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Perception of Secondary School Teachers towards the Use of Concrete Materials in Constructing Mathematical Meaning

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ABSTRACT This work presents a research carried out in schools around Sekhukhune district, Limpopo, South Africa, investigating mathematics teachers' perceptions on the use of concrete materials in constructing mathematical meaning. The sample for the study consisted of 30 purposively selected mathematics teachers. A self-constructed questionnaire was administered to solicit teachers' perceptions towards the use of concrete materials in constructing mathematical meaning. Six constructs of teachers' perceptions for using or not using concrete materials were investigated: to teacher qualities, time and cost, learners' academic background, the motivational effects of concrete materials, nature of concrete materials and students' retention of knowledge. Descriptive and inferential statistics were applied to analyse the data. The results displayed that teachers hold different perceptions towards the use of concrete materials as teaching and learning aids. The main highlights of the study revealed that 86.7% of the participants agreed that teachers' experience and expertise determine the use of concrete materials as teaching and learning aids. The majority (96.7%) of the participants also subscribed to the notion that concrete material enhances teachers and students to bridge the gap that separates how mathematics is taught and how mathematics is learned. t-test results confirmed significant differences in the way males and females perceive the use of concrete materials. The results from ANOVA test indicate that teacher's experience has no significant effect on perceptions of the use of concrete materials.

INTRODUCTION

Mathematics teachers are constantly considering various ways of improving their teaching and helping students to understand mathematical concepts. Researchers hold the view that mathematics instruction and student understanding are more effective if concrete materials are used (Steedly et al. 2008). However, Maslen (2014) warned that concrete materials are potentially harmful if used improperly. Improperly used concrete materials are likely to convince students that two mathematical worlds exist: concrete materials and symbolic (Milgram and Wu 2008). Concrete materials must be relevant for the concept being developed and appropriate for the cognitive development level of the students. Thus, the utility of concrete materials in conveying mathematical concepts is deeply rooted in the teacher's ability to select, organise and make appropriate linkages. This research therefore attempts to gain insight into teachers' perceptions towards the use concrete materials in constructing mathematical meaning.

Concrete materials are regarded as a way of increasing mathematical understanding (Lee 2014). They are typically real-life objects that are used to represent mathematical concepts (Kosko and Wilkins 2010). The benefits associated with the use of concrete materials can be attributed Bruner's (1973) investigations in which concrete to materials were used to develop deep understandings of certain mathematical concepts. Teachers utilise them to clarify abstract mathematical concepts that ordinarily may be difficult for students, such as adding and subtracting integers, solving inequalities, and simplifying algebraic expressions (Lira and Ezeife 2008). The learning process involves transitioning from manipulating concrete materials to creating images from the student's perception of the concept, and finally to the development or adoption of some form of symbolic notation representing the concept (Ameron et al. 2011). Research indicates that students of all ages can benefit by first being introduced to mathematical concepts through physical exploration (Fraser 2013). By planning lessons that proceed from concrete to pictorial to abstract representations

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of concepts, content mastery becomes more accessible to students (Goonen and Pittman-Shetler 2012). With concrete exploration (through touching, seeing, and doing), students can gain deeper and lasting understandings of mathematical concepts.

Concrete materials are also perceived as hands-on models that appeal to the senses and can be touched by students (Heddens 2011). Teachers should select these materials in such a way that they relate to a student's real world. The teacher's successful use of concrete materials occurs when they are used as symbols as opposed to literal representations of what they actually are. In order to gain mathematical understanding using concrete materials, learners need to identify the mathematical concept being learned with the concrete materials used (Martin et al. 2012).Literature indicated that the use of concrete materials as teaching and learning aids can help teachers to create conducive classroom environments (Ross 2008). Concrete materials can also serve as a means of motivating learners (Merriam and Brockett 2011). Moyer (2001) observed that in lessons where concrete materials were used students appeared to be fascinated, active, and involved. Research also indicated that proper use of concrete materials yields on-task behaviour and student awareness. Students can only come to understand concepts when they are actively engaged in their own learning. They need to take control of their own learning and teachers must provide them with the opportunities to do so. Ferguson and McDonough (ý2010) supports the idea that concrete materials enhance teachers and students to bridge the gap that separates how mathematics is taught and how mathematics is learned. Strom (2009) also noted that use of concrete material in the classroom can help students to understand processes and communicate their mathematical thinking at all grade levels and extend their mathematical ideas to higher cognitive levels.

