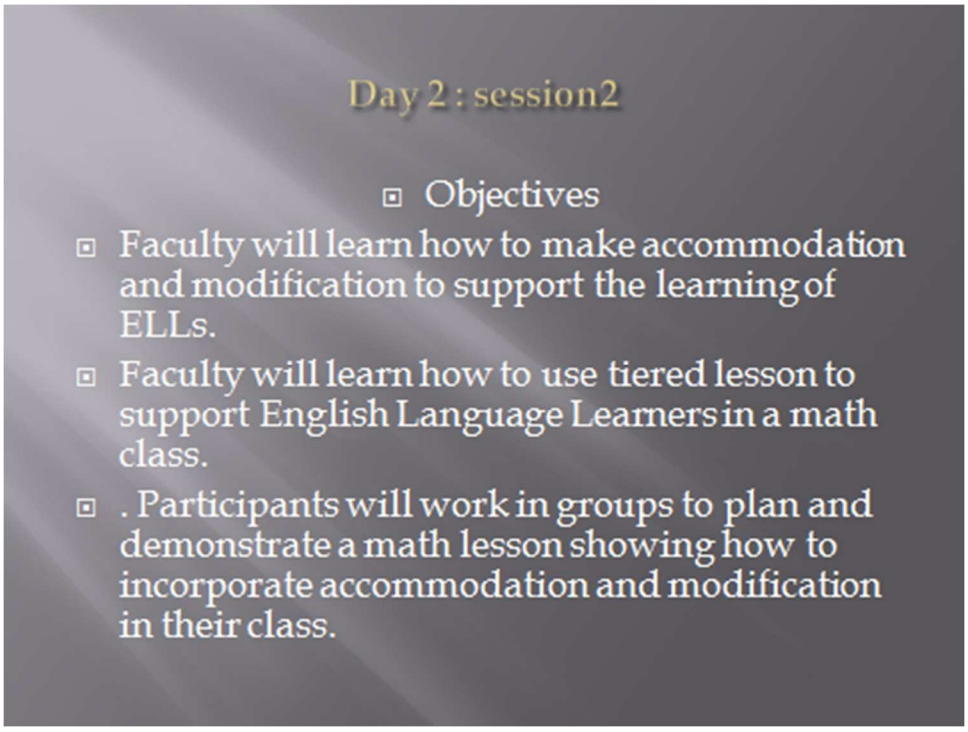

Purpose
The purpose of the professional development series is to improve instructors' understanding and utilization of instructional activities for ELLs.

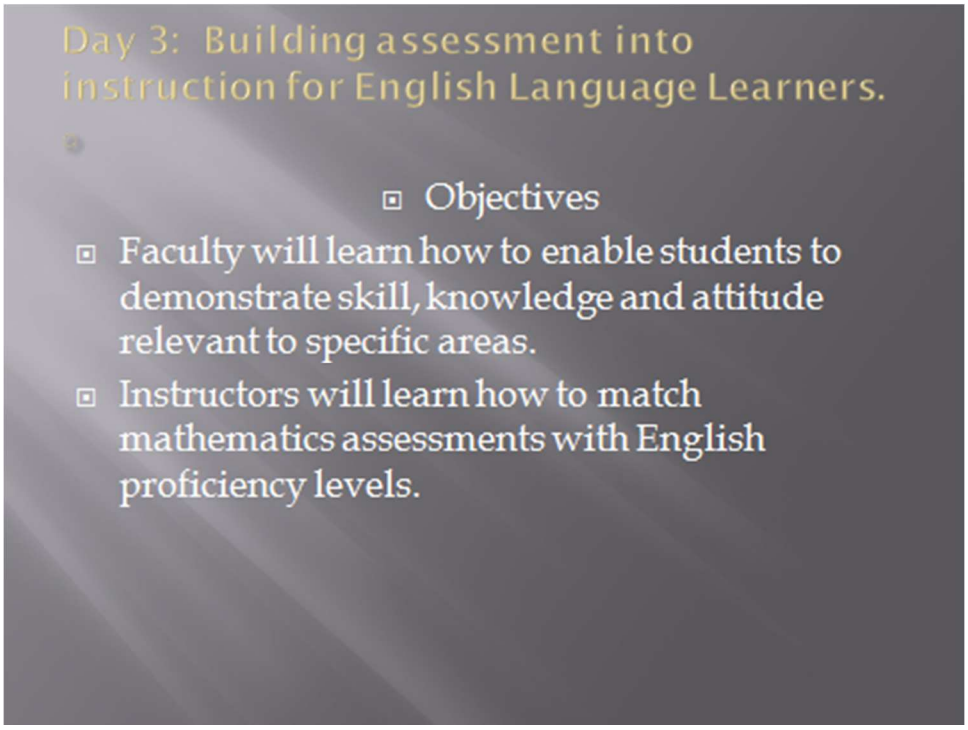

Day One
session 1
The influence of language on the teaching and learning of mathematics
Teaching mathematics equitably to English Language learners

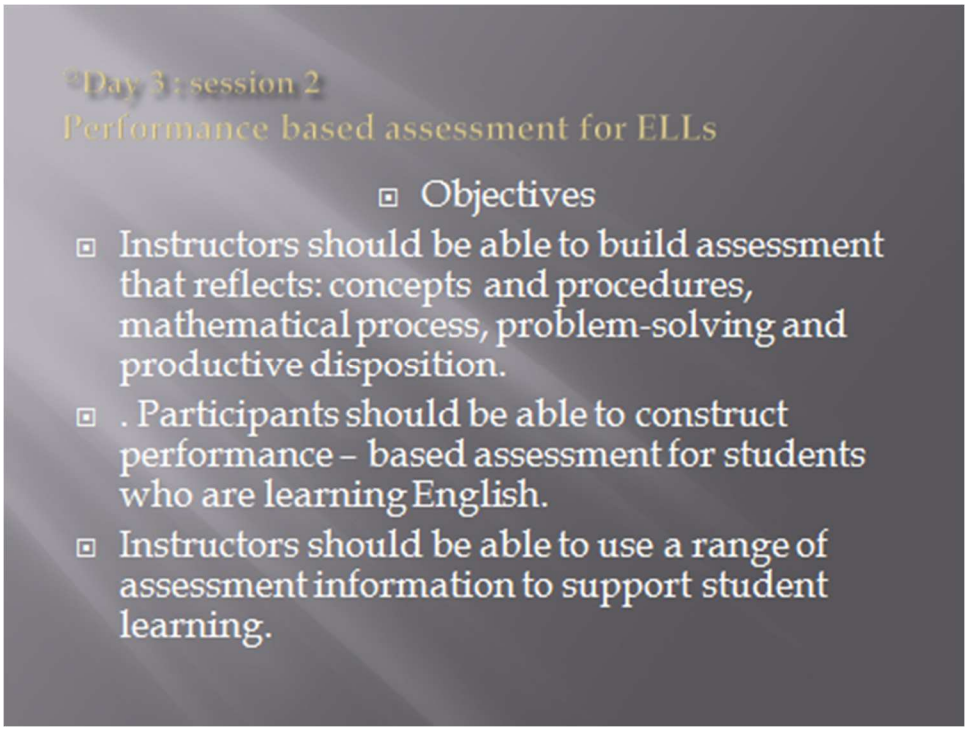

Day one objectives
Participants will learn about the difference in performance of ELL and non-ELL students in solving mathematical word problem.
Participants will learn about how language impacts the teaching and learning of mathematics.
Math instructors will learn about the mathematics register.

