

Original Paper

ID Model Development and Validation: Improving Secondary School Students' Mathematics Achievement through Cooperative Learning Strategies

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Abstract

Many secondary school students within the Caribbean region are consistently failing to grasp basic mathematical concepts. The purpose of this Design and Development Research was to generate an Instructional Design (ID) Model that demonstrates how the effective use of cooperative learning strategies improved students' mathematical achievement, at a junior secondary school in the British Virgin Islands. The researcher collected information from Mathematics teachers (n = 5) and their students (n = 5). Each participant was involved in semi-structured interviews and MAXQDA¹² was employed for analysis. Two research questions guided this research. The results of this research showed that the consistent use of effective cooperative learning strategies contributed to students' academic achievement in Mathematics, especially at the junior secondary school level. The results stand to benefit both Mathematics teachers of junior secondary schools and their students. There is one recommendation for future research.

Keywords

academic achievement, cooperative learning, ID Model, instructional design, mathematics, secondary school, validation

1. Introduction

Mathematics education, at the elementary school level, should not be overlooked. This level of Mathematical instruction sets the foundation for students' Grade 12 exit examination. Mathematics education is fundamentally essential to a dynamic global economy. Students' academic achievement and the effective implementation of teachers' pedagogical strategies have been the most hotly debated

topic in recent years. However, the ongoing debate, regarding the improvement of students' academic achievement in Mathematics, seems to be at a stand-still. The urgent need of the education system is to ensure that teachers who are trained in the area of Mathematics are equipped with the required Content Knowledge (CK) and Pedagogical Content Knowledge (PCK) that intentionally and ultimately aims at making a positive difference in students' mathematical gains. Cooperative learning strategies employed in the teaching of Mathematics are perceived to make a difference in students' academic gains.

Podolak, Młynarska, Kawałek, Śnieżek, and Napiórkowska (2016) posit that present-day teaching strategies should provide students with creative and critical thinking skills, which inevitably lead to self-development. They further stated that this contemporary teaching strategy is rooted in Piaget's theory of cognitive development. Action teaching is synonymous to providing students with creative and critical thinking skills. Plous (2012) mentioned that action teaching is dichotomous because it is designed to address the needs, interests, and abilities of the diverse student-population in a collaborative classroom culture, while simultaneously preserving the social fabric of the society. In other words, action teaching and cooperative learning strategies have some common characteristics, one of which involves the preservation of social interaction among students and teachers.

Few teachers are making the best use of the cooperative learning and teaching strategies while others continue to exhibit the traditional teaching strategies at the expense of students' cognitive and social development. This suggests that students are not meeting their Mathematics grade-level standards, partially due to the teaching strategies employed. Even though, in every sphere of life mathematical concepts can be found, many students are unable to make connections to real-life situations because teachers shy away from teaching this skill. This may explain the unacceptable Mathematics grades students receive.

While unacceptable grades can be attributed to poor teaching method . . . (Alami, 2016), Mangilit (n.d), in the article, *Why Smart Students Get Low Grades* said that students receive low grades because they are unable to make connections between the Mathematics content knowledge and the real-world. A clear understanding of why students receive low grades in Mathematics can begin the process of change.

It is essential for educators to be aware of the benefits, well-thought out, change affords. To meaningfully generate an *ID Model* that would help students develop an appreciation for mathematical concepts, teachers must first be willing to intentionally incorporate cooperative learning techniques and strategies within their Mathematics classrooms. With the consistent and effective use of this knowledge and skill in cooperative learning and teaching strategies, it is perceived that the students' mathematical achievement, will improve. We are living in a competitively charged environment; therefore, Mathematics methodology should be on the cutting edge of our education system. This practice will ensure that students are prepared for the environment in which they live.

1.1 Background of the Study

The Caribbean Examinations Council (CXC) Annual Technical Reports (2009-2019) revealed that students are consistently underperforming in the Caribbean Secondary Education Council (CSEC) Mathematics at an alarming rate. As a result, there are widespread concerns among policy makers, teachers, parents, and students with respect to the overall performance of our students. An extremely brief report of students' Mathematics performance for 11 consecutive years (2009-2019) is shown below.

Table 1. Aggregate and BVI Performance in CSEC Mathematics Examination during 2009-2019

Year of Examination (<i>Mathematics</i>)	% of Registrants obtaining Grades <i>I-III</i> (<i>Aggregate</i>)	% of Registrants obtaining Grades <i>I-III</i> (<i>BVI</i>)
2009	41	73
2010	41	66
2011	35	65
2012	33	60
2013	30	55
2014	50	68
2015	57	74
2016	44	88
2017	45	71
2018	49	78
2019	46	63

Note. The aggregate column represents the performance of students in the CXC territories, while the BVI column represents the performance of students in the British Virgin Islands. The mean percentage of aggregate and BVI students who received acceptable grades for the CSEC Mathematics examination, May/June sitting is 42.8 and 69.2 respectively. The standard deviation percentage of aggregate and BVI students who received acceptable grades for the CSEC Mathematics examination, May/June sitting is 7.60 and 8.66 respectively.

