

Teachers' Perception of the Relevance, Adequacy and Confidence in their Preservice Content and Pedagogical Knowledge in the Teaching of Secondary School Mathematics

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Abstract: Teachers in an education system are one of the core pillars in achieving educational goals. There is no education system that can progress and succeed to enculturate succeeding generations without teachers. Teacher quality and quality of instruction require comprehensive preservice or in-service teacher education and training programs. A teachers' training program is aimed at producing quality and effective teachers who eventually can guide students not only on academic success but also in the lifelong learning. Descriptive survey research design was adopted for the study. The target population of study comprised of Mathematics teachers in Konoin Sub County, Bomet County, Kenya. A total of 70 (89.7%) of the mathematics teachers selected participated in the study. The research instrument used was a questionnaire which consisted of five closed-ended question items. Data collected was coded and analyzed. Statistical significance was evaluated based on the Chi-square goodness-of-fit test, Fisher's exact and Freeman-Halton test (an extension of Fisher's exact test). The findings shows that majority of the mathematics teachers perceive their preservice mathematics content as not relevant to teach secondary school mathematics compared to those who perceive as relevant dependent on initial academic qualifications. Majority of teachers were not confident. High number of teachers attributed the content they teach to their secondary school mathematics teacher. Majority of teachers perceived general methods of teaching taught in college are applicable and adequate to their practice compared to those who perceived as not applicable.

Key Word: Secondary school, mathematics, pedagogical content knowledge, preservice training

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I. Introduction

Teachers in an education system are one of the core pillars in achieving educational goals. There is no education system that can progress and succeed to enculturate succeeding generations without teachers. Teachers' roles in the education of a society's children are many and interrelated: they act as role models besides their critical duty of imparting knowledge. Thus, the place of teachers in our schools and school systems cannot be wished away. Consequently, the urgent question to be address and has been lingering for quite some time now, should be on how to enhance the "quality" of teachers in order to be effective in their roles in schools.

Teacher quality and quality of instruction require comprehensive preservice or in-service teacher education and training programs (Ball & Hill, 2007). These programs should lead to "reasonable standards of mathematical proficiency" (Ball, Hill & Bass, 2005). Research findings should inform the grafting of these programs so as to yield optimum benefits to all education stakeholders. It is true thus far that various concerns have been raised on lack of (or inadequate) research on preservice training of teachers on how best their programs should be tailored to suit their practice. The OECD (2005) report, "Teachers Matter; Attracting Developing and Retaining Effective Teachers", commented on lack of existing research on preservice teachers education in many of the OECD countries and stated that in many countries there were no extensive research gaps concerning teachers, their preparation and their work careers. This call has seen enhanced efforts to offer proposals on possible solutions (Ball & Hill, 2007; Ball, Hill & Bass, 2005; Thanheiser, Browning, Moss, Watanabe & Garza-Kling, 2010).

A teachers' training program is aimed at producing quality and effective teachers who eventually can guide students not only on academic success but also in the lifelong learning. Though a complex of factors determines students' achievement, Olfos, Goldrine, and Estrella (2014) emphasized that educational context, student and teacher characteristics (such as socioeconomic class of the student's family and the teacher's own knowledge) are some of the main factors (Akiba, Letendre & Scribner, 2007; OECD, 2009). Teacher's knowledge is the key to teacher's quality.

In these paper, we report the findings on the perceptions of mathematics teachers on their preservice knowledge as regards to relevance, confidence and adequacy in handling secondary school mathematics. Some studies have shown that the mathematical understanding required of a (mathematics) teacher (for quality education) is a specific professional knowledge that can be acquired in preservice training and developed through reflections on teaching practices (Grossman, 2008; Hine, 2015; Leong, Meng& Rahim, 2015; Turnuklu&Yisildere, 2007).

Theoretical Background

Teacher's knowledge, refers to a multidimensional construct that comprises a number of subdomains. These domains were first advanced by Lee Shulman (Shulman, 1986). This conception of teacher knowledge as multidimensional has undergone numerous extensions and expositions (see for example, Anguilar-Gonzalez, Munoz-Catala& Carrillo, 2019; Ball & Hill, 2007; Ball, Hill & Bass, 2005). Pedagogical Content Knowledge (PCK) model espoused by Shulman (Shulman, 1987) provided guidance on responses elicited from teacher perception reported in this paper. Shulman advances the view that teacher's professional knowledge draws from sources of knowledge that can be identified. These are: content knowledge, pedagogical knowledge and pedagogical content knowledge amongst others like knowledge of the curriculum, knowledge of learners and knowledge of educational context, settings and governance.

Marks (1990) classified PCK for mathematics teachers identifying four components strands: knowledge of student understanding, knowledge of subject matter for instructional purposes, knowledge of media for instruction, and knowledge of instructional processes (Figure 1 shows a simplified version of teacher's knowledge). According to Olfos et al. (2014), the past 25 years have seen an internationally increasing focus on the command of content required by teachers for effective teaching.