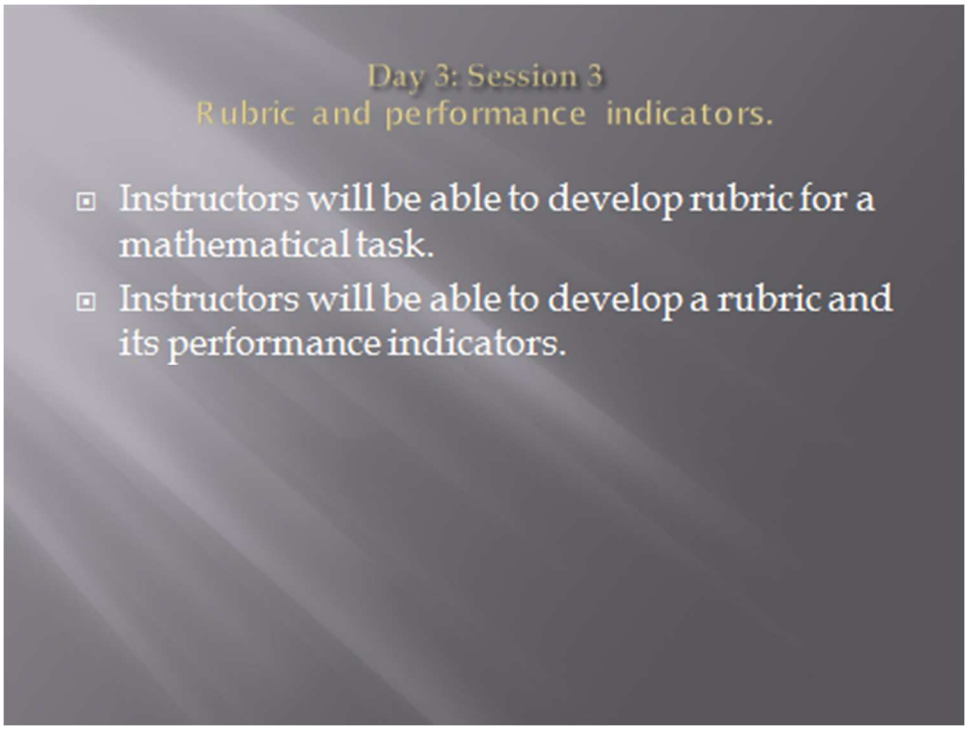

Day one : session 2
Teaching mathematics equitably to English Language learners
Objectives
Participants will learn instructional strategies for diverse learners.
Participants will learn about the individualization of content for English
Math faculty will learn how to incorporate the Jamaican dialect into their lessons so as to promote access for learners.

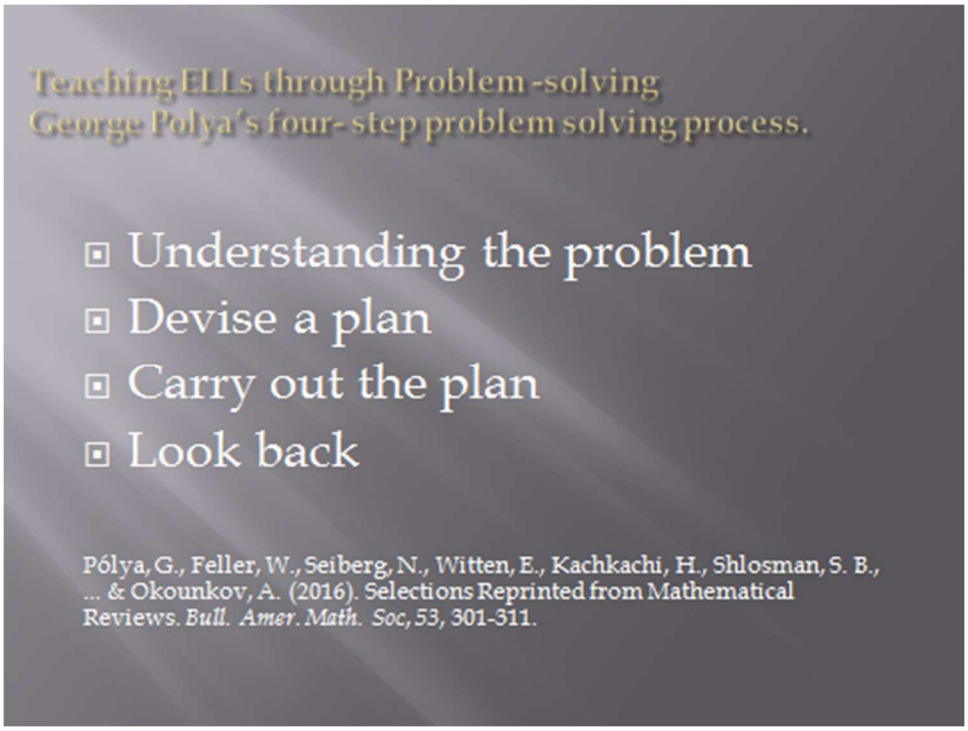

Day 2: Strategies for teaching mathematics for computational fluency, problem-solving and conceptual understanding.
Objectives
Participants will learn how to teach ELLs through problem- solving.
Faculty will learn how to use differentiated instruction to support the needs of English language learners.
Faculty will learn how to make accommodation and modification to support the learning of ELLs.
Faculty will learn how to use tiered lesson to support English Language Learners in a math class.

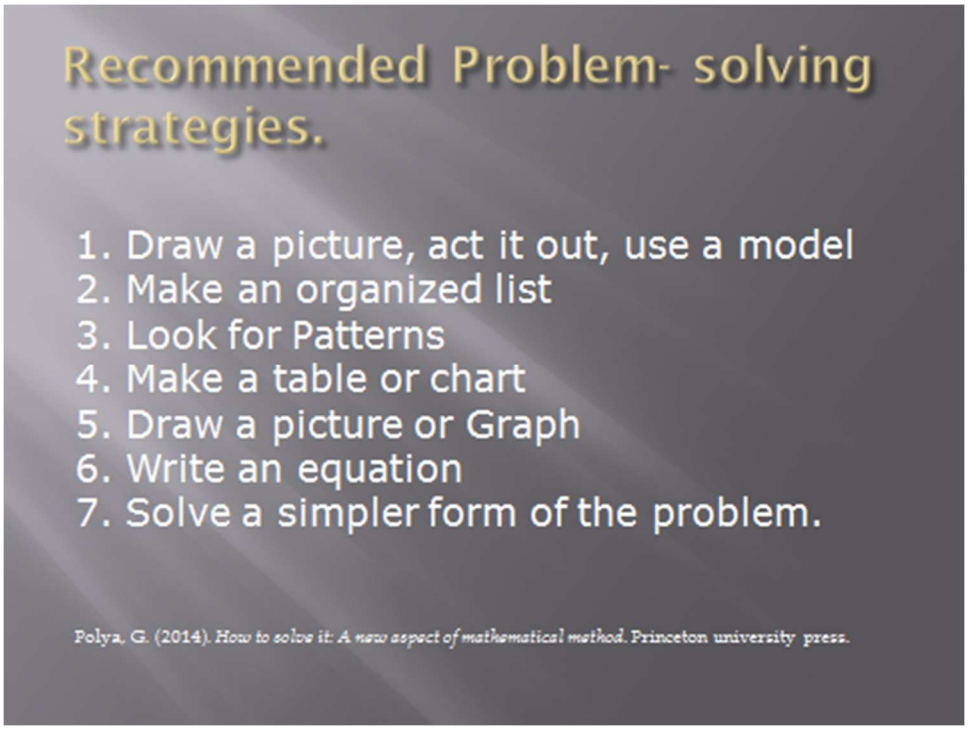

Day 2 : session2
Objectives
Faculty will learn how to make accommodation and modification to support the learning of ELLs.
Faculty will learn how to use tiered lesson to support English Language Learners in a math class.
. Participants will work in groups to plan and demonstrate a math lesson showing how to incorporate accommodation and modification in their class.