A cursory glance, at these statistics, reveals that the registrants in the BVI out-performed their counterparts on the aggregate level. For this reason, the students of the BVI were selected for this research which ultimately led to the development of the *ID Model*.

The researcher, a former Head of Department (Mathematics), a trained certified graduate Mathematics teacher has been teaching Mathematics at all grade levels within the secondary school for more than

two decades. Throughout these years of teaching Mathematics, it has been observed that each student can learn and information is processed according to their needs, interests, and abilities. This suggests that knowing one or two teaching strategies is insufficient. If students are not performing at an acceptable standard with the current teaching strategies employed by the teacher, a change is necessary. With a rigorous and intentional change or adjustment in teaching strategies, the teachers will be able to identify the factors that are most likely to be responsible for students' academic achievement in Mathematics. This working knowledge of cooperative learning and teaching strategies can assist teachers in becoming more informed of Pedagogical Content Knowledge (PCK). Simultaneously, the deliberate use of cooperative learning and teaching strategies can act as an initial pathway towards improving students' mathematical achievement within the junior secondary schools.

1.2 Statement of the Problem

Problems are ubiquitous and the education system is not immune to them. There are numerous educational challenges that are affecting the pedagogical platform within the junior secondary school system. Educators are faced with major problems and challenges within and without the classroom and the teaching profession as a whole. A problem can be viewed as the difference between what now exist and an expectation of a more favourable situation. The researcher delved into the likely cause of this discrepancy; students' current unacceptable performance and a more desirable performance in Mathematics. The reduction of this performance gap is perceived to be possible through the analysis, design, development, and evaluation of this *ID Model* that is intended to improve students' Mathematics achievement at the junior secondary schools, through the effective use of cooperative teaching and learning strategies. Hence, the statement of the problem for this research was generated from the basis of the CXC annual technical reports which state that, many students are consistently underperforming in Mathematics, due to their inability to grasp basic mathematical concepts and apply them to real-world situations.

1.3 Purpose of the Study

Creswell (2013) stated that a purpose statement provides a major objective, intent, or road map to the research and is considered one of the most important statements in research. Hence, the purpose of this Grounded Theory (GT) qualitative Design and Development Research (DDR) was to analyze, design, develop, and evaluate an *ID Model* that is perceived to improve students' performance in Mathematics through cooperative teaching and learning strategies at a private junior secondary school in the British Virgin Islands (BVI). At this stage in the research the *ID Model* is generally defined as the cooperative teaching and learning strategies suitable to improve the performance of junior secondary school Mathematics students and by extension students writing the CSEC Mathematics examination.

1.4 Pragmatism: An Interpretive Framework

Pragmatism as an interpretive framework focuses on the practical implications of research (Creswell, 2013). The term pragmatism was first coined by Charles Peirce in 1905 because he wanted to name a philosophy that was considered new and diverse (Ghenea, 2015). To educate students in the field of

Mathematics, the teacher must take on a practical framework that is perceived to encourage learners to be actively involved in the learning process. Teaching and learning mathematical concepts through cooperative learning strategies encourage meaningful planning and intentional practical involvement. For the pragmatists, learning is driven by social interaction. In fact, Gorshkova (2015) said that Dewey believes students should be guided along their intellectual journey through practical engagement.

1.5 Ontology: A Philosophical Assumption

There is a positive connection between pragmatism and ontology to the teaching of Mathematics through cooperative teaching and learning strategies. Almeida (2013) said that the branch of philosophy concerned with the study of reality is known as metaphysics and a fundamental component of metaphysics is ontology. This suggests that ontological beliefs play a major role in understanding the nature of reality. Creswell (2013) said that qualitative researchers embrace multiple realities since each participant can provide a different reality. This research showed how each student and teacher shared their own reality about the nature of cooperative teaching and learning at a junior secondary school level and their perception of the use of this teaching strategy within their Mathematics classroom. One general ontological question within this research is, what is the reality of the analysis, design, development, and evaluation processes of the *ID Model* that is perceived to bridge the performance gap in the Mathematics classrooms using cooperative teaching and learning strategies?

2. Methodology

2.1 Research Design

The Glaserian grounded theory research design is the most appropriate for this research. One of the primary rationales of this design was to develop a substantive theory that emerged from the identification of the core categories grounded in the data (Merriam, 2009) and the fact that, all the participants involved in this research was selected because of common characteristics that they share (Creswell, 2013). This Design and Development Research, also called Type II Design, Development, and Validation Research, was conducted with Mathematics teachers and their students of junior secondary schools in mind. Ibrahim (2016) mentioned that there are four phases in a Design and Development Research: analysis, design, development, and evaluation. This research strongly embraced these four phases.