According to Moch (2001) some teachers perceive the use of concrete materials as a means to improve conceptual knowledge and help students to visualize abstract mathematics concepts (De George and Santoro 2004; Suh and Moyer 2007; Green et al. 2008). Piaget (1952) proposed that children do not have the mental maturity that is required to understand abstract mathematical concepts that are presented to them only in words and symbols. Therefore they need the guidance of the teacher to manipulate concrete materials. The utilization of concrete materials enables the teacher and learners to break away from the traditional classroom setting and instructional style.

Teacher's ability to use concrete materials appropriately in the classroom ensures that the learners grasp the mathematical concepts presented (Vinson 2001). While a kinaesthetic involvement can enhance perception, thinking, and conceptual understanding, Lett (2007) however stated that understanding does not take place through activity based learning. Kerekes (2006) raised concern that teachers view concrete materials as magical tools that heal all the problems that students have in acquiring mathematical knowledge. Concrete materials need to be introduced and used properly in order for them to work. According to Kelly (2006) concrete materials selected must support the goals of teaching. Kelly (2006) further cautioned teachers who give students the materials and allow them to play with them without ensuring that learning is taking place. Teachers need to plan and conduct lessons using concrete materials (Boggan et al. 2010). Students should be allowed an opportunity to discuss and share techniques and strategies related to concrete materials use. If there is no discourse between the teacher and students, the students are more likely to follow rote procedures for the use of the materials. Teachers using concrete materials in their classrooms need to possess a deep conceptual understanding and have the ability to pass that along to their students (Hounsell 2009).

In addition to conceptual understanding, it is recommended that teachers should have a certain comfort level in handling concrete materials in order to use them properly. Ross (2008) noted that teachers who are not comfortable with the use of concrete materials are likely to decrease the effectiveness of instruction, classroom management, and student achievement. Teachers trained to use and understand concrete materials properly may be able to override their natural tendency to teach the way they were taught (Borgen 2006). Teachers must be able to demonstrate how to use the concrete materials as tools for better understanding and open doors for many students who struggle with abstract symbols.

Another critical component of the use of concrete materials is that the teacher must be able to build a connection between the mathematical concepts that is learned through the use of the concrete materials and the intended procedural knowledge. If concrete materials are utilized to bridge the two types of knowledge, then they can be an essential and enlightening component of the mathematics experience (Brown 2007). Concrete materials should not be perceived as a means to quick fix or an exclusive method in solving math problems; however they are to be used as building blocks to provide students with the conceptual understanding of math content with the goal of enabling them to find their own efficient strategies for solving problems.

Concrete materials are also for aiding teachers to impart knowledge to students with limited English-language skills as they can focus on an object and how it relates to the mathematical concept rather than interpreting the language even before getting to uncover the concept they are to learn (DeGeorge and Santoro 2004). The use of concrete materials not only enriches the learning of average ability students, but also helps slow learners to develop their understanding without special modifications to the lesson for them. Concrete materials give the teachers and students a chance to work on concrete ideas, and slowly develop their abstract understanding, therefore scaffolding their learning (Moch 2001). Working with concrete materials focuses the students' attention solely on the activity at hand, so the teacher needs to direct the students' attention to the big picture of the concept (Suh and Moyer 2007).

Problem Statement

Concrete materials are instructional tools for learning abstract mathematical concepts, yet teachers tend to not use them due various explanations. They tend to hold various opinions about incorporating concrete materials in their teaching. There are conflicting views on the value of concrete materials for learning and transfer. Teachers face difficulties in deciding whether to present new knowledge in concrete terms (through concrete materials), when to present it in abstract terms, and when to combine these approaches. Knowledge of teachers' beliefs and teachers' teaching practices regarding the use of concrete materials is not highly studied in literature. Normally teachers hold different perspectives about the use concrete materials, on whether they impede or enhance lesson delivery. Such an unresolved situation continues to perplex teachers' decisions about incorporating concrete materials in their teaching. Therefore, this study seeks to investigate mathematics teachers' perceptions about the use of concrete materials in enhancing or impeding understanding. It seeks to establish the views teachers hold about the use concrete materials in constructing mathematical knowledge. The views held by these teachers help to explain the presence or absence of concrete materials in mathematics classes.

Significance of the Study

The use of concrete materials has been proposed as worthwhile but teachers have different reasons for using or not using these tools during instruction. This study therefore sought to present possible reasons or explanations that teachers have for using or not using concrete materials in their classrooms.

Objectives of the Study

The objectives of this study were:

a) To determine secondary teachers' perceptions towards the use of concrete materials in constructing mathematical meaning.
b) To investigate how concrete materials are being used in classroom, and teachers' perceptions of their efficacy in enhancing the learning of mathematics.
c) To gain a broad impression of the issues associated with concrete materials use from teachers' experiences.