Day 3: Building assessment into instruction for English Language Learners.
Objectives
Faculty will learn how to enable students to demonstrate skill, knowledge and attitude relevant to specific areas.
Instructors will learn how to match mathematics assessments with English proficiency levels.

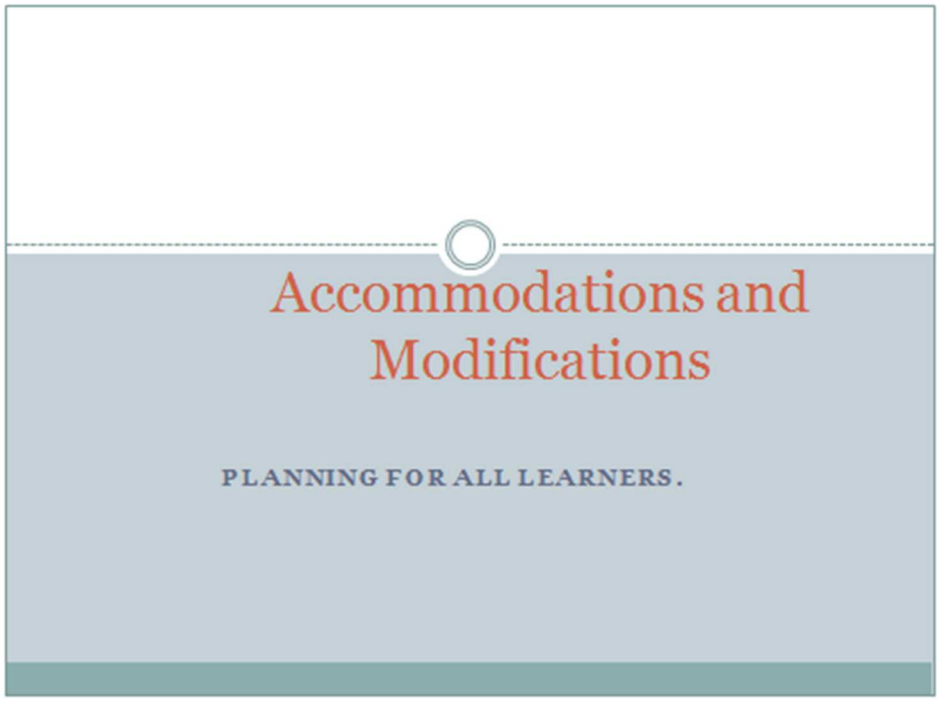

Day 3 : session 2
Performance based assessment for ELLs
Objectives
Instructors should be able to build assessment that reflects: concepts and procedures, mathematical process, problem-solving and productive disposition.
. Participants should be able to construct performance – based assessment for students who are learning English.
Instructors should be able to use a range of assessment information to support student learning.

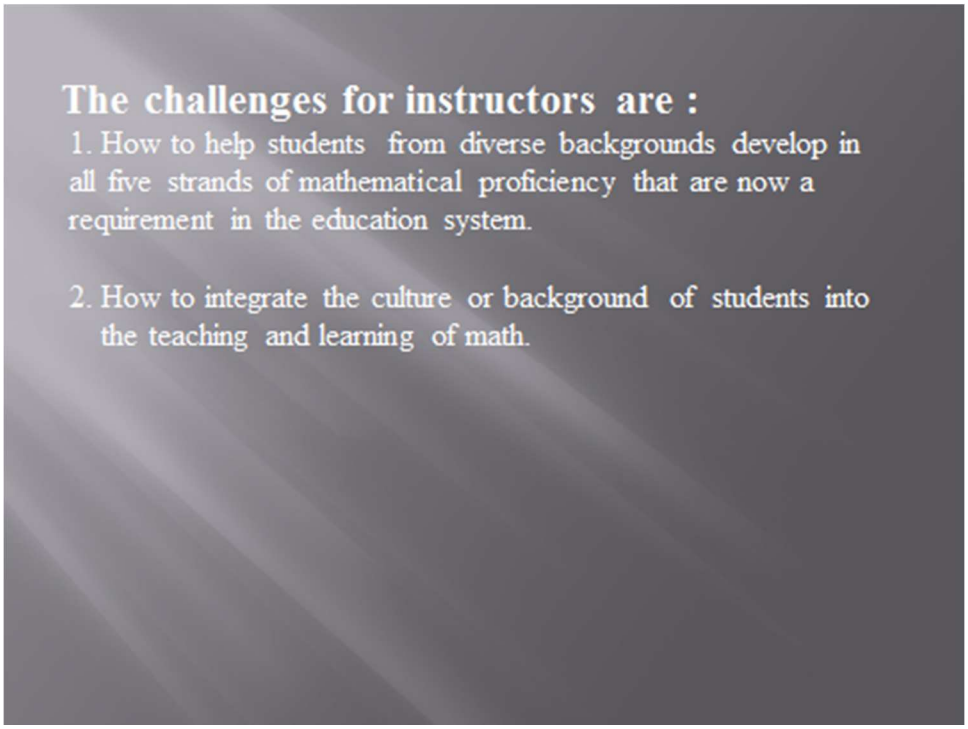

Day 3: Session 3
Rubric and performance indicators.
Instructors will be able to develop rubric for a mathematical task.
Instructors will be able to develop a rubric and its performance indicators.


Teaching ELLs through Problem -solving
George Polya's four- step problem solving process.
Understanding the problem
Devise a plan
Carry out the plan
Look back
Pólya, G., Feller, W., Seiberg, N., Witten, E., Kachkachi, H., Shlosman, S. B., ... & Okounkov, A. (2016). Selections Reprinted from Mathematical Reviews. Bull. Amer. Math. Soc, 53, 301-311.


Recommended Problem- solving strategies.
1. Draw a picture, act it out, use a model
2. Make an organized list
3. Look for Patterns
4. Make a table or chart
5. Draw a picture or Graph
6. Write an equation
7. Solve a simpler form of the problem.
Polya, G. (2014). How to solve it: A new aspect of mathematical method. Princeton university press.


Goals for problem-solving
Lead pupils to generalisation
Introduce or integrate other branches of mathematics
Provide opportunities for divergent thinking and making value judgements


Accommodations and Modifications
PLANNING FOR ALL LEARNERS.


The challenges for instructors are :
1. How to help students from diverse backgrounds develop in all five strands of mathematical proficiency that are now a requirement in the education system.
2. How to integrate the culture or background of students into the teaching and learning of math.

The recommended strategy that can be used to address the needs of ELLs are accommodation and modification.