2.2 Population and Sample

The target population of this research was the junior secondary school students and their Mathematics teachers. The sample came from this group of students and teachers. These participants came from a private junior secondary school on the island of Tortola, British Virgin Islands. They were also bona fide students and full-time teachers of the institution. These students were not considered as being a part of any vulnerable group. The teachers were exposed to the strategies of cooperative learning by the researcher while their students were exposed to this teaching strategy, by their respective Mathematics

teacher. The three grade levels that constituted the junior secondary school were made up of mixed gender—male and female between the 12-19 age range.

There were five students and five teachers directly involved in this research. These five teachers were assigned different classes within the three grade levels to teach Mathematics by the school's administration at the beginning of the school year, 2018-2019. Each teacher had at least seven years of experience teaching Mathematics at various secondary schools and at different grade levels. Each teacher holds a Bachelor's degree, except for Mathematics and was between the ages of 30 and 51 years.

2.3 Sampling Strategy

Each participant was purposively sampled because the researcher felt that they were able to provide adequate information for the development of the research *ID Model* for improving students' academic achievement in Mathematics. Interacting with these students and recognizing their ability to supply rich and thick information was incredible. As a result, they were selected as participants, subject to the signing of their informed consent forms by their parents or legal guardian. Teachers also read, signed, and returned their informed consent forms to the researcher.

2.4 Research Procedure

The researcher first made an appointment with the principal of the research site, two weeks prior to meeting with the Mathematics faculty of the junior secondary school. At that meeting, the researcher shared an overview of the research as well as an outline of the procedure, which was eventually followed. The principal gave the researcher permission to meet with the Mathematics teachers of the junior secondary school and to conduct the research.

The researcher shared with each potential participant the purpose of the study, the significance of the study, the estimated number of interviews, sensitivity to the demand on their time, the high level of confidentiality and respect for the research process, and the voluntary nature of their participation. Teachers were allowed to ask questions and seek clarifications. The researcher responded to each question asked as well as clarified misconceptions during the meeting. At the end of the interactive meeting, the researcher asked each potential participant to indicate their commitment and willingness to the research process. They read, signed, and returned their informed consent form to the researcher. The students were purposively sampled and they were given an informed consent form for their parents or legal guardian to read, sign, and return directly to the researcher. Once these signed informed consent forms were returned, the researcher asked each student to give assent to their willingness to participate in the research. The researcher conducted two weeks of training for Mathematics teachers in cooperative learning strategies. Each teacher implemented these strategies in their Mathematics classrooms. As a result of this intentional implementation, the tentative *ID Model* was developed and this was followed by an evaluation process. This tentative model was validated prior to the development of the final *ID Model*.

2.4.1 ID Model Explanation and Validation

This DDR involved four phases: analysis, design, development, and evaluation. The first phase, *analysis*, focused primarily on the qualitative review of students' current Mathematics achievement at the junior secondary school level. A careful document analysis of the students' Mathematics copy books and their teachers' grade book revealed that students continue to perform below their grade-level standard.

The second phase, *design*, focused on the training of the Mathematics faculty in cooperative teaching and learning strategies. The teachers of the junior secondary school were exposed for the first time to in-depth sessions on cooperative learning strategies. The researcher was the lone facilitator. Each teacher at the two-week training session was asked to incorporate the Pedagogical Content Knowledge (PCK) gained at the training sessions, into their Mathematics classes. There were two training sessions held each week, on Tuesday's and Thursday's; that lasted for an average of 90 minutes. These sessions were adequate for the implementation of foundational principles in cooperative learning strategies, within the Mathematics classrooms.

The third phase, *development*, saw the development of a tentative *ID Model* from the information each participant contributed. Each teacher as participant was given at most two weeks before beginning the implementation of the cooperative learning strategy, in their Mathematics classrooms. During the implementation of the cooperative learning strategies, by the Mathematics teachers, the researcher conducted continuous observations, interviews, and document analyses. The information received from the in-progress data, was analyzed using MAXQDA¹² software. The results from this analysis were used to develop a tentative *ID Model* that was subsequently validated in the fourth phase.

Phase four was the internal validation of this tentative *ID Model*. This fourth and final phase also known as the Delphi study consisted of a three-round process prior to the final development of the substantive *ID Model*. Mulder (2017) postulates that limiting the Delphi study to the first round fails to test the complex processes of analysis and measurement occurring later in the Delphi research process. For this reason the researcher utilized three rounds in this process. At each round the researcher used the information submitted by the panellists to update each tentative model. This Delphi study panel consisted of three persons. These three persons were the Mathematics expert, cooperative learning practitioner, and a Curriculum and Instruction specialist. This validation process relied heavily on the Delphi panel arriving at a consensual agreement for the *ID Model*. Each member of the panel voted in favour of the final substantive *ID Model*.