Research Questions

1. What are the perceptions of mathematics teachers towards the use of concrete materials during mathematics instruction?
2. Do teachers perceive the use of concrete materials during mathematics instruction more effective in improving mathematics achievement?
3. What factors impede or facilitate mathematics teachers' use of concrete materials in developing mathematical concept and skills?

Research Hypotheses

The following hypotheses were tested:

- ***H_1*:** There is a significant relationship between concrete material use and student's performance/student maths understanding.
- ***H_2*:** There is a significant difference between gender and teacher perceptions on concrete material use.
- ***H_3*:** There is a significant difference between teaching experience and teacher perceptions on concrete material use.

Literature Review

Teacher competence or knowledge in using concrete materials is reported by researchers as an important factor in enhancing conceptual retention in mathematics. However, a number of important factors such as lack of time, availability of concrete materials, learners' prior and relevance of materials to the concept represented have been also identified as crucial. Uribe-Flórez and Wilkins (2010) reported that lack of time is considered to be an important factor because some teachers understand that activities involving concrete require more time. Trespalacios (2008) argued that teachers in his study recommended that time spend on concrete materials could be better utilized with other instructional approaches.

Classroom management is another factor that impedes teachers' use of concrete materials (the types of texts, equipment, and other learning resources that teachers use). Ormrod (2014) reported that the use of concrete materials is viewed as a strategy where students could get out of control as they may get overly enthusiastic working with concrete materials. Poorly designed lessons, uninteresting learning materials, or unclear expectations, for example, could contribute to greater student disinterest, increased behavioural problems. Some teachers avoid using materials because parents and others at the school believe that they are games and are counterproductive to teaching (Moyer 2001).

Motivation is another reason to explain the use of concrete materials in mathematics classes because lessons involving concrete materials are fun and engage students. A study conducted by Allen ý (2007) found that some of the teachers use concrete materials with the purpose of giving students enjoyment and fun. Furthermore, Morris (2013) also pointed out that students tend to enjoy activities involving concrete materials as teachers use those activities as rewards for students' behaviour instead of as active tools in helping them to learn mathematical concepts. In a similar view, Uribe-Flórez and Wilkins (2010) reported that through using these tools, students can see and feel concepts in a concrete way.

However, Literature indicates that teachers use concrete materials if they are looking for ways to involve students (Furner et al. 2005), make mathematics lessons more enjoyable (Moyer 2001), and help students learn mathematics (McNeil and Jarvin 2007). However, there are mixed interpretations about the ways to utilise these materials in order to accomplish objectives. Teachers assume that because they use teaching and learning aids, their lessons are enhanced, successful and entertaining. Despite all these positive contributions of concrete materials, it is worthwhile to note that their use does not guarantee understanding of mathematical concepts as eluded by Kamii et al. (2001).

Theoretical Framework

This study is guided by Piaget's constructivist view of learning. Piaget (1952) propounded that learners lack cognitive maturity to acquire mathematical concepts presented abstractly. Students are regarded as active learners that need to interact with their environment. Such interactions with the environment allow students to create their own understanding and meaning about the world. This view of learning postulates that children are not blank slates; instead they interact with their environment as they learn. The learning process takes place as learners create their own knowledge as a result of this interaction (Lippmann 2010). Hence the basic foundation of this theory is grounded on the notion that learners construct their own knowledge. Therefore, mathematical concepts cannot be simply presented to students; rather these learners must be actively involved and able to extract meaning out of mathematical concepts through experience (Moyer 2001).

When learning mathematics concepts, students need to have concrete references and examples on which to hinge and relate their learning experiences, and thereby solve problems (Wenglinsky 2003). This can be achieved through the use of concrete materials. Concrete materials should scaffold students cognitively until they are capable of thinking at the abstract level, and are able to generalize concepts to other concepts. Several studies indicated that 80% or more of secondary school students operate in the concrete operational stage rather than the formal operational stage (Hattie 2013; Thoron 2014). This has implications for mathematics instruction for students at this level. The highly abstract concepts such as operations with integers, square roots, and solving equations need learners to operate at the formal operational stage. If students are still operating and thinking in terms of concrete operations, secondary school teachers need to address this by using appropriate instructional materials such as concrete materials to enhance retention, and make mathematics more meaningful to the learners.

RESEARCH METHODOLOGY

Research Approach

The study was descriptive in nature. A quantitative research approach was used to analyse the hypothesised relationships.