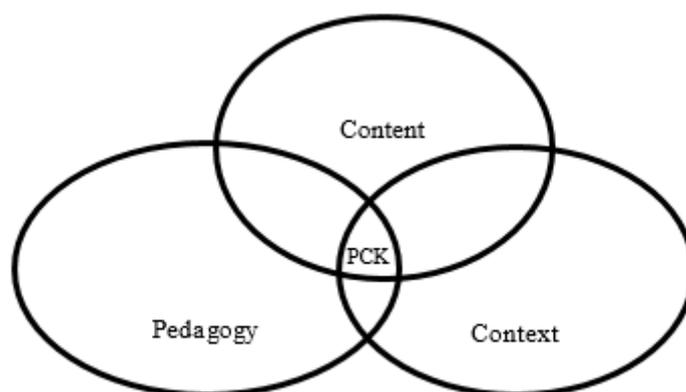


Figure 1. Shulman (1986) Domains of Pedagogical Content Knowledge

Teacher's Content Knowledge

Content knowledge, is the “what” of teaching or the subject-matter knowledge. This kind of knowledge is different for the different subjects taught in the school and is required by the teachers in order to teach their respective subjects effectively in the classroom. To teach mathematics effectively teachers must have a good mastery of substantive and syntactic structures of Mathematics. Mathematics knowledge is widely acknowledged as one of the critical attributes of mathematics teachers (Ponte & Chapman, 2008). They must not only be capable of telling students the accepted facts ,concepts and principles of different branches of mathematics but they must also be able to explain to students why a particular principle is worth knowing and how it relates to other principles within the same branch and across other branches of mathematics. Good grasp of mathematics knowledge leads to effective mathematics instruction and student learning (Ball & Hill, 2007; Lannin, Webb, Chval et al., 2013).

Wenglinsky (2002) and Gustafsson (2003) hold that teachers' content knowledge relates directly to student achievement. Wilson, Floden and Ferrini-Mundy (2001) reviewed 57 empirical research studies in the United States teacher education and found evidence of a positive relationship between teachers' preparation in terms of subjects matter and the performance of their students. However, Ball, Hill and Bass (2005) affirmed that many US teachers lack sound mathematical understanding and skill. Research on mathematics teaching suggests that many teachers do not possess the requisite subject-matter knowledge to implement high-quality instruction (Hill, Rowan & Ball, 2005; Ma, 1999, Olfos et al. 2014). The National Mathematics Advisory Panel (NMAP) (2008) underscores the need for teachers to “know” mathematics knowledge for teaching in order to teach effectively, “Teachers must know in detail and from a more advanced perspective the mathematical content they are responsible for teaching and the connections of that content to other important mathematics, both prior to and beyond the level they are assigned to teach” (p38).

Teacher's Pedagogical Knowledge

Pedagogical knowledge includes the 'how' of teaching generally acquired through education course work and experiences in the schools. Pedagogical knowledge comes from three sources:

The discipline perspective: This is based on breadth and the depth of content knowledge i.e. understanding of the organization of concepts and principles in the discipline (basic to the subject matter to be taught) and the strategies the discipline uses to enable the learners understand those concepts and processes as well as the use of that knowledge and its application in daily life.

The learner perspective: This concerns the rich factual knowledge base with many interconnections such as knowledge of analogies, similes, examples and metaphors by which to explain the subject matter to the pupils; as well as knowledge of learners' pre-conceptions, experience in everyday life and difficulties that are commonly experienced by pupils that may help teachers to effectively guide their learners. The pupil perspective calls for the kind of teaching that puts the learner in the center of the learning process, recognizing the learners current understandings and the pre-conceptions that may affect learning (Driver, 1995). The learner's day to day experiences should be used to develop new scientific understanding.

The general methodology perspective: This concerns the knowledge of and insight into the different ways in which topics can be taught and the pros and cons of each approach (Shulman, 1987). The general methodology perspective will require that a mathematics teacher become conversant with the various methods of teaching and the advantages and disadvantages of various methods employed.

Teacher's Pedagogical content knowledge

Apart from acquiring relevant content knowledge, it has been argued that to be a successful mathematics teacher also requires a solid foundation in pedagogical content knowledge which is a type of professional knowledge that is used to teach the mathematics subject content (Olfo et al. 2004; Wilson, Floden & Ferrini-Mundy, 2002). PCK represents a blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted and represented for instruction (Shulman, 1986). Notice therefore, that content knowledge (CK) and pedagogical content knowledge (PCK) are strongly related but distinct entities (Turnuklu & Yesildere, 2007). According to An, Kulm, and Wu (2004), "teaching knowledge" is the basic component of pedagogical content knowledge out of the following three teacher knowledge domains: content, curriculum, and teaching.

In Shulman (1987) view, pedagogical content knowledge is a form of practical knowledge that is used by teachers to guide their actions in a highly contextualized classroom setting. This form of practical knowledge among other things entails (a) knowledge of how to structure and represent academic content for direct teaching to students (b) knowledge of the common conceptions, misconceptions, and difficulties that students encounter when learning a particular content (c) knowledge of the specific teaching strategies that can be used to address students learning needs in particular classroom circumstances. In their contribution to clarify the knowledge required to teach mathematics; Ball, Hill and Bass (2005) and Hill, Ball and Schilling (2008) categorized PCK into three subdomains as (a) knowledge of content and students (KCS), (b) knowledge of content and teaching (KCT), and (c) knowledge of curriculum.