2.5 Research Questions

Research questions provide researchers with an action plan for the development of research instruments. It is expected that, "researchers identify a general question followed by a sub-question referred to as the research question" (Creswell, 2013, p. 138). The general question for this research is, "*What is the Design and Development Research ID Model that would improve students' mathematical performance*

at the junior secondary school level at a private secondary school in Tortola, British Virgin Islands?”

As a result, this study was guided by two sub-questions referred to as the research questions.

Research question #1. What role will Mathematics teachers of junior secondary school play in the process of developing an Instructional Design Model that will improve students’ academic performance in Mathematics through the use of cooperative learning strategies?

Research question #2. What role will junior secondary school students play in the process of developing an Instructional Design Model that will improve the students’ academic performance in Mathematics through the use of cooperative learning strategies?

2.6 Data Collection Sources and Procedures

2.6.1 Interview—Focus Group and Individual

Semi-structured interviews were conducted with individual participants as well as in focus groups. Only students were involved in the focus group interviews. Focus group interviews stimulate an extremely dynamic interaction between and among group participants (Merriam, 2009). The focus group interviews were held with four and sometimes all five students. The difference in the numerical composition of the focus group was due to the absence of a participant from school on the day in question. There were four focus group interviews conducted bi-weekly for two weeks. Each interview session lasted for an average of 30 minutes. During these focus group interviews the researcher made keen observations of those students who he believes have the proclivity to supply additional rich, thick description for the study. These students were formally invited to participate in the individual interviews.

Merriam (2009) advanced, “Interviews in a qualitative research are more open-ended and less structured” (p. 90). Both students and teachers participated in the individual interviews. The individual interview process lasted for approximately three weeks. The interview process ended when the researcher believed that the point of saturation was reached and no meaningful additional information was being contributed by the participants. Each participant was interviewed at least once during the three weeks. At most four participants were interviewed weekly. These interviews lasted for an average of 30 minutes.

At the conclusion of each interview, the researcher spoke into an audio tape recorder. This was immediately followed by a detailed transcription of the reflection. Participants did not consent to have their interviews, individual and focus group, audio nor video-taped.

2.6.2 Observation

At the conclusion of the teacher-training in cooperative teaching and learning strategies, the researcher allowed at most two weeks “grace period” before the teachers began implementing these strategies in their respective Mathematics classrooms. During the two-week “grace period”, the teachers were asked to practice these skills. Following this two-week period, the researcher conducted bi-weekly observations of teachers during interactive classroom sessions. During these observations the researcher took field notes using the observation protocol. Immediately following the completion of an

observation, the researcher reverted to the interview room and quietly spoke into an audio tape recorder whatever transpired on that occasion, made personal reflections, and comments. This process was immediately followed by verbatim transcription of that session and the information was filed according to date, time, data source, and research site before being uploaded in MAXQDA¹² software for analysis. These observations determined the level of use, of the cooperative learning strategies by the teacher and how students were responding to them, in the Mathematics classrooms.

2.6.3 Document Analysis

At least twice weekly during the research process which lasted for six weeks, the teachers' log books, lesson plans/record and forecast, and students' Mathematics note books were reviewed. The review of their note books was done at least once weekly. After each review, the researcher spoke into the audio tape recorder, a reflection of the review process.

These data collection sources were used to ensure a wide cross-section of views from the participants, from which a substantive *ID Model* was developed. These three data collection sources were most appropriate for this research since it gave the researcher a clearer and deeper understanding of the phenomenon of interest.

2.7 Data Analysis Strategies

Joyner, Rouse, and Glatthorn (2013) posited that qualitative data is more challenging to analyze as the data are not numerical, but textual. Merriam (2009) suggested, "All qualitative research data analysis is primarily inductive and comparative" (p. 175). Gay, Mills, and Airasian (2009) concurred that the collection and analysis of qualitative data could occur simultaneously. This current study engaged in an iterative data collection and analysis process (Creswell, 2013; Gay, Mills, & Airasian, 2009; Merriam, 2009). The reflective notes from the interviews, observations, and document analyses were saved on an 8 GB Kingston flash drive and a Seagate External USB 2 TB device, according to date, time, data source, data collection strategy, and research site. When the researcher was satisfied through member checks that the information received was true and accurate, it was uploaded into MAXQDA¹² software for analysis.

2.7.1 Coding Procedures

A code in qualitative research is a single word or short phrase that is symbolically assigned to a selected portion of text or visual data (Saldana, 2013). To enable the generation of the grounded theory, Creswell (2013) suggested three coding phases (a) open, (b) axial, and (c) selective coding. NVivo codes were used, which according to Creswell (2013) captured the exact words spoken by the participants. This type of coding helps to capture the essence of the participants' contribution to the theory generation.