Research Participants

Mathematics teachers (junior and senior) from the selected high schools in the Limpopo Province, South Africa, participated in this study.

Sample

The sampling frame was obtained from the office of HR in the Department of Basic education and a sample of 45 mathematics educators participated in the study. Purposive sampling technique was used to determine the sample to participate in the study. Purposive sampling technique is the deliberate choice of an informant due to the qualities the informant possesses (Tongco 2007). The researchers utilised this sampling technique as the best among other sampling techniques since the study was purposively conducted targeting mathematics teachers.

Measures

Five-item Likert scale seven-part self-administered structured questionnaire was used to solicit data for the study. The first part of the questionnaire tapped data related to demographic and occupational variables. This data was tapped with a view to obtaining a clear understanding of the participants for the study. The other six parts of the questionnaire were used to measure perceptions of mathematics teachers towards the use of concrete materials in constructing mathematical meaning.

Data Analysis

A statistical package (SPSS version 22) was used to analyse the data. Data analysis was done by means of the descriptive statistics, Pearson Product Moment Correlation technique, t-test, Analysis of Variance (ANOVA).

Ethical Consideration

Permission was sought and granted by the school principals of the selected high schools around Limpopo Province. Informed-consent protocols were sought with the participants. The researchers informed participants about the purpose of the research, expected duration and procedures. Participants' rights to decline to participate and to withdraw from the research were respected. In addition, confidentiality was maintained at all times and participants were informed through a letter from the principal's offices which communicated essential information about the research.

Reliability and Validity

In the present study, the Cronbach alpha for the 47-item questionnaire is 0 .798. This figure is viable since an acceptable value must lie between 0.70 and 0.90 (Mutodi and Ngirande 2014). To observe content validity, the questionnaire was structured so that the questions posed were clearly articulated and directed. All statements were formulated to eliminate the possibility of misinterpretations. This was followed by a pretest administered to 10 teachers who were excluded from the main study. The identified amendments were made to ensure simplicity and clarity of some questions, making it more understandable to the participants (Mutodi and Ngirande 2014). The Cronbach's alpha reliability coefficients for the other constructs are shown in Table 1.

Table 1: Cronbach's alpha reliability coefficients

Cronbach's coefficient alpha		
Variable(s)	*Number of items*	*Alpha*
Teacher qualities	10	0.742
Time and costs constraints	5	0.756
Motivation and attitudes	10	0.840
Learner qualities	5	0.566
Nature of concrete materials	9	0.696
Retention and understanding	8	0.721
Overall questionnaire	47	0.798

RESULTS AND DISCUSSION

Response Rate

A follow up of the questionnaires showed a good response rate from the research participants. At the end of the data collection phase, the total number of the completed questionnaires was 30. Given that the sample size of the study was 45, this represented a response rate of 67%. This was considered sufficient enough to continue with the analysis of the data as eluded by Fleiss et al. (2013) who posit that a response rate above 60% is acceptable.

The majority of teachers who participated in this study 25(83.3%) were males. The majority of the respondents 15(50%) range from 31-40 years of age, followed by 41 and above years of age 13(43.3%) and the least age group was within the range of 21-30 years 92(6.7%).The results in Table 2 furthermore show that most of the participants residing in the rural areas 20(66.7%) and were Sepedi speaking, 54% (237). Most of the participants 11(36.6%) had 11-15 years of teaching experience.

Table 2: Demographic variables: Gender, age, teaching experience, home language and residential area

Variable	*Categories*	*Frequency*	*Percentages (%)*
Gender	Female	5	16.7
	Male	25	83.3
Age	21-30 Years	2	6.7
	31-40 Years	15	50.0
	41 Years and above	13	43.3
Teaching Experience	5 years and below	1	3.3
	6-10 years	4	13.3
	11-15 years	11	36.7
	16-20 years	8	26.7
	21 years and above	6	20
Home Language	Sepedi	8	26.7
	Sotho	1	3.3
	Venda	3	10.0
	Shangane	1	3.3
	Shona	17	56.7
Residential Area	Urban	6	20.0
	Semi-urban	4	13.3
	Rural	20	66.7

Table 3 shows the teachers' perceptions on the use of concrete materials in constructing mathematical meaning. The study revealed that 26 (86.7%) of the participants agreed that teachers' experience and expertise determines the use of concrete materials as teaching and learning aids. The majority of the respondents, 29(96.7%) also agreed that concrete material help teachers and students to bridge the gap that divides how mathematics is taught and how mathematics is learned. Ferguson and McDonough (2010) supports the idea by stating that concrete materials can help teachers and students to bridge the gap that divides how mathematics is taught and how mathematics is learned.