Ball, Hill and Bass (2005) assert that the capacity of teachers to use instructional, assess students' progress and making sound judgments is influenced by how well they know mathematics. However, challenges abound that hinder teacher's acquisition of adequate knowledge. Two main challenges have been associated with ensuring that teachers have the adequate content knowledge to teach mathematics effectively. First, because mathematics education research has been fraught with philosophical differences, defining the content or subject matter that teachers should master has been a matter of some debate (National Council of Teachers of Mathematics, 2006; National Mathematics Advisory Panel, 2008). Second, the use of indirect indicators or proxies for teacher knowledge, such as certification, coursework, and teacher licensing exams, rather than more robust and direct measures of teachers' mathematical knowledge, has made the study of content knowledge and its link to student learning difficult (Hill, Rowan, & Ball, 2005).

Secondary School Mathematics Curriculum in Kenya

Mathematics in the secondary school curriculum in Kenya is one of the compulsory subjects. Secondary mathematics aims at producing a person who will be numerate, orderly, logical, accurate and precise in thought. The person should be competent in appraising and utilizing mathematical skills in playing a positive role in the development of a modern society. The curriculum has been designed in a way that ensures continuity from primary mathematics, broadens the basic skills already established, takes care of the needs of those learners who will leave the formal education at the end of the four year secondary cycle and prepares those

learners who will pursue further studies in the subject and other related courses. The mathematics curriculum is guided by 12 general objectives summarized by Mwei and Too (2017, pp. 230-231) as under:

1. To use mathematics as a tool to solve real world problems, personal and in the society in general, and for further training in mathematics and other related fields of study.
2. To acquire competence in the language of mathematics, to be fluent in the words, symbols and the specific syntax of mathematics language in order to communicate mathematical ideas clearly and concisely.
3. To nurture critical thinking and reasoning, by acquiring investigative and problem solving skills, and to handle data in order to establish mathematical relationships, generalizations and predictions.
4. To acquire favorable attitudes towards and confidence in mathematics, and readiness for collaborative work.

The mathematics content for secondary education covers a number of concepts categorized into: Numbers, measurement, algebra, shapes and space, commercial arithmetic, data and elementary calculus (Mwei & Too, 2017, p. 232). These concepts are not exclusive but overlap.

Preservice Training for Secondary Mathematics Teachers in Kenya

Secondary school mathematics teachers are initially trained under Diploma in Education, Bachelor of Education, and Bachelor of Arts or Bachelor of Science with a Post Graduate Diploma in Education. The Bachelor of Education mathematics course aims at producing a mathematics teacher who is equipped with methods and skills for teaching in secondary schools, primary and secondary teacher training colleges, ECDE teacher colleges, institutes and polytechnics (Otunga, Odera&Barasa, 2011). The course content at this level has two major components: the mathematical content and the pedagogy. The mathematical content consist of the content of secondary school curriculum and advanced courses on some mathematics topics like calculus and analytic geometry, geometry and applied mathematics, probability and statistics, vector analysis, introduction to computers, ordinary differential equations and algebra.

Pedagogical knowledge is composed of general areas in education and special methods in teaching mathematics. There are also common university courses which include courses in communication skills, quantitative skills, development concepts, state society and development and entrepreneurship Bachelor of education programs are mainly offered by universities. Every university designs its own curriculum basing on its philosophical orientation. Each university design its own course code, course name, course units, number of hours per week, course duration, when the course will be offered during the degree program, the objectives of the course, course description and the evaluation procedures.

In this study, we investigate mathematics teachers' perception on the relevance and adequacy of their pedagogical content knowledge and confidence in mathematics and methodology units in their preservice training programs. We assume that practicing teachers are able to retrospectively identify how well their preservice training prepared them to the tasks they are undertaking in their daily routine in teaching mathematics.

Research Objectives

The study had the following objectives:

1. To determine mathematics teachers perception of the Relevance of preservice mathematics subject content to the secondary school mathematics.
2. To determine mathematics teachers' confidence in their ability to teach secondary school mathematics using preservice mathematics content.
3. To find out whom to mathematics teachers attribute the content they teach in secondary school.
4. To determine the applicability of the general teaching methods learnt during preservice training to teaching.
5. To determine the adequacy of the number of methodology courses learnt.

Hypotheses

Each of the research objective above yielded two hypotheses, expressed here in their null form:

Hypothesis (H01): There is no statistically significant difference in the number of teachers who perceive mathematics content learnt in preservice training as relevant and those who perceive as not relevant.

Hypothesis (H02): There is no significant difference in teacher's perception of the relevance of mathematics content learnt in preservice training based on their initial academic qualification.

Hypothesis (H03): There is no significant difference in the number of teachers who are confident and those not confident in their ability to teach secondary mathematics with the subject content learnt during preservice training.

Hypothesis (H04): There is no significant difference in teachers' confidence on their ability to teach secondary mathematics with the subject content learnt during preservice training based on initial academic qualification.

Hypothesis (H05): There is no significant difference in the number of teachers who attribute mathematics content they teach in secondary school to secondary school teacher, college subject content or both.