2.7.1.1 Open Coding

The goal of open coding is to remain flexible to all possible theoretical directions indicated by the reading of the data collected from the participants (Charmaz, 2006). There are three data collection sources in this research. These sources are: interview, observation, and document analysis. The coding,

for this research, began with open coding in which the researcher engaged in line-by-line coding to ensure that every possible theoretical direction was indicated.

2.7.1.2 Axial Coding

Saldana (2013) used the term axial coding to describe the relationship between categories and sub-categories. Charmaz (2006) asserted that focused coding also known as axial coding aims at linking categories with sub-categories to make sense of the data and show how they are related. Creswell (2013) provided an axial coding relationship model which consists of (a) causal conditions—what factors caused the core phenomenon, (b) strategies—actions taken in response to the core phenomenon, (c) intervening conditions—broad and specific situational factors that influence the strategies, and (d) consequences—outcomes from using the strategies.

2.7.1.3 Selective Coding

The final coding phase in the qualitative data analysis process for this grounded theory is selective coding. At this juncture, the researcher further examined the relationships formed from within the axial coding paradigm and developed propositions that followed an analytical storyline making the connection between categories more meaningful (Creswell, 2013). It was within this phase that the researcher generated the theory that was found within the information received. This theory came as a result of rigorous analysis of the data that led to a profound storyline. The ability to make connections between categories and sub-categories added to this storyline, simultaneously augmenting the meaningfulness and usefulness of the research.

2.8 Validation Strategies: Credibility

To ensure internal validity, the researcher engaged in three data collection sources for each research question. The most commonly known strategy to shore up validity is triangulation and member checks (Merriam, 2009). The type of triangulation that was employed in this research was the multiple sources of data triangulation. This ensured the comparable use of different data that were collected. Member checks were done to solicit feedback on the responses from the participants interviewed, observed, and whose document was analyzed.

2.8.1 Triangulation

Triangulation, according to Creswell (2013), is a process of corroborating evidence from various sources that inevitably lead to a comprehensive understanding of the phenomenon being studied. This research involved a combination of different collection data sources: interview, observation, and document analysis. The information shared in each source brought clarity to the phenomenon.

2.8.2 Member Checks

Member checks, also called respondent validation, is a process of taking your preliminary analysis back to the respondents for verification and clarification (Merriam, 2009). Creswell (2013) used the term, member checking, to suggest the researcher returning to the participants so that they can judge the exactness and integrity of the account. Returning to the participants involves verifying whether the researcher's interpretation of the information is accurate. The researcher returned to the participants to

verify and clarify data and interpretation. Member checks were done throughout the research process where the researcher met individually with the research participants whose information shared was unclear and needed clarification.

2.9 Validation Strategies: Consistency

Reliability is based on the supposition that there is one reality and if a study is repeated over time, it will yield the same or similar results (Merriam, 2009). Reliability poses tremendous problems whenever human subjects are involved, because of their vacillating complexity. Individuals' dispositions constantly change which suggests that the findings in one study may not be achieved in another, even if the same participants are involved. When this occurs, it does not mean that the findings are unreliable. It simply means that human behaviour is consistent with change and the results are consistent with the data collected. As a result, the researcher pilot studied the interview and the observation protocols and the final instruments were used.

2.10 Reader Generalizability

Merriam (2009) contends that a common understanding of generalizability in qualitative research is reader or user generalizability. This suggests that the individual that reads or uses the research must decide whether or not the findings can be applied to his or her particular context. The researchers or readers should not freely apply the findings to general scenarios. More specifically, the DDR is usually contextual and should not be seen as being applicable to different or similar contexts (Richey & Klein, 2007). Creswell and Plano Clark (2011) mentioned that qualitative data are not to be generalized from the sample to the population. It is primarily used to gain an in-depth understanding of the phenomenon being studied.

2.11 Ethical and Legal Considerations

Intentionally, each participant was assured orally and in their written informed consent form, that their identity, responses, and research site will be treated with a high degree of confidentiality. In addition to confidentiality measures, there will be no perceived form of discrimination based on sexual orientation, age, social class, disability, ethnicity, gender, religious affiliation, or otherwise. In other words, the information received from each research respondent will not be divulged to anyone at any time. Only the researcher will have full and absolute access to the information collected which will be stored in a personal cupboard with lock and key at all times. All research participants were reminded that their participation is voluntary and that they are free to withdraw at any time without prior notification and without fear of being victimized in any way.

2.11.1 Access and Hierarchy

The researcher formally requested permission from the Chairman of the School Board of Management of the Adventer Community College (pseudonym). With the permission granted by the Chairman of the School Board of Management, the researcher made a formal request to meet with the principal, the Mathematics faculty of the junior secondary school and their students. These meetings were held in a

research-designated room and void of external interference and distractions. They were also held on different occasions.