A significant number of respondents 29 (96.75%) support that concrete material help teachers and students to bridge the gap that divides how mathematics is taught and how mathematics is learned. The results in Table 3 also show that most of the respondents 27(90%) also agreed that teachers must be able to build a connection between the mathematical concepts and the procedural knowledge that the concrete materials are expected to support. These findings in are consistent with the findings of Ferguson and McDonough (2010) that supported the idea that concrete materials can help teachers and students to bridge the gap that divides how mathematics is taught and how mathematics is learned.

However with reference to Table 3, 11(36.6%) of the respondents disagreed that teachers are reluctant to use concrete materials and also that teachers do not have adequate user guides to use concrete material respectively.

An important issue emerging from these findings is that teacher's experience and expertise determines the use of concrete materials, concrete material help teachers and students to bridge the gap that divides how mathematics is taught and how mathematics is learned. However, teachers using concrete material in their classrooms need to possess a conceptual understanding and have the ability to pass that along to their students. The data in Table 3 indicates con-

Table 3: Constructs of teachers' perceptions

Description	*Agree*		*Neutral*		*Disagree*	
	f	*%*	*f*	*%*	*f*	*%*
Perspectives on Teacher Variables						
Teacher's experience and expertise determines the use of concrete materials (teaching and learning aids).	26	86.7	4	13.3	0	0
Teachers are reluctant to use concrete materials.	17	56.7	2	6.7	11	36.6
Teachers do not have adequate user guides.	17	56.7	2	6.7	11	36.6
Teachers have limited choice and variation of concrete material use	19	63.3	4	13.3	7	23.4
Concrete material help teachers and students to bridge the gap that divides how mathematics is taught and how mathematics is learned.	29	96.7	1	3.3	0	0
Concrete materials allow the teacher and pupils to break away from the traditional classroom setting and instructional style.	25	83.3	3	10	2	6.7
Teachers using concrete material in their classrooms need to possess a deep conceptual understanding and have the ability to pass that along to their students.	22	73.4	4	13.3	4	13.3
Teachers who are not comfortable with the use of manipulative materials are likely to decrease the effectiveness of instruction, classroom management, and student achievement.	25	83.3	3	10	2	6.7
Teachers must be able to build a connection between the mathematical concepts and the procedural knowledge that the concrete materials are supposed to support.	27	90	2	6.7	1	3.3
Teachers who are not comfortable with the use of concrete materials are likely to experience classroom management problems.	21	70	5	16.7	4	13.3
Time and Cost Perspectives						
Time allocated for instruction (teaching/learning) is too short to include concrete materials.	12	40	2	6.7	16	53.3
Time for preparation of the use of concrete materials is limited.	15	50	1	3.33	14	46.7
Time to test the effectiveness of concrete materials use is limited.	11	36.6	5	16.7	14	46.7
Issue of cost or availability of concrete materials determines their presence in the class.	19	63.3	2	6.7	9	30
Activities involving concrete materials require more time that could be better utilized with other instructional approaches.	15	50	5	16.7	10	33.3
Motivation and Attitudes Towards Mathematics						
The use of concrete materials in teaching mathematics will help students learn to relate real world situations to mathematics symbolism.	29	96.7	0	0	1	3.3
The use of concrete materials in teaching mathematics will help students to work cooperatively in solving problems, discuss mathematical ideas and concepts.	30	100	0	0	0	0
The use of concrete materials is a fun and easy way to introduce and visualize a mathematical concept.	28	93.3	1	3.3	1	3.3
The use of concrete materials leads to a decrease in math anxiety.	13	43.3	5	16.7	12	40
The use of concrete materials makes students retain the knowledge better.	23	76.7	5	16.7	2	6.7
Through touching, seeing, and doing, students can gain deeper and longer-lasting understandings of math concepts.	27	90	1	3.3	2	6.7
The use of concrete materials leads to increased student mathematics performance.	25	83.3	3	10	2	6.7
The use of concrete materials leads to improved attitudes towards mathematics.	26	86.6	2	6.7	2	6.7
The use of concrete materials can produce meaningful use of notational systems and increase student concept development.	26	86.7	1	3.3	3	10
The use of concrete materials serves as a means of motivating learners.	27	90	0	0	3	10
Learner Qualities						
Learners' prior knowledge affects their understanding of mathematics via the use of concrete materials.	25	83.3	3	10	2	6.7
Learners sometimes fail to identify the mathematical concept being learned with the concrete materials used.	17	56.7	3	10	10	33.3
The use of concrete materials helps students to extend their mathematical ideas to higher cognitive levels.	25	83.3	2	6.7	3	10

Table 3: Contd...