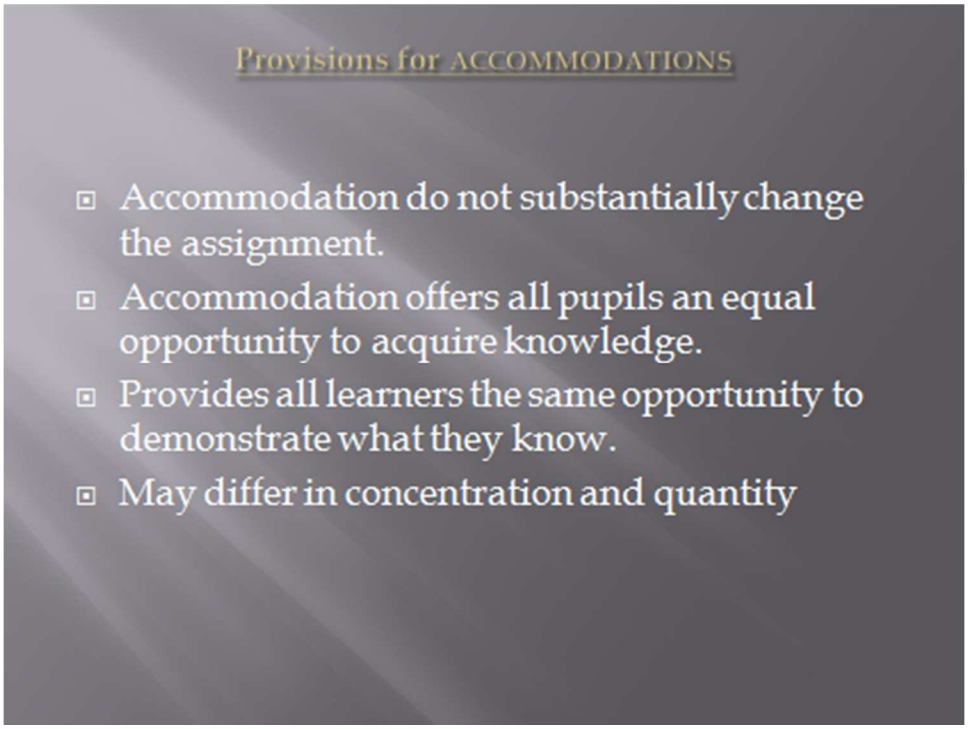
Mathematics teachers should be able to identify what accommodations and modifications are necessary whenever they are instructing student from different cultural backgrounds.

The math instructors should have the competence to determine when accommodations or modifications are necessary in the teaching and learning process. **The accommodations and modifications should be incorporated into the instructional outcomes for each ELL student.**

- **The methodology of instruction and content to be learned will be left to the class teacher with the expectations that the accommodations and modifications will be incorporated into the instructional outcomes for each student.**

Good teachers know how to structure their lessons to cater for the needs of most all students. Some teacher will have difficulty with how they must accommodate and modify instruction.


Accommodations
An accommodation is a provision of a different setting or context made with a particular student in mind (Van de Walle Karp, & Bay –Williams 2010).care is taken so that all pupils have an equal opportunity to learn and to show what they have learned.


Provisions for ACCOMMODATIONS
Accommodation do not substantially change the assignment.
Accommodation offers all pupils an equal opportunity to acquire knowledge.
Provides all learners the same opportunity to demonstrate what they know.
May differ in concentration and quantity

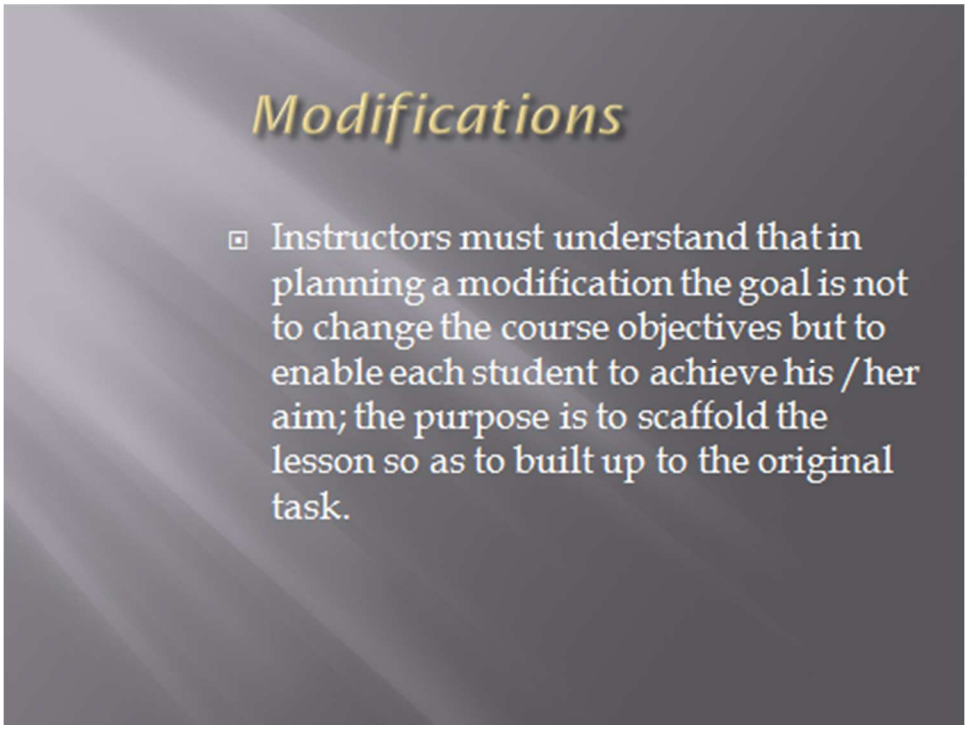
Accommodations do not:

- make adjustment to the content that is to taught.
- Change the quantity of information that is to be learned.

MODIFICATIONS

A modification refers to a alteration in the problem or job (Van de Walle Karp, & Bay – Williams 2010).

- Modification may result in a change in the instructional level or standard.
- Modification can influence a change in the number of key concepts to be learned or even the content of the course.


Modifications
Instructors must understand that in planning a modification the goal is not to change the course objectives but to enable each student to achieve his /her aim; the purpose is to scaffold the lesson so as to built up to the original task.

Instructors who are making modification to a given task must be able to adequately address the following questions:

- What are the main grade level expectations ?
- Can ELL students satisfy the age appropriate standard in the same way as non-ELL students?

Strategies for Accommodations. Stratagems to achieve equity.

i. verbal tests
ii. coursework read orally or taped
iii. assignment shortened yet replicates all of the required components of the given task
iv. access to a computer for written assignments tests.

Introduction to Performance –Based Assessment

What is an Assessment Task?

Performance assessment refer to tasks that are connected to problem-solving activities used in instruction (Van de Walle, Karp & Bay- Williams, 2010).

PERFORMANCE TASK

- Performance–Based tasks are related to real-life situations; the approach that an ELL student use to solve a problem will inform the instructor about his or her conceptual understanding of a mathematical problem.

Performance –Based Assessment

- One of the benefits of performance- based assessment is that it provides the instructor with more information than a test item that requires only answer alone. The teacher can now embrace and are more sensitive to the learning needs of the students.