2.11.2 Informed Consent

An informed consent form was given to potential participants in this research. They were told that if they acceded to the request, they must return the signed copy to the researcher within three days of the receipt of the informed consent form. Each teacher as a potential participant returned their signed consent form and they were given a schedule outlining the stages of their involvement in the development and internal validation of the *ID Model*. Each student was also given an informed consent form for their parent or legal guardian to read, sign, and return. The students, who returned their signed informed consent form from their parent or legal guardian, gave assent to being a part of the research process.

2.11.3 Pseudonym and Anonymity

During the meeting with the prospective participants, the researcher reassured them of the high level of confidentiality that will be upheld throughout the research process. For the researcher to maintain a high level of confidentiality, an appropriate pseudonym was decided upon for each participant as well as the research site.

3. Results

There were two research questions that guided this research. Five themes, two from research question #1 and three from research question #2, emerged as a direct result of the data that were collected from the three data collection sources - observation, interview, and document analysis. Collectively, the information was incorporated to generate the grounded theory and the substantive *ID Model*. Ten participants voluntarily contributed to this research until the researcher perceived that information saturation was reached. In other words, there was no additional substantive information that was being collected by the researcher.

3.1 Grounded Theory Identified

The Grounded Theory that emerged from this research has widened teachers' and students' understanding of cooperative teaching and learning techniques and strategies. After rigorous analysis of the data received from participants, the Grounded Theory derived from this qualitative research orientation is: Collaboration through Cooperative Consultation. This suggests that students' mathematical performance can be improved through intentional collaboration between teachers, teachers and students, as well as between students engaged in meaningful small-group discussions.

3.2 Research Question #1: What role will Mathematics teachers of junior secondary school play in the process of developing an Instructional Design Model that will improve students' academic performance in Mathematics through the use of cooperative learning strategies? The data sources that were used to obtain information that provided answers to this research question were semi-structured interviews and

document analysis. The two themes that emerged as a result of rigorous analysis of the data collected are knowledge transfer ability and maximizing students' potential.

3.2.1 Knowledge Transfer Ability

The ability to transfer knowledge from the classroom setting to the real-world does not evolve in a vacuum, but through meaningful engagement among teachers and students in small-group discussions. Small-group discussions lend themselves to the development of analytical skills followed by a clearer understanding of the content being taught. It is prudent that teachers teach these analytical skills to students before requiring them to demonstrate such mastery. Teachers should assist students in recognizing the relevance between the knowledge of the classroom and the real-world setting and this may provide a smoother transition from the school setting to the world-of-work.

3.2.1.1 Summary Statement

Cooperative learning classrooms facilitate the growth of students both academically and socially. Through such collaborative environment, students develop their ability to transfer knowledge from the classroom to the real-world.

3.2.2 Maximizing Students' Potential

An intentional collaborative effort between teachers and students can maximize students' learning potential. Students learn at various rates. As a result, some students would require being taught beyond the school day. Cooperative learning strategies build students' self-confidence, critical-thinking skills, and creativity. Self-confidence is built by occasional independent work as students discover their creativity. It is perceived that these students are better equipped to handle classroom challenges. Students' learning potential can be maximized academically and socially, since they are encouraged to engage in constructive discussions within small groups.

3.2.2.1 Summary Statement

Through small-group discussions, students are able to maximize their true learning potential and become more proficient in understanding mathematical concepts. Self-confidence, creativity, and critical-thinking skills are developed within small-group discussions.

3.2.2.2 Overall Summary Statement

Cooperative learning classrooms support both academic and social development of students. When students develop these abilities, their learning is maximized as they are able to think critically, creatively, and develop their self-confidence.

3.3 Research Question #2: What role will junior secondary school students play in the process of developing an Instructional Design Model that will improve the students' academic performance in Mathematics through the use of cooperative learning strategies? The data sources that were used to obtain information that provided answers to this research question were semi-structured interviews and observation and the three themes that emerged were dual beneficiaries from knowledge engagement, learning in a psychologically charged environment, and independence drives need for cooperation.

3.3.1 Dual Beneficiaries from Knowledge Engagement

Students who are engaged in consistent sharing of information within their small-groups augment their ability to retain the information learned. They are able to explain a concept in a simplified manner, “better” than the teacher, with the use of their familiar jargons. The student’s explanation of a concept will determine first if that student understands the information, and during this process may recognize his/her misunderstanding. Students with differing aptitude levels working together in a small-group can be beneficial to each member within that group. Teachers also benefit by being familiar with the jargons used by their students, in an effort to serve them better.

3.3.1.1 Summary Statement

Students readily adopt their familiar jargons that lend clarity to their small-group discussions. The content, of these discussions, appears to be “clearer” than the teacher’s explanation and as a result, more students are able to grasp a better understanding of the concept being taught. It is expected that teachers familiarize themselves with these jargons in order to be of greater assistance to their students.