Description	Agree		Neutral		Disagree	
	f	%	*f*	%	*f*	%
Students sometimes treat concrete materials as representations instead of symbols for mathematical concepts.	17	56.7	11	36.7	3	10
Concrete materials need to be introduced and used properly in order for them to work.	23	76.7	5	16.7	2	6.7
The Nature of Concrete Materials						
The use of concrete materials is potentially confusing to the learners if their presentation is haphazard and disorganized.	24	80	2	6.7	4	13.3
The use of concrete materials is potentially confusing to the learners if lacking appropriate guidance and instruction from the teacher.	21	70	3	10	6	20
The use of concrete materials is a potential cause of classroom management and control problems.	8	26.7	7	23.3	15	50
Concrete materials and intended reference relation is not easy to establish.	10	33.3	8	26.7	12	40
The use of concrete materials is inappropriate for students above primary school level.	8	26.7	4	13.3	18	60
Class sizes are too large to be taught using concrete materials.	13	43.3	3	10	14	46.7
The use of concrete materials may prevent students from learning abstract thinking skills.	11	36.7	4	13.3	15	50
The use of concrete materials could cause students to become too accustomed to the activities of the lesson and forget the actual lesson.	10	33.3	4	13.3	16	53.4
Not all concrete materials can be used to meet curriculum expectations.	20	66.7	3	10	7	23.3
Retention and Understanding of Mathematical Concepts						
The use of concrete materials can be used to introduce concepts.	26	86.6	2	6.7	2	6.7

firm that teachers who are not comfortable with the use of manipulative materials are likely to decrease the effectiveness of instruction, classroom management, and student achievement.

The study also investigates whether time and cost perspectives play a significant role in teachers‘ perception towards concrete material use in constructing mathematical meaning to students. Results in Table 3 depict that the majority of the participants agreed that the issue of cost or availability of concrete materials determines their presence in the class 19(63.3%), activitiesinvolving concrete materials require more time that could be better utilized with other instructional approaches. Fifteen (50%) indicated that time for preparation of the use of concrete materials was reported to be limited as well. However this view was opposed by 16(53.3%) of the participants who disagreed with the statement that time allocated for instruction (teaching/learning) is too short to include concrete material use during teaching mathematics in classroom.

The results are supported by previous studies which reported that lack of time is considered to be an important factor because some teachers understand that activities involving concrete require more time (Uribe-Flórez and Wilkins 2010). Similarly, Trespalacios (2008) also reported that teachers in his study recommended that time spend on concrete materials could be better utilized with other instructional approaches. From the results, the majority of the participants perceive that time was a limiting factor for them to make use of concrete materials in their mathematics classrooms although some tend to differ with the statement.

In trying to understand the reasons and attitudes of teachers towards the use of concrete materials in teaching mathematics, results in Table 3 show that the majority of the respondents 30(100%), agreed that the use of concrete materials in teaching mathematics will enhance students to work cooperatively in solving problems, discuss mathematical ideas and concepts. Twenty-nine (96.7%) of the participants also supports that the use of concrete materials in teaching mathematics will help students learn to relate real world situations to mathematics symbolism. This is supported by the literature which pointed out that some teachers reported that through using these tools, students can see and feel concepts in a concrete way (Uribe-Flórez and Wilkins 2010). Therefore these tools help introduce abstract concepts in mathematics as well as increase students' understanding.

Respondents were also asked whether the use of concrete materials is easy to introduce and visualize a mathematical concept. From their responses, 28(93.3%) strongly agreed with the statement, followed by 27(90%) who also share the same sentiments and also indicated that through touching, seeing, and doing, students can gain deeper and longer-lasting understandings of math concepts. Moyer (2001) also shares similar sentiments when he pointed out that in lessons where concrete materials are used, students appeared to be interested, active, and involved.

The respondents were also asked whether the use of concrete materials leads to a decrease in math anxiety. The results from Table 3 show that almost an equal number of participants 13(43.3%) agreed, whilst 12(40%) disagreed with the statement as well. However, the results revealed that concrete material use is very important in assisting students in better understanding of mathematics. In support of this, Ross (2008) also pointed out that the use of concrete materials as part of instruction can help teachers to create favourable classroom environments.