PERFORMANCE TASK

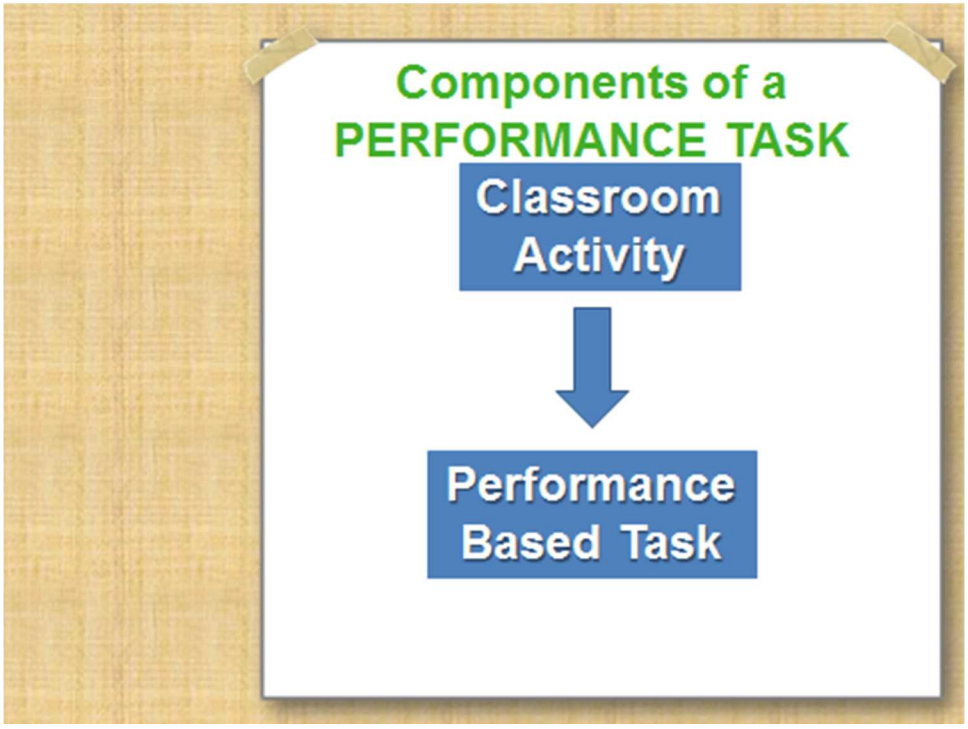
Performance- Based assessment support teaching and learning, allowing all students to be engaged in adaptive reasoning, explaining and justifying their responses and reflecting on their solutions.

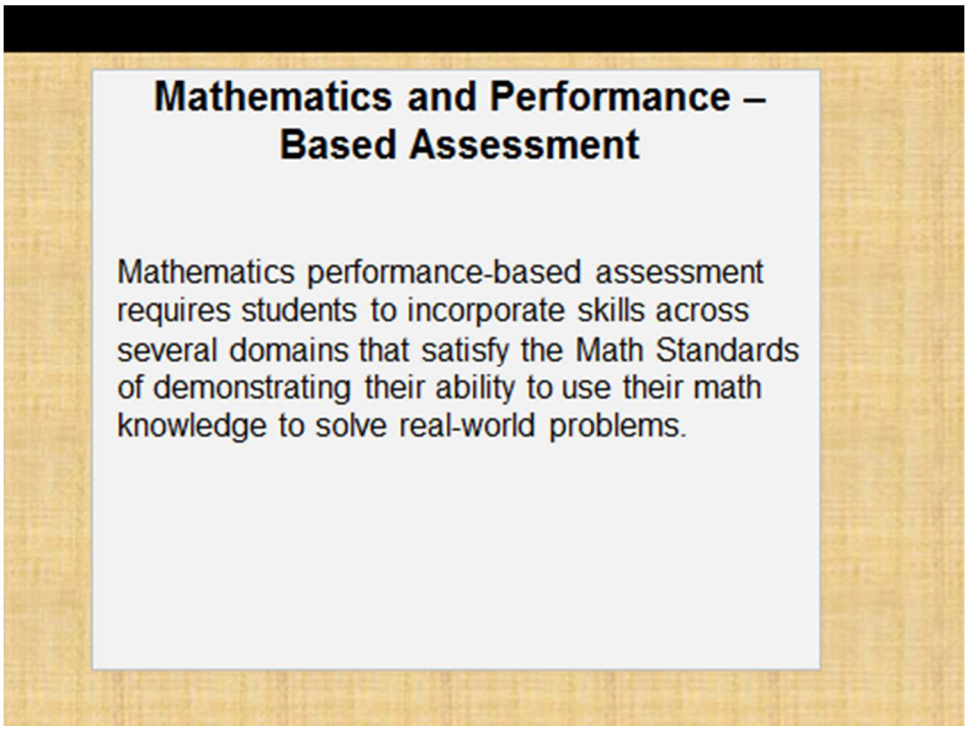
PERFORMANCE TASK

- Ascertain how well a learner can assimilate knowledge and skills across multiple claims and goals.
  - *Assertion:* Broad evidence-based statements about what students know and can do as demonstrated by their performance on the assessment.
  - *Goal:* Connects the Standards to evidence that will be collected from the task.

PERFORMANCE TASK

Assessment tasks motivate students to share ideas, write and listen to justifications. The ability to integrate knowledge and skills across multiple domain is an important part of being college student.


Components of a
PERFORMANCE TASK
Classroom Activity
Performance Based Task


Mathematics and Performance – Based Assessment
Mathematics performance-based assessment requires students to incorporate skills across several domains that satisfy the Math Standards of demonstrating their ability to use their math knowledge to solve real-world problems.

Rubric development and performance indicators.

- Definition
  - A framework that can be designed or adapted by the teacher for a particular group of students or a particular mathematical task (Van de Walle, Karp & Bay-Williams 2010)
  - A set of clear explanations or criteria used to help teachers and students focus on what is valued in a subject, topic, or activity (Russell, & Airasian, 2012).
  - "Most important, it is a statement of our mutual commitment to be guided by the highest and most carefully considered values in our professional practice. It is what we promise to teach" (Griffin, 2009,p. 13).

Components of a rubric

- A rubric is made up of a scale from 3 to 6 points that is used as an evaluation of performance on a particular task rather than a count of how many items in a series of problems are correct or incorrect. The rating or mark is applied by examining overall performance.
- Types of rubrics: The following four point rubric was developed by the New Standards Project
- 4 Excellent: Full mastery
- 3 Proficient: Substantial Accomplishment
- 2 Marginal : Partial accomplishment
- 1 Unsatisfactory: little accomplishment

Characteristics of Good Rubrics (1)

- Well defined
  - Clearly describe the expected level of student performance for each criterion in a rubric
  - Avoid general evaluative words (poor, excellent, etc.)
  - Use specific objective terms (correctly identifies, uses only basic vocabulary, chooses incorrect formula…)
- Context specific
  - Describe what teachers expect from student for a given performance or work product on a particular subject domain
  - Viable for instruction

Performance indicators

Performance indicators are task driven statements that describes what performance looks like at each level of the rubric thereby establishing criteria for acceptable performance.

Performance indicators

- A rubric and its indicators should focus the instructor on the objectives and away from the question which can be restrictive.

When should Rubrics be used?