3.3.2 Learning in a Psychologically Charged Environment

The most important learning environment, that must be created before teaching and learning is maximized, is a psychologically charged learning environment. Such environment must be intentionally created by the teacher because it develops students’ confidence and enthusiasm. Teachers must be sensitive to the composition of the small groups, since they would be familiar with their students’ abilities. Teachers must also ensure that the information being discussed in the small groups is correct or plausible before students are allowed to share with the entire class. When this is done a stronger cordial social bond is developed and maintained between teachers and students and learning becomes meaningful and rewarding.

3.3.2.1 Summary Statement

The psychologically charged classroom environment must be intentionally prepared to receive students who are eager to learn. Part of the benefit of this environment includes students being willing and comfortable to engage in fruitful discussion and sharing.

3.3.3 Independence Drives Need for Cooperation

Secondary school students working independently, especially in a Mathematics classroom, highlight their misunderstanding and subsequent need for collaboration. Not every student learns best in groups. Learning depends on the content being taught and the level of cognitive skills that are required. Students can also learn challenging content through organized collaborative work as is evident through meaningful socialization.

3.3.3.1 Summary Statement

Some students are able to succeed academically through periodic independent engagements while others need constant scaffolding from their colleagues. However, prolonged period of independence robs them of the social element of learning.

3.3.3.2 Overall Summary Statement

The benefits of learning come through meaningful learning engagements. It is remarkable to know that both teacher and students can benefit from the learning experience. However, it is important to prepare the psychological environment before meaningful learning can occur. Students learn at different rates, but it does not negate the fact that independence drives need for collaboration.

4. Discussion

The purpose of this grounded theory Design and Development Research was to develop and validate an Instructional Design Model that can be used to improve students' performance in Mathematics through cooperative teaching and learning strategies at a private junior secondary school in the British Virgin Islands (BVI). Its purpose was also to generate a substantive theory that explored how students' Mathematics achievement can be improved through the application of cooperative learning strategies. At this stage in the research the Instructional Design Model was generally defined as the cooperative learning strategies suitable to improve the performance of students at the junior secondary school level and by extension students writing the CSEC Mathematics examination. The reason for collecting qualitative data was to clearly understand the research problem by interacting with participants and spending prolonged periods of time in the research site.

4.1 Discussion of Findings from Research Question #1

Research question #1 is: What roles will Mathematics teachers of junior secondary school play in the process of developing an Instructional Design Model that will improve students' academic performance in Mathematics through the use of cooperative learning strategies? It is evident that cooperative learning classrooms cater for the holistic development of students. In some classroom scenarios, only the cognitive development of the students is intentionally developed, losing sight of other aspects of student growth. The social development of an individual is just as important as their mental growth. For this reason, educators in general and Mathematics educators in particular must intentionally plan for the "whole child". Each facet of the holistic development of a student supports one another. When students are intentionally exposed to a holistic development, their learning is maximized rather than skewed. Maximization of learning helps students to think critically, creatively, and develop their self-confidence. Cooperative learning strategies support students' all-round development. Mathematics teachers who intentionally engage in this teaching strategy recognize that students are social beings and that they can learn through well-organized small-group discussions. These discussions can well transcend beyond the walls of the classroom.

4.2 Discussion of Findings from Research Question #2

Research question #2 is: What role will junior secondary school students play in the process of developing an Instructional Design Model that will improve the students' academic performance in Mathematics through the use of cooperative learning strategies? The power of learning is phenomenal. Mathematics educators need to factor in the classroom discourse, variables of engagement. The era for

students to sit still and be quiet throughout a Mathematics lesson has become extinct. The level of interaction and the sharing of ideas should never constitute “noise” but meaningfully controlled learning engagements. Students should not be treated like commercial institutions, where deposits are made. Rather they must be treated like entrepreneurs who are also able to make valuable contributions to the learning experience. It is remarkable to know that both teachers and students can benefit from the teaching and learning experience. If consciously engineered, each person has the capacity and the ability to make valuable contributions to the learning process. The intentional use of various cooperative teaching and learning strategies can foster exponential academic growth. One of the many ways that teachers can make a valuable contribution to the learning process is to prepare the psychological environment of each student. This is by far one of the most critical environments that must be prepared prior to meaningful engagement and learning. Meaningful learning is contingent on the understanding that students learn at different rates. Learners must be treated with a high level of importance and Mathematics lessons should be planned with them in mind. No effort should be spared for all students to acquire learning, which is evident by a change in their behaviour. This may include both independent and collaborative engagements. We need each other at some point in our learning experience. Sharing one’s knowledge about a particular concept helps the sharer to know whether or not he or she clearly understands that concept. The student becomes aware of his or her misunderstanding and reaches out for assistance. Seeking assistance is not a difficult venture in a psychologically charged learning environment. Everyone feels comfortable learning from each other and each person in the cooperative learning group is willing to share their knowledge.