Hypothesis (H06): There is no significant difference in the number of teachers who attribute mathematics content they teach in secondary school to secondary school teacher, college subject content or both based on initial academic qualifications.

Hypothesis (H07): There is no statistically significant difference in the number of teachers who perceive general teaching methods learnt in preservice training as applicable and those who perceive as not applicable.

Hypothesis (H08): There is no significant difference in teacher's perception of general teaching methods learnt in preservice training as applicable and those who perceive as not applicable based on their initial academic qualifications.

Hypothesis (H09): There is no statistically significant difference in the number of teachers who perceive number of methodology units learnt in preservice training as adequate and those who perceive as not adequate.

Hypothesis (H10): There is no statistically significant difference in the number of teachers who perceive number of methodology units learnt in preservice training as adequate and those who perceive as not adequate based on their initial academic qualifications.

II. Material And Methods

Descriptive survey research design was adopted for the study. This design is appropriate for this study because it sought the views of teachers on their perception of the relevance, adequacy and confidence in their preservice pedagogical content knowledge for teaching secondary school mathematics. The target population of study comprised of Mathematics teachers in Konoin Sub County, Bomet County, Kenya. A total of 70 (89.7%) of the mathematics teachers selected participated in the study. The research instrument used was a questionnaire which consisted of four closed-ended question items.

Question One required respondents to provide responses on a four-point scale: strongly agree, agree, disagree and strongly disagree. Question Two on a five-point scale: strongly agree, agree, undecided, disagree and strongly disagree. Question Three to choose among three choices (secondary school teacher, college subject matter and both). Question Four on a four-point scale as in question one, and finally, Question Five on a five-point scale: very adequate, adequate, undecided, inadequate and very inadequate.

Data collected was coded and analyzed. Statistical significance was evaluated based on the Chi-square goodness-of-fit test, Fisher's exact and Freeman-Halton test (an extension of Fisher's exact test). The Chi-square values (χ^2) obtained with the corresponding degrees of freedom were fed into the Microsoft Excel, **CHIDIST(x, deg_freedom)** function to obtain p - values which were then compared with the significance level, $\alpha = .05$. Furthermore, any significant Freeman-Halton tests were subjected further to post-hoc tests using either Fisher's Exact or Freeman-Halton tests as pairwise comparisons with Bonferroni correction (Hazra & Gogtay, 2016; McDonald, 2014; Shan & Gerstenberger, 2017; Sharpe, 2015). The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result and Discussions

Teachers Initial Academic Qualifications

The initial academic qualifications of the respondents were categorized as either Diploma in Education (Diploma), Bachelor of Education degree (BEd), Bachelor of Arts (BA) or Bachelor of Science (BSc) with Post Graduate Diploma in Education (PGDE). Initial academic qualification is the qualification with which a teacher entered the teaching profession. Out of the 70 mathematics teachers respondents, 24(34.3%) initially trained under Diploma in Education program, 42(60.0%) initially trained under Bachelor of Education degree program while (5.7%) initially trained under either Bachelor of Arts or Bachelor of Science degree program with PGDE.

Research Objective One: To determine mathematics teachers perception of the Relevance of preservice mathematics subject content to the secondary school mathematics.

Mathematics teachers were asked to respond to the question: "*the mathematics content that I learnt in college was relevant to what I teach in the secondary school*" on a four-point Likert-type item (Strongly Agree, Agree, Disagree and Strongly Disagree). The results indicated that majority of the respondents, 33(47.1%) disagreed to this statement while the least 3(4.3%) strongly agreed. Those who agreed were 16(22.9%) and those that strongly disagreed were 18(25.7%). When we collapsed the number of categories into "relevant" (strongly agree and agree), "not relevant" (strongly disagree and disagree) to secondary school teaching and the "undecided" as shown in Table 1. A majority of respondents, 51(72.9%) felt that the content they learnt in college is not relevant to what they teach in secondary school mathematics. In contrast, 19(27.1%) felt that what they learnt in their preservice training is relevant.

H01: There is no statistically significant difference in the number of teachers who perceive mathematics content learnt in preservice training as relevant and those who perceive as not relevant.

To test whether the number of teachers who perceived their preservice mathematics content as “relevant” and those who perceived as “not relevant” were significantly different or not, a chi-square goodness-of-fit test was conducted (Table 1). This analysis indicated that there was a statistically significant difference ($\chi^2(1) = 14.62, p < .001$). Hypothesis H01 is therefore rejected. This finding implies that the number of those who perceived their preservice mathematics content as not relevant ($n = 51, 72.9\%$) is significantly higher than those who perceived as relevant ($n = 19, 27.1\%$).

This finding supports that of Ball (1990), Son and Lee (2016), and Ma (1999) who underscored that many teachers do not possess the requisite subject matter knowledge to implement high quality instruction. This implies that majority of mathematics teachers does not demonstrate sufficient content mastery on what they are teaching. The National Mathematics Advisory Panel, NMAP (2008) underscores the need for mathematics teachers to know mathematics for teaching in order to teach effectively. It noted that teachers must know in detail and from a more advanced perspective the mathematical content that they are responsible for teaching and the connections of that content to other important mathematics, both prior to and beyond the level they are assigned to teach. This perceived lack of relevant mathematics content for teachers may be the reason why students are performing dismally in mathematics as the NMAP (2008) posit that research on the relationship between teachers’ mathematical knowledge and students’ achievement supports the importance of teachers’ content knowledge in students learning.