- On problem-based tasks:
  - extended response items
  - projects
  - presentations
  - portfolios

Creating a Rubrics

- Focus on the task & content
  - Learning outcomes of the unit and the particular assessment
  - What we want from the students, why we created this assessment, what our expectations are
- List the learning outcomes & expectations
  - Focus on the particular details of the task and what specific learning objectives we expect to see in the completed task
- Grouping & labeling the outcomes & criteria
  - Organize the results of reflections, group similar expectations together to become the rubric Indicators
- Application of a rubric format
  - Apply the templates & descriptions to the final form of the rubrics

Rubrics PPT by the Oregon Department of Education and Berkeley Evaluation and Assessment Research Center

Benefits of a Rubric

For teachers:

- Prompt a criterion-referenced assessment
- Provide students with detailed and timely feedback
- Encourage critical thinking
- Facilitate communication with others involved in scoring
- Help to refine teaching skills/learning activities

For students:

- Clarify the teacher's expectations of student performance
- Provide informative descriptions of expected performance
- Help to monitor and critique own work

Discussion questions about Instructors' Attitude towards English Language Learners

Questions	Responses
Does the inclusion of ELLs in math classes create a positive educational atmosphere?	
Does the inclusion of ELLs in your math lessons benefit all students?	
Do you believe that college students whose primary language is the JD should be excluded from math classes until they attain a minimum level of English proficiency?	
Do you welcome the inclusion of ELLs in your math lessons?	
Is it a good practice to make accommodation for ELLs?	
Is it difficult for you to justify the modification of coursework for ELLs?	
Would you support a legislation making the JD the official language of Jamaica?	
Do you think math Instructors are exposed to enough PD to address the learning needs of ELLs adequately?	
Do you believe that ELLs should avoid using their native language while at school?	
Do you believe that it should be compulsory for all ELL college students to acquire English proficiency within 2 years of enrolling in Jamaican colleges?	

Tiered Lessons:

Meeting the needs of culturally and linguistically diverse students.

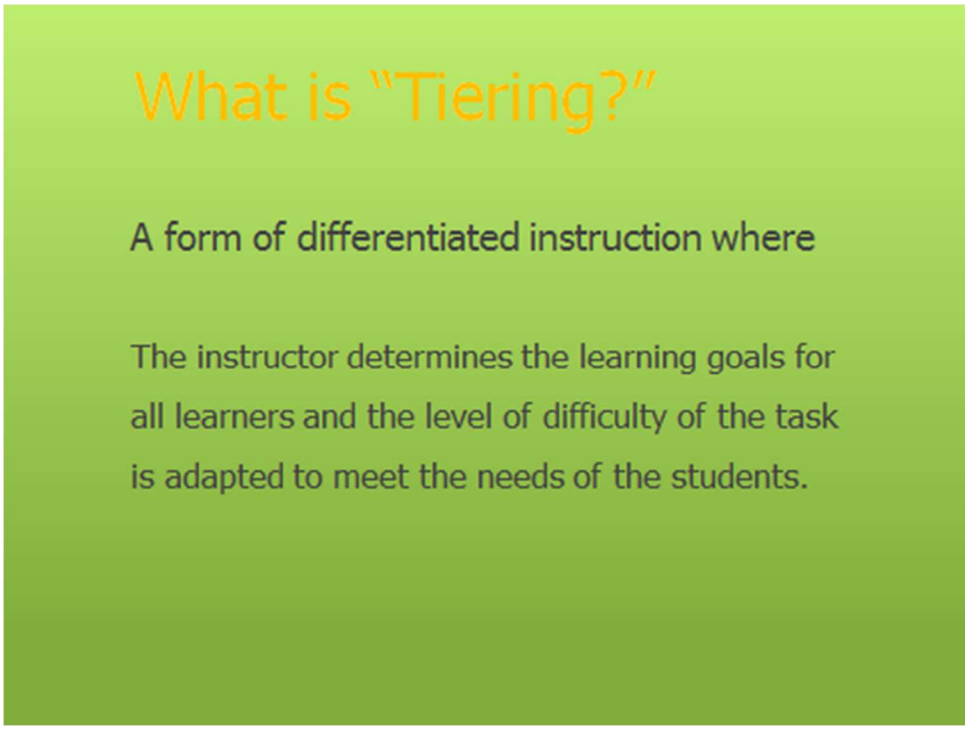
Objectives

Participants *will be able to…*

i. Define tiering and associated vocabulary

ii. Explain how students will benefit from a tiered lesson.

iii. Design a tiered lesson and tiering assignments


What is "Tiering?"
A form of differentiated instruction where
The instructor determines the learning goals for all learners and the level of difficulty of the task is adapted to meet the needs of the students.

Design of a tiered lesson…

1) Identify the level of the students and topic for which the lesson plan will be written.

2) Identify the national standard that must be satisfied.

3) Identify the key concepts to be taught.

4) Ensure that all the students have satisfied all the prerequisites.

5) Determine which section of the lesson must be tiered.

Design of a tiered lesson

6) Determine which of the following kind of tiering that will : readiness, interest, or learning profile.

7) Determine how many tiers are needed

8) Design the assessment component to the lesson.

Pierce, R. L., & Adams, C. M. (2004). Tierdless Lessons: One Way to Differentiate Mathematics Instruction. *Gifted Child Today*, *27*(2), 58-65.

Key Principle:

In a tiered lesson the instructors' plan will include strategies that supports the different ability levels

Tiered assignments should be created based on :

1) Students' ability to complete a task.

2) Students' Learning styles

3) Complexity of the task

Planning for all students

When planning a tiered lesson it should be clear in the mind of the instructor that one of the goals of the tired lesson is to achieve equity for all students; each learner must be assured that they will be able to fulfil their potential

Assignments are :

1) structured differently but the same content is tested to ensure that the students grasp all the content that was taught.

2) Equally active

3) Similarly stimulating and engaging

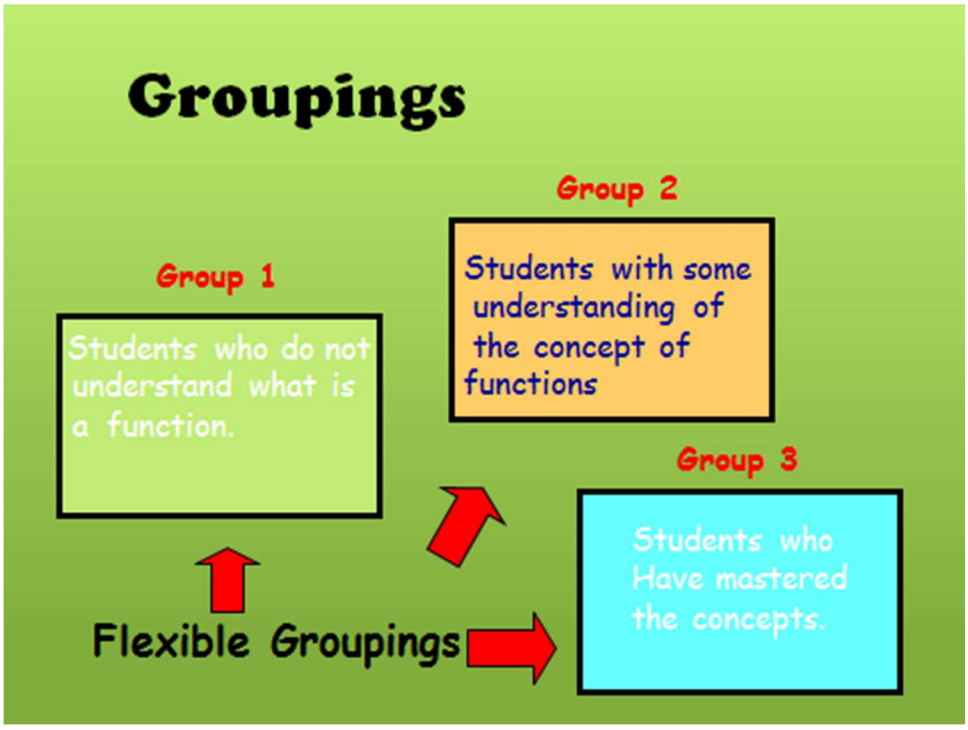
3) Not above the content but include higher level thinking questions.