Table 3 shows how teachers perceive leaner qualities as a factor that influences their understanding of mathematics concepts through the use of concrete. Twenty-five (83.3%) of the participants agreed that learners' prior knowledge affects their understanding of mathematics via the use of concrete materials, 3(10%) of the participants neither agree nor disagree and only 2(6.7%) disagreed with the statement. Seventeen (56.7%) of the participants indicated that learners sometimes fail to identify the mathematical concept being learned with the concrete materials used and 10(33.3%) of them disagreed with the statement.

The results also show that concrete materials need to be introduced and used properly in order for them to work as shown by 23(76.7%) of the participants who agreed to the statement with only 2(6.7%) who disagreed with the statement. The results are supported by Strom (2009) who pointed out that concrete material use in the classroom can help students at all grade levels to understand processes, communicate their mathematical thinking, and extend their mathematical ideas to higher cognitive levels.

Table 3 shows the perceptions of teachers on whether the nature of concrete materials used will influence students' understanding of mathematics. The results show that the majority 24(80%) of the participants agreed that the use of concrete materials is potentially confusing to the learners if their presentation is haphazard and disorganized and only, 21(70%) agreed that the use of concrete materials is potentially confusing to the learners if lacking appropriate guidance and instruction from the teacher and 20(66.7%) also agreed that not all concrete materials can be used to meet curriculum expectations.

The findings are in line with the literature as Kelly (2006) states that concrete materials selected must support the goals of teaching. Simply giving the students the materials and allowing them to play with them will not ensure that learning is taking place. Furthermore, teachers need to develop and oversee lessons utilizing concrete materials (Boggan et al. 2010). Teachers using concrete materials in their classrooms also need to possess a deep conceptual understanding and have the ability to pass that along to their students (Hounsell 2009). Given this, one can argue that in order for concrete materials to be used to their maximum potential, they must be utilized properly.

However, results in Table 3 indicate that 15(50%) of the participants disagreed that the use of concrete materials is a potential cause of classroom management and control problems. From the results, one can argue that the nature of concrete materials used can have an effect to the understanding of students and teachers should be very careful with the nature of concrete materials to use so as to minimise their negative effects to student understanding.

Teachers' perceptions on whether the use of concrete materials assist students retention and understanding of mathematical concepts, results in Table 3 shows that the majority of participants, 26(86.6%) agreed that the use of concrete materials can be used to introduce concepts and can help children to grasp concepts or reinforce them respectively. Results also show that most of the participants also agreed that the use of concrete materials helps to improved children's fine motor skills 24(80%), helps to provide opportunities for collaborative learning and peer tutoring to occur 25(83.3%) as well as relieve boredom in students 20(66.7%). From the results, the study revealed that teachers perceive the use of concrete materials as a tool for student retention and understanding of mathematical concepts. The results are in line with Goldstone and Son (2005) who revealed that concrete materials can also serve as a means of motivating learners. The research findings are supported by several studies which postulate that concrete materials have been found to improve conceptual knowledge and help students to visualize abstract mathematics concepts (De George and Santoro 2004; Suh and Moyer 2007; Green et al. 2008).

Pearson's correlation coefficient (r) results in Table 4 shows that there is a weak positive relationship between teacher qualities and learner qualities (r=.455*, p=0.011). This means that students' variables such as strong prior knowledge, ability to identify the mathematical concept being learned with the concrete materials used and their ability to treat concrete materials as representations instead of symbols for mathematical concepts has an influence on their understanding of mathematical concept being explained by the concrete materials. The results are compatible with Dunlosky's (ý2013) findings which revealed that students' background knowledge affects their conceptual understanding if they are taught using teaching and learning materials.

The results of the study also yields a statistically significant positive correlations with teacher quality and time and costs (r=0. .487**, p=0.006). This means that teachers perceive cost and time to prepare the teaching materials as an important variable that determines their presence or absence in their classes.

The results of the study also yields a statistically significant positive correlations with the motivating effects of concrete materials and students retention of mathematical concepts (r=0. 503**, p=0.005).This means that teachers perceived concrete materials as a source of student motivation as well as facilitating students' retention and understanding of mathematical concepts. These findings are consistent with views from Kosko and Wilkins (2010) who found that concrete materials motivate and increase students' retention of mathematical concepts.

The results of the study yields a statistically insignificant correlations between the motivating effects of concrete materials and nature of concrete materials (r=0.005, p=0.979), teacher quality and nature of concrete materials(r=0.145; p=0.444), cost and time and motivation(r=-0.105; p=0.585).