Table 1. Chi-square analysis for relevant and not relevant

	Relevant	Not Relevant	Total
Observed Frequency (O)	19(27.1)	51(72.9)	70
Expected Frequency (E)	35	35	70
$\frac{(O - E)^2}{E}$	7.31	7.31	14.62

Note:

1. Relevant = agree (16) + strongly agree (3); Not relevant = disagree (33) + strongly disagree (18).
2. Percentages are in parentheses
3. Expected Frequencies are obtained as follows: $E = \text{Total Number (70)} \text{ divided by } \text{Number of Levels (2)}$.

H02: There is no significant difference in teacher’s perception of the relevance of mathematics content learnt in preservice training based on their initial academic qualification.

Having established that a significantly higher number of mathematics teacher respondents consider their preservice mathematics content as not relevant to their teaching in secondary mathematics, we further investigate this with respect to their initial academic qualifications. To determine whether this observation on perception of the relevance of preservice mathematics content is independent (or not) of initial teacher qualifications, a Freeman-Halton test an extension of Fisher’s exact test was conducted (Table 2). The results indicated there exists a statistically significant difference on the perception of the relevance of preservice mathematics content by teachers with different initial qualification ($p < .001$). Thus, the hypothesis (H02) is rejected and we conclude that there is a significant difference in teacher’s perception of the relevance of mathematics content learnt in preservice training based on their initial academic qualification. This finding is congruent with that of Leong, Meng and Rahim (2015) on Malaysian preservice mathematics teachers having low content knowledge.

A post hoc analysis with Fisher’s Exact test with pairwise comparisons indicated: diploma versus BEd, $p < .001$; diploma versus BA/BSc with PGDE, $p = 1.000$; and BEd versus BA/BSc with PGDE, $p = .033$. Using Bonferroni correction for multiple comparisons to judge these pairwise comparisons with a significance level of 0.017 (0.05/3) (for three pairwise comparisons), we found that significantly higher Diploma teachers (62.5%) perceived mathematics content in preservice training as relevant to their practice than Bachelor of Education teachers (4.8%). All the other pairwise comparisons were not statistically significant. The implication here is that more bachelor of education degree holders (95.2%) felt that what they learnt is largely irrelevant to what they teach compared to their diploma (37.5%) or BA/BSc with PGDE (50.0%) counterparts.

Table 2 Initial Qualifications versus Relevance of preservice mathematics content

	Relevance
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Initial Qualification	Relevant	Not Relevant	Total
Diploma	15(62.5)	9(37.5)	24(100.0)
BEd	2(4.8)	40(95.2)	42(100.0)
BA/BSC with PGDE	2(50.0)	2(50.0)	4(100.0)
Totals	19	51	70

Note:

1. BEd = Bachelor of Education; BA = Bachelor of Arts; BSc = Bachelor of Science; PGDE = Post Graduate Diploma in Education.
2. Relevant = (SA = strongly agree + A = agree); Not Relevant = (D = disagree + SD = strongly disagree)
3. Row percentages for each cell are given in parentheses (as per initial qualification)

Poor performance that has for many years been recorded in secondary school mathematics may be attributed to this poor preparation of teachers in terms of subject content. This believe tends to agree with the position held by Darling-Hammond and Hudson (1989), who observed that how well prepared teachers are, depends on what they have taken during their training and how well these courses compare to the actual content and skills required for teaching the intended curriculum. Van der Sandt (2017) agrees with these sentiments that “the current education programs at tertiary institutions seem not to have the desired impact on preservice teachers’ level and degree of geometric acquisition expected and required to teach effectively”. Furthermore, Deng (2007) and Dreher, Lindmeier, Heinze and Niemand (2018) argue that universities teach a kind of mathematics that is apparently different from that taught in schools.

Research Objective Two: To determine mathematics teachers’ confidence in their ability to teach secondary school mathematics using preservice mathematics content.

Mathematics teachers were asked respond to the question: “I can confidently teach secondary school mathematics using the mathematics content I learnt in college” on a five-point Likert item. This item gave the following results: strongly Agree 4 (5.7%), Agree 16 (22.9%), Undecided 3(4.3%), Disagree 30(42.9%) and strongly Disagree 17(24.3%).

H03: There is no significant difference in the number of teachers who are confident and those not confident in their ability to teach secondary mathematics with the subject content learnt during preservice training.

We grouped those who “strongly agree” and those who “agree” as “confident” ($n = 20$) and similarly the “not confident” are those who “strongly disagree” and “disagree” ($n = 47$) to this statement. From these results, 47 (67.2%) mathematics teachers did not think that they are confident enough to teach secondary school mathematics using the subject content learnt in college compared to their 20(28.6%) who think they are confident. These results were further subjected to a chi-square goodness-of-fit test to investigate whether the number of those that are confident is significantly different from those not confident or those undecided (Table 3). A statistically significant difference emerged among teachers being either confident, undecided or not confident ($\chi^2 (2) = 25.47, p < .001$), the number of teachers who are not confident are significantly higher than those who are confident ($\chi^2 (1) = 15.18, p < .001$).