Sample test items: Mathematics

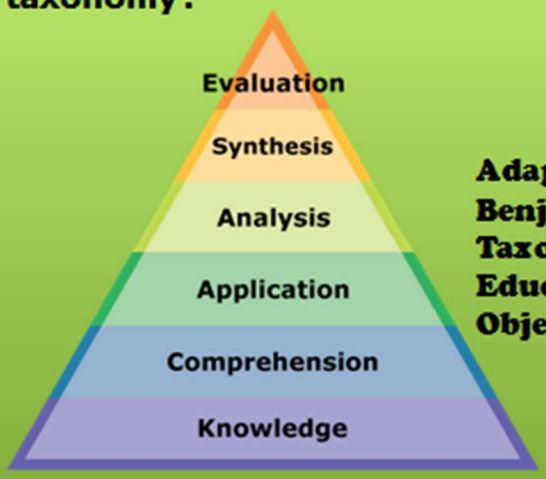
1)Explain what is a function?

2) With the aid of a well labelled diagram explain what are injective functions.

3) With the aid of a well labelled diagram explain what are surjective functions.


Groupings
Group 2
Students with some understanding of the concept of functions
Group 1
Students who do not understand what is a function.
Group 3
Students who Have mastered the concepts.
Flexible Groupings

Tiered Lessons should be based on Bloom's taxonomy .



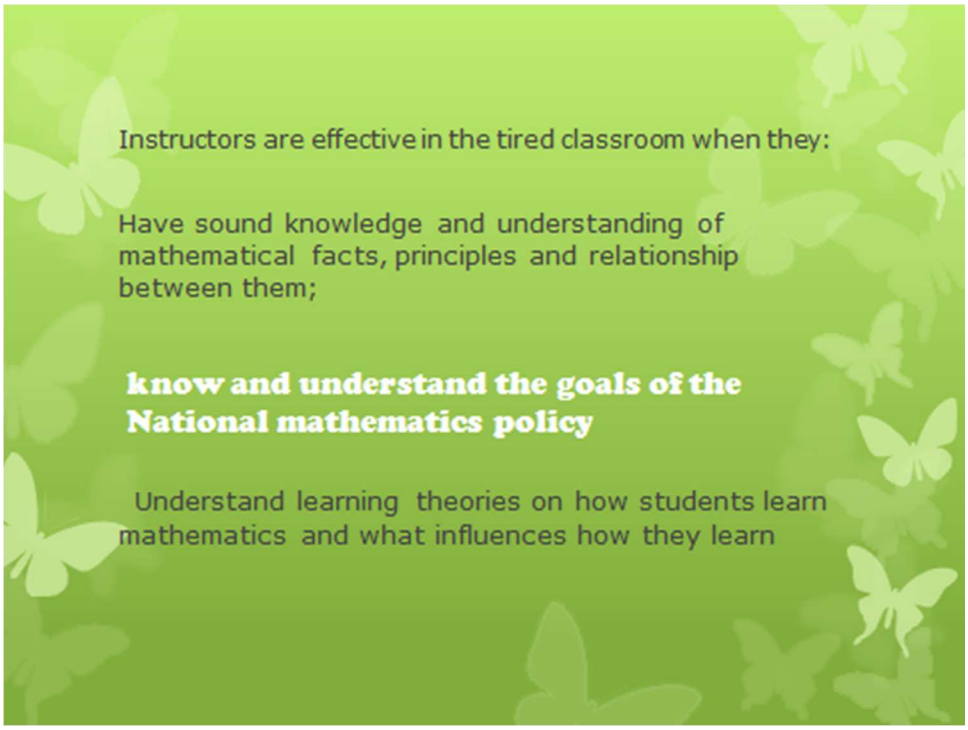
Adapted from Benjamin Bloom's Taxonomy of Educational Objectives.

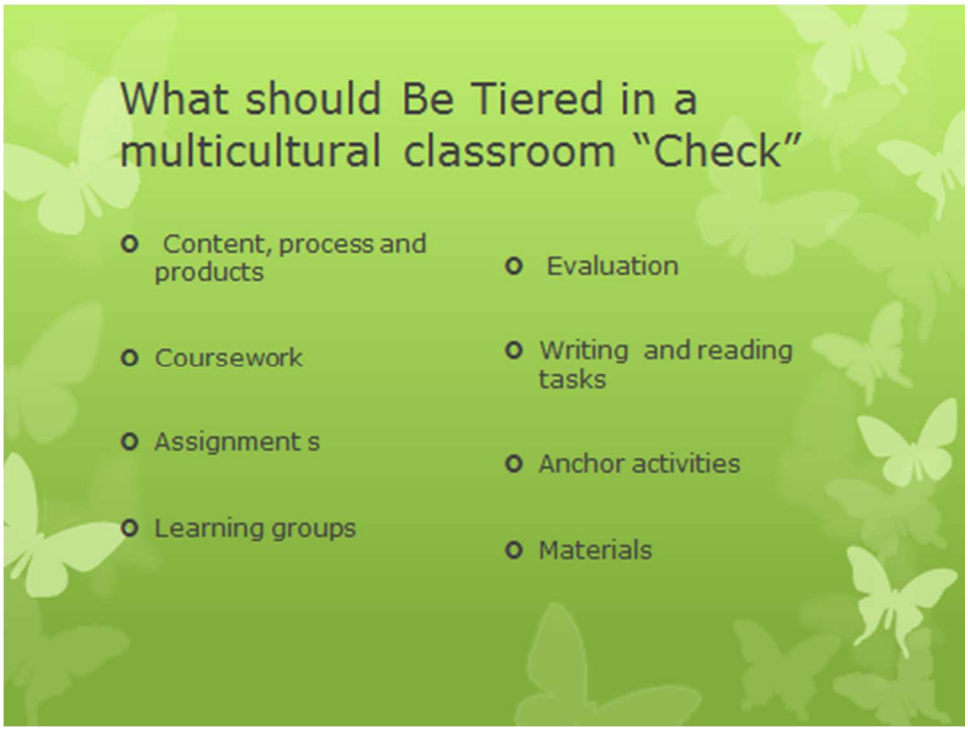
Instructors are effective in the tired classroom when they:

- • Have faith in their students' ability to succeed at mastering the concepts taught;
- • Know that diverse thinking is a vital and valued resource;
- • Know and understand mathematics in a way that allows them to explain and interpret students' mathematical efforts;
- • Have sound knowledge of the language of math and use it consistently and appropriately.

www.mathsolutions.com/documents/.../09_nctm_differentiating_instruction_talk1.pdf

2009 Math Solutions


Instructors are effective in the tired classroom when they:
Have sound knowledge and understanding of mathematical facts, principles and relationship between them;
know and understand the goals of the National mathematics policy
Understand learning theories on how students learn mathematics and what influences how they learn


What should Be Tiered in a multicultural classroom "Check"
Content, process and products
Coursework
Assignment s
Learning groups
Evaluation
Writing and reading tasks
Anchor activities
Materials

Discussion Questions for College Administrators

In the Jamaican education sector, the obstacles that lie between ELL students and equal access to college education are not only matters of language. Administrative policies that use an inclusive approach to support the teaching and learning of all students would provide more opportunities for learning. If there are clear guidelines that address the diverse abilities of all, then instructors will become more conscious of the reality that educating linguistically diverse students are a complex task that involves a large number of factors that should not be ignored. When school administrators and teachers are attuned to their student's cultures and need then academic achievement will improve. One of the objectives of a school administration should be to assist in finding the resources to assist mathematics educators to develop a deeper awareness of the role of language and culture in the teaching and learning of mathematics. According to Elfers and Stritikus (2013) good educational leadership improve educational outcomes for students.