5. Conclusion

The grounded theory approach was utilized in this qualitative research design. Through this design, a substantive *ID Model* was developed to assist junior secondary school students improve their Mathematics achievement through cooperative learning strategies. There was a total of 10 participants, five teachers and five students. These participants were purposively selected because the researcher believes that they would adequately contribute to the development of the *ID Model* and the theory grounded in the data collected.

Two research questions guided this research. Three data collection sources were incorporated throughout this research and they added to the rich and thick description emanating from the voices of the participants. The MAXQDA¹² qualitative data analysis software was employed to analyze all the data that were collected. As a result of the analysis of the data, five themes emerged. This research was relevant since students at a private junior secondary school in the BVI were consistently under-performing in their Mathematics examinations.

Analysis of the data indicated that cooperative learning strategies supported students’ all-round development. Mathematics teachers who intentionally engaged in this learning and teaching strategy recognized that students are social beings and that they can learn through well-organized small-group

discussions. These discussions can well transcend beyond the immediate walls of the classroom. We need each other at some point in our learning experiences. Sharing one's knowledge about a particular concept helps the sharer to know whether or not he or she clearly understands that concept. The student becomes aware of his or her misunderstanding and reaches out for assistance. Seeking assistance is not a difficult venture in a psychologically charged learning environment. Everyone feels comfortable learning from each other and each person in the cooperative learning group is willing to share their knowledge.

6. Recommendation for Further Research

- 1) The scope of this research explored the development of an Instructional Design Model using the cooperative learning strategies in the Mathematics classroom. Hence, there needs to be further research to determine which teaching strategy would yield the greatest academic achievement of students in Mathematics.

A graphical representation of the meaningfulness of the grounded theory is shown in *Figure 1* below.

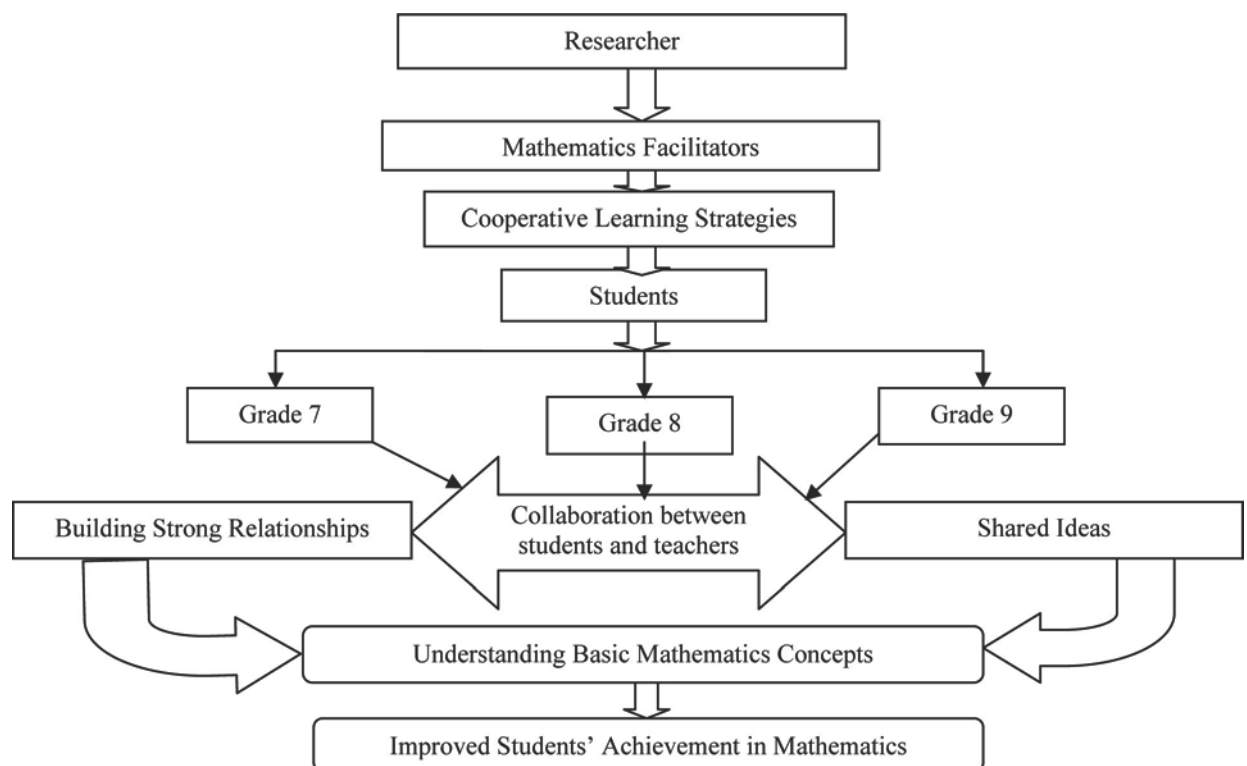


Figure 1. Theoretical ID Model for the Implementation of Cooperative Learning Strategies

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