This finding is contrary to that of Beswick, Watson and Brown (2006) who found lack of confidence of many middle school teachers in relation to the mathematics that they teach. Ball and Hill (2005) are concerned that “we are simply failing to reach reasonable standards of mathematical proficiency with most of our students, and those students become the next generation of adults, some of them teachers” (p. 14). We are cautioned that teaching mathematics does not automatically improve teachers’ confidence in teaching (Reid & Reid, 2017). Wilburne and Long (2010) assert that those preservice teachers with strong mathematics content are more comfortable teaching mathematics content, indicating a strong relationship between content knowledge and pedagogical knowledge.

Table 3. Chi-square analysis for Level of Confidence

	Observed Frequency(O)	Expected Frequency(E)	$\frac{(O - E)^2}{E}$
Confident	20(28.6)	28	2.29
Not confident	47(67.1)	28	12.89
Undecided	3(4.3)	14	10.29
Total	70	70	25.47

$$\chi^2(2) = \sum \frac{(O - E)^2}{E} = 25.47, p < .001$$

Note:

1. Row percentages for each cell are given in parentheses (as per each initial qualification)
2. Expected Frequencies are obtained as follows: $E = \text{Total Number (70)} \div \text{Number of Levels (5)}$.

H04: There is no significant difference in teachers' confidence on their ability to teach secondary mathematics with the subject content learnt during preservice training based on initial academic qualification.

The results on the ability of mathematics teachers to confidently teach secondary school mathematics using the subject content learnt during the preservice training were further analyzed along the teacher's level of initial preservice training and the findings are given in the Table 4. Out of the 47 respondents who were not confident to teach secondary mathematics using the subject content learnt during their preservice training, 8(17.0%) initially trained under diploma, 38(80.85%) under BEd and only 1(2.13%) under BA/BSc program. It is coming out clearly that more BEd trained teachers felt ill equipped to implement the secondary school curriculum than their diploma or BA/ BSc counter parts.

Table 4 Frequencies for Teachers' confidence against Initial Qualifications

Initial Qualifications	Level of Teachers' Confidence					Total
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	
Diploma	4(5.7)	11(15.7)	1(1.4)	4(5.7)	4(5.7)	24(34.2)
Degree (BEd)	0(0.0)	2(2.9)	2(2.9)	26(37.1)	12(17.1)	42(60.0)
BA/BSc with PGDE	0(0.0)	3(4.3)	0(0.0)	0(0.0)	1(1.4)	4(5.7)
Total	4(5.7)	16(22.9)	3(4.3)	30(42.8)	17(24.3)	70(99.9*)

Note:

1. * indicates an approximate value to 70
2. BEd = Bachelor of Education; BA = Bachelor of Arts; BSc = Bachelor of Science; PGDE = Post Graduate Diploma in Education.
3. Percentages of total for each cell are given in parentheses

The data in Table 4 were regrouped into confident, not confident and undecided (see Table 5 and subjected to further analysis based on initial qualifications of teachers. To establish whether teacher confidence to teach with preservice mathematics content is independent of their initial qualifications, a Freeman-Halton test was conducted on the data in Table 5. The results indicated there exists a statistically significant difference on teacher confidence to teach with preservice mathematics content by teachers with different initial qualification ($p < .001$). Thus, the hypothesis (H06) was rejected and we concluded that there is a significant difference in teacher's confidence to teach with mathematics content learnt in preservice training based on their initial academic qualification.

To identify where these difference lies, a post hoc analysis with the Freeman-Halton test with pairwise comparisons indicated: diploma versus BEd, $p < .001$; diploma versus BA/BSc with PGDE, $p = 1.000$; and BEd versus BA/BSc with PGDE, $p = .004$. Judging these pairwise comparisons subjected to Bonferroni adjustment with a significance level of 0.017 (0.05/3), we found that:

1. Significantly higher Diploma teachers (62.5%) were confident to teach secondary mathematics with preservice mathematics content than Bachelor of Education teachers (4.8%).
2. Significantly higher Bachelor of Arts/Bachelor of Science with post graduate diploma teachers (75.0%) were confident to teach secondary mathematics with preservice mathematics content than Bachelor of Education teachers (4.8%).
3. No significant difference in confidence to teach secondary mathematics with preservice mathematics content between Diploma (62.5%) and Bachelor of Arts/Bachelor of Science with post graduate diploma teachers (75.0%)

According to the findings of Hine (2015b), preservice teachers indicated varying degrees of readiness to teach mathematics, especially less than half of the sampled participants asserted that they felt confident in teaching. On the other hand, Norton (2017) established that confidence to do and to teach mathematics was reasonably correlated with competence. This implies that such mathematics teachers would not be effective in the teaching of the subject upon graduation. Such teachers might not be able to diagnose and address students' mathematical.