Table 4: Correlations

		Teacher variables	*Time and variables*	*Motivation and attitudes*	*Learner qualities*	*Nature of concrete materials*	*Retention and understan-ding*
Teacher Variables	Pearson Correlation	1	.175	.300	.455*	.145	.355
	Sig. (2-tailed)		.354	.107	.011	.444	.054
	N	30	30	30	30	30	30
Time and Cost Variables	Pearson Correlation	175	1	-.105	.487**	.457*	-.014
	Sig. (2-tailed)	.354		.582	.006	.011	.942
	N	30	30	30	30	30	30
Motivation and Attitudes	Pearson Correlation	.300	-.105	1	.301	.005	.503**
	Sig. (2-tailed)	.107	.582		.106	.979	.005
	N	30	30	30	30	30	30
Learner Qualities	Pearson Correlation	.455*	.487**	.301	1	.475**	.372*
	Sig. (2-tailed)	.011	.006	.106		.008	.043
	N	30	30	30	30	30	30
Nature of Concrete Materials	Pearson Correlation	.145	.457*	.005	.475**	1	-.022
	Sig. (2-tailed)	.444	.011	.979	.008		.906
	N	30	30	30	30	30	30
Retention and Understanding	Pearson Correlation	.355	-.014	.503**	.372*	-.022	
	Sig. (2-tailed)	.054	.942	.005	.043	.906	
	N	30	30	30	30	30	30

A t-test was conducted to test whether there was a significant difference between male and female teachers' perceptions towards the use of concrete materials. It must be recalled that the study hypothesised that there is a significant difference between male and female teachers' perceptions of the use concrete materials in constructing mathematical meaning. The results for the t-test are shown in Table 5 (df = 29, t =16.858, p=0.00). The null hypothesis was rejected since the p-value is less than 0.05. Therefore we conclude that there is a significant difference in the way concrete materials are perceived between males and females. This is consistent with findings by Perry et al. (2006) that showed that male consistently reported slightly more positive perceptions and attitudes than females. However a research carried out by Bobis (2002) showed that the teachers had positive attitudes towards the use of concrete materials is medium and reports no gender differences in their perceptions.

To assess if there are significant differences in perceptions based on teachers' experiences as mathematics educators, an Analysis of Variance (ANOVA) was conducted to test the following hypothesis.

***H_1*:** There is a significant difference in perceptions of the use of concrete materials in constructing mathematical meaning based on teachers' experience.

The results of the test in Table 6 are (df = 4, df =25, F= 1.139, p=0.361).Therefore, the null hypothesis is retained since p>0.05 and conclude that there are no significant differences in teachers' perceptions about the use of concrete materials. Teacher's experience has no significant effect but the expectation was that most experienced teachers value the use of teaching materials than newly qualified teachers (Alderman 2013).

CONCLUSION

Generally, the majority of teachers indicated the use of concrete materials is positively related to increased achievement and improved attitudes towards mathematics. Responses to items regarding teacher qualities indicated an overall consensus that teacher experience and expertise determines their use of concrete materials as teaching and learning aids. Teachers' confirmed that the use of concrete materials can produce meaningful understanding and increase student concept development. Teachers perceive that the use of concrete materials enable students and teachers to represent concretely the abstract concepts that they are learning in mathematics class and to link these concepts to prior knowledge. This result led to the conclusion that the use of concrete during instruction has a positive influence towards shaping students' attitudes toward mathematics.

In terms of time and cost, respondents confirmed that cost or availability of concrete materials determines their presence in the class. Respondents strongly agreed that activities involving concrete materials require more time that could be better utilized with other instructional approaches. Preparation time was also pointed out as limiting factor while instructional time was

Table 5: t-test

	Test value = 0					
	t	*df*	*Sig. (2-tailed)*	*Mean difference*	*95% Confidence interval of the difference*	*95% Confidence interval of the difference*
					Lower	*Upper*
Gender	16.858	29	.000	1.1667	1.025	1.308

Table 6: Anova

	Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Between groups	1.407	4	.352	1.139	.361
Within groups	7.723	25	.309		
Total	9.130	29			

too short to accommodate the use of concrete materials. Overally, the results indicated limited time and cost as impediments to the use of concrete materials. In terms of motivation and developing positive attitudes towards mathematics respondents reported that the use of concrete materials in teaching mathematics enhances students to work cooperatively in solving problems, discuss mathematical ideas and concepts.

In terms of learner qualities findings revealed that learners' prior knowledge affects their understanding of mathematics via the use of concrete materials. From a pedagogical point of view participants agreed that the use of concrete materials is potentially confusing to the learners if their presentation is haphazard and disorganized. Hence teachers need to present knowledge logically and provide strong links between the concept and its real –world representation. Finally the study revealed that teachers perceive the use of concrete materials enhances student retention and understanding of mathematical concepts.

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