Please think carefully on how you are prioritizing for the ELLs in your school.

1. What resources have the college allocated to the development of programs for ELLs?
2. What are the main demands that you have received from the ELL math instructors?
3. What is the attitude of the Board of Governors as it relates to the admission of ELLs?
4. Have you received any guidelines from the Ministry of Education in Jamaica as it relates to employing Specialist Instructors to teach ELLs?
5. How is the instruction of ELLs aligned with the goals of the college?

6. How are you ensuring that they have access to all programs?

7. Have you set aside any money from your budget to make provision for the PDof the math lecturers?

Training evaluation

PD Training Information:

ELL PD Series.

Training Title: _____ Date Attended: ----------

Please indicate the rating for the each section based on the following criteria:

5= excellent 4= good 3= average 2= fair 1= poor

Please rate the trainer(s) on the following:

1**. Knowledge of the subject matter.** ☐**5** ☐**4** ☐**3** ☐**2** ☐**1**

2. Ability to explain and illustrate concepts. ☐**5** ☐**4** ☐**3** ☐**2** ☐**1**

3. Ability to answer questions completely. ☐**5** ☐**4** ☐**3** ☐**2** ☐**1**

Open-ended comments (use the back if you need more space):

4. What specifically did the trainer do well?

5. What recommendations do you have for the trainer to improve?

Please rate the content and structure of the training:

The usefulness of the information received in training. ☐**5** ☐**4** ☐**3** ☐**2** ☐**1**

5. The structure of the training session(s). ☐**5** ☐**4** ☐**3** ☐**2** ☐**1**

6. The pace of the training session(s). ☐**5** ☐**4** ☐**3** ☐**2** ☐**1**

7. The convenience of the training schedule. ☐**5** ☐**4** ☐**3** ☐**2** ☐**1**

8. The usefulness of the training materials. ☐5 ☐4 ☐3 ☐2 ☐1

9. Was this training appropriate for your level of experience? ☐Yes ☐No

If you said "No" to #9, please explain:

Open-ended comments (use the back if you need more space):

10. What did you most like about the training?

11. What can be improved with regard to the structure, format, and/or materials?

Your Name: _____ **(Optional)**

Thank you for completing our training evaluation.

Appendix B: Planned Intervention to Address Deficiencies Identified

The Department of Mathematics and Computer Studies will provide remediation to students enrolled in the Primary and Secondary (mathematics) teacher education programs over the first three years of the four year Bachelors in Education. We plan to address the content strands, so that all deficiencies in knowledge and ability will be addressed before the student their program of study. It is anticipated that as new sets of students enter the college they can fit into the activities planned. Some of the constraints being number of students and ensuring that prerequisite knowledge is in place before confronting more advanced topics. In the case of special seminars or seminars the number of students participating should not be so large as to make discussions and attention to individual needs impractical. This suggests the need to separate students into year groups and by programs and plan concurrent intervention activities.

The interventions planned are as follows:

1. Several of the weaknesses identified through the diagnostic test will be addressed in courses within the teacher training programs. For example the Primary Education courses Number Concepts I & II in year 1 and Algebra & Problem Solving in year 2 will treat concepts within those strands. Secondary Education courses like Measurement, College Algebra, Trigonometry, Pre – Calculus and Linear Algebra will address some weaknesses in the related strands. Every instructor in the department will be given a copy of the summary of results from the diagnostic test. They will also be given the opportunity to see the individual reports for each student. Some of the students' weaknesses will need extra – curricular interventions in the form of seminars, which will focus not only on content knowledge but on developing understanding and reasoning. The seminars will make use of manipulatives, examine real life scenarios and require students to not only solve problems but explain in writing or verbally the processes they will use. It is anticipated that these mathematics seminars can be held once per month.

JeffVon Kuster (Mr.)

Appendix C: National Mathematics Program 2013 Secondary Mathematics Diagnostic Test (Report) for Freshmen Education Students

Institution: University College of Science and Education (UCSC) Number of students: 52

	Min (%)	Max (%)	School Average (%)	Standard Deviation	National Average (%)
Overall Score	29.85	47.76	40.55	6.06	-
Number	16.67	58.33	36.11	14.16	-
Measurement	0.00	66.67	41.67	20.97	-
Trigonometry and Geometry	14.29	57.14	40.48	15.79	-
Algebra	16.67	83.33	41.67	20.41	-
Functions, Relations and Graph	26.67	66.67	50.00	14.78	-
Vectors and Matrices	12.50	50.00	27.08	13.34	-
Knowledge Computation	23.53	47.06	36.28	7.91	-
Conceptual Understanding	31.25	53.13	40.11	6.85	-
Critical Reasoning	33.33	61.11	45.37	9.31	-

LEVELS OF PERFORMANCE	NO. OF STUDENTS	PERCENTAGE
LEVEL 1: Students exhibit PROFOUND deficits in their content knowledge and need INTENSIVE support.	26	50.00%
LEVEL 2: Students exhibit SEVERE deficits in their content knowledge and need REMEDIATION.	20	38.5%
LEVEL 3: Students exhibits MODERATE deficits in their content knowledge and need GENERAL support.	6	11.5%
LEVEL 4: Students exhibit MINIMAL deficits in their content knowledge and would benefit from ENRICHMENT activities.	0	0.00%
TOTAL	52	100.00%

Appendix D: National Mathematics Program 2014 Secondary Mathematics Diagnostic Test (Report) for Freshmen Education Students

Institution: University College of Science and Education (UCSE) Number of students: 45

	Min (%)	Max (%)	School Average (%)	Standard Deviation	National Average (%)
Overall Score	20.75	50.94	33.24	9.64	-
Number	10.00	55.00	33.46	12.62	-
Measurement	22.22	46.67	38.46	14.20	-
Geometry	8.33	50.00	25.00	11.78	-
Algebra	0.00	55.71	46.15	25.77	-
Statistics	0.00	50.00	24.62	19.46	-
Knowledge Computation	23.53	58.82	33.48	10.42	-
Conceptual Understanding	11.54	53.85	35.21	13.65	-
Critical Reasoning	0.00	60.00	27.69	18.46	-

LEVELS OF PERFORMANCE	NO. OF STUDENTS	PERCENTAGE
LEVEL 1: Students exhibit PROFOUND deficits in their content knowledge and need INTENSIVE support.	19	69.23%
LEVEL 2: Students exhibit SEVERE deficits in their content knowledge and need REMEDIATION.	13	23.08%
LEVEL 3: Students exhibits MODERATE deficits in their content knowledge and need GENERAL support.	1	7.69%
LEVEL 4: Students exhibit MINIMAL deficits in their content knowledge and would benefit from ENRICHMENT activities.	0	0.00%
TOTAL	**13**	**100.00%**