Table 5 Initial Qualifications versus Teacher's confidence of preservice mathematics content

Initial level of preservice training	Level of Teachers' Confidence			Total
	Confident	Undecided	Not Confident	
Diploma	15(62.5)	1(4.2)	8(33.3)	24(100.0)
Degree (BEd)	2(4.8)	2(4.8)	38(90.4)	42(100.0)
BA/BSc with PGDE	3(75.0)	0(0.0)	1(25.0)	4(100.0)
Total	20	3	47	70

Note: Row percentages for each cell are given in parentheses (as per each initial qualification)

Research Objective Three: To find out whom to mathematics teachers attribute the content they teach in secondary school.

The Mathematics teacher respondents were asked to respond to the question: "To whom do you attribute the mathematics content that you teach in secondary school?" Their responses were given in one of the three categories (secondary school teacher, college subject content or both) as recorded in the Table 7. Table 7 indicates that 50(71.4%) of all the participating teachers attributed to their secondary school teacher, 9(12.9%) attributed to college subject content and 11(15.7%) attributed to both (secondary school teacher and college subject matter).

H05: There is no significant difference in the number of teachers who attribute mathematics content they teach in secondary school to secondary school teacher, college subject content or both.

To determine whether the number of respondents for the different attributions of mathematics content they teach differ significantly from the expected, a chi-square goodness-of-fit test was conducted (Table 6). The chi-square analysis ($\chi^2(2) = 45.9, p < .001$), indicated that these numbers are significantly different from the expected. Secondary school mathematics teacher (71.4%) being the main source of mathematics content while college subject content being the least (12.9%). The strong influence of secondary school teacher could support Kleickmann, Richter, Kunter et al. (2013) that school mathematics curriculum offers formal learning opportunities for acquiring content knowledge in the pre-training phase and learning situations prior to teacher education facilitates the informal construction of PCK. This results could support Dreher et al. (2018) who has pointed out the gap that exists between school and academic mathematics.

Table 6. To whom mathematics teachers attribute the content that they teach

Attributed to:	Observed Frequency (O)	Expected Frequency (E)	$\frac{(O - E)^2}{E}$
Secondary school teacher	50(71.4)	23.3	30.6
College subject content	9(12.9)	23.3	8.8
Both	11(15.7)	23.3	6.5
Total	70(100.0)	69.9*	45.9

$$\chi^2(2) = \sum \frac{(O - E)^2}{E} = 45.9, p < .001$$

Note:

- * indicates an approximate value to 70
- Percentages in parentheses
- Expected Frequencies are obtained as follows: E = Total Number (70) divided by Number of Levels (3).

H06: There is no significant difference in the number of teachers who attribute mathematics content they teach in secondary school to secondary school teacher, college subject content or both based on initial academic qualifications.

Further analysis to answer the question of whether these results of attribution are independent of initial qualifications of teachers was performed. To establish whether teacher attribution of mathematics content to teach secondary school mathematics is independent of their initial qualifications, a Fisher-Freeman-Halton Exact test was conducted on the data in Table 7. The results indicated there is no statistically significant difference on teacher attribution based on initial qualification ($p = .823$). Thus, we fail to reject the hypothesis (H06) and conclude that the attribution of content taught in secondary school mathematics is comparable among the different initial qualifications because their pattern of responses are statistically similar. Specifically, that

higher percentage of teachers in each initial qualification (Diploma = 75.0%, Bed = 69.0% and BA/BSc with PGDE = 75.0%) attributed the content they teach to their secondary school teacher and a smaller number attributed to college subject matter or both across initial qualifications.

Table 7 Mathematics teachers attribution of content they teach versus initial qualifications

Initial qualification	Whom the mathematics teachers attribute the content they teach			
	Secondary School Teacher	College Subject matter	Both	Total
Diploma	18(75.0)	3(12.5)	3(12.5)	24(100.0)
BEd	29(69.0)	5(11.9)	8(19.1)	42(100.0)
BA/BSc with PGDE	3(75.0)	1(25.0)	0(0.0)	4(100.0)
Total	50	9	11	70

Note: BEd = Bachelor of Education; BA = Bachelor of Arts; BSc = Bachelor of Science; PGDE = Post Graduate Diploma in Education

Research Objective Four: To determine the applicability of the general teaching methods learnt during preservice training to teaching

Teacher respondents were asked to indicate the extent of agreement on the applicability of the teaching methods learnt during their preservice training to their teaching needs in the secondary school mathematics curriculum. The responses were as follows: 21 (30.0%) of the teachers strongly agreed that the teaching methods learnt are applicable to teaching, 34 (48.6%) agreed, 6(8.6%) disagreed, 5(7.1%) strongly disagree while 4(5.7%) were undecided. Generally put, majority of the mathematics teachers did not have any problem with the teaching methods and can teach mathematics effectively using the teaching methods that they learnt during their preservice training.

H07: There is no statistically significant difference in the number of teachers who perceive general teaching methods learnt in preservice training as applicable and those who perceive as not applicable.

A chi-square statistic was computed to test whether the observed frequencies of the perception on the applicability of general teaching methods is significantly different from the expected frequencies. To do this, the responses were grouped into: (a) "Applicable" for those that agreed and strongly agreed and (b) "Not Applicable" for those that disagreed and strongly disagreed to the statement, as shown in Table 8. The chi-square goodness-of-fit test indicates that the mathematics teachers who perceive general teaching methods as applicable to their teaching in secondary school is statistically significantly higher than the expected while those deemed not applicable were statistically significantly lower than the expected ($\chi^2(2) = 43.4, p < .001$). In other words, significantly higher number of secondary school mathematics teachers would agree that, indeed the general methods of teaching are applicable to their practice. This confirms views of Ball (200) who posit that what is needed for competent teaching in any domain is a combination of sound subject matter knowledge and general pedagogical training that a teacher must have for effective teaching and learning to take place.

Table 8. Applicability of the general teaching methods learnt during preservice training

Applicability	Observed Frequency(O)	Expected Frequency(E)	$\frac{(O - E)^2}{E}$
Applicable	55(78.6)	28	26.0
Not Applicable	11(15.7)	28	10.3
Undecided	4(5.7)	14	7.1
Total	70	70	43.4

$$\chi^2(2) = \sum \frac{(O - E)^2}{E} = 43.4, p < .001$$

Note:

1. Expected Frequencies are obtained as follows: E = **Total Number** (70) divided by **Number of Levels** (5).
2. Percentages in parentheses
3. Applicable = Agreed + Strongly Agreed; Not Applicable = Disagreed + Strongly Disagreed.

H08: There is no significant difference in teacher's perception of general teaching methods learnt in preservice training as applicable and those who perceive as not applicable based on their initial academic qualifications.

Further analysis of the applicability of general methods of teaching was conducted in relation to teacher initial qualifications (Table 9). Table 9 indicates that the number of respondents who agreed or strongly disagreed are higher for all initial qualifications as compared to those who disagreed or strongly disagreed.

Table 9 Initial Qualifications against Applicability of general teaching methods

Initial Qualification	Applicability					Total
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	
Diploma	10	8	1	2	3	24
BEd	11	24	2	4	1	42
BA/BSc with PGDE	0	2	1	0	1	4
Total	21	34	4	6	5	70

Note: BEd = Bachelor of Education; BA = Bachelor of Arts; BSc = Bachelor of Science, PGDE = Postgraduate Diploma in Education.

To identify whether the seemingly comparable numbers for the different initial qualifications on applicability of general teaching methods, a Freeman-Halton test was conducted (Table 10). This tests whether the number of mathematics teachers who perceived general methods of teaching in their preservice training as applicable, not applicable or were undecided is significantly different based on initial qualifications (Table 10). The results indicated that there is no statistically significant difference in the perception of applicability based on mathematics teacher initial qualification ($p = .247$). Specifically, higher percentage of teachers in each initial qualification (Diploma = 75.0%, Bed = 83.3% and BA/BSc with PGDE = 50.0%) considered applicable and a smaller number considered not applicable across initial qualifications (Diploma = 20.8%, Bed = 11.9% and BA/BSc with PGDE = 25.0%).

Table 10. Initial Qualifications versus Applicability of General Methods of Teaching

Initial Qualification	Applicability			Total
	Applicable	Not Applicable	Undecided	
Diploma	18(75.0)	5(20.8)	1(4.2)	24(100.0)
BEd	35(83.3)	5(11.9)	2(4.8)	42(100.0)
BA/BSc with PGDE	2(50.0)	1(25.0)	1(25.0)	4(100.0)
	55	11	4	70

Note:
 1. BEd = Bachelor of Education; BA = Bachelor of Arts; BSc = Bachelor of Science; PGDE = Postgraduate Diploma in Education.
 2. Applicable = Agree + Strongly Agree; Not Applicable = Disagree + Strongly Disagree.

Research Objective Five: Adequacy of the number of methodology courses learnt

A question was asked to the mathematics teachers on the adequacy of the number of methodology units learnt during preservice training. Their responses are as follows: 9 (12.9%) of the teachers indicated “very adequate” on the adequacy of the general teaching methods learnt, 30(42.9%) indicated “adequate”, 20(28.6%) indicated “inadequate”, 4(5.7%) indicated “very inadequate” while 7(10.0%) were undecided. Generally put, majority of the mathematics teachers are contented on the adequacy of the number of methodology units learnt during their preservice training.

H09: There is no statistically significant difference in the number of teachers who perceive number of methodology units learnt in preservice training as adequate and those who perceive as not adequate.

A chi-square statistic was computed to test whether the observed frequencies of the perception on the adequacy of the number of methodology units learnt is significantly different from the expected frequencies ($\chi^2(2) = 8.38, p = .015$). To do this, the responses were grouped into: (a) “adequate” for those that agreed and strongly agreed and (b) “Not adequate” for those that disagreed and strongly disagreed to the statement, as shown in Table 11. From Table 11, it can be seen that teachers tend to perceive methodological units learnt in their preservice training as adequate ($n = 39, 55.7%$) rather than inadequate ($n = 24, 34.3%$) or undecided ($n = 7, 10.0%$). This results may suggest a contrary position to that of Leong, Meng and Rahim (2015) on Malaysian

preservice mathematics teachers (primary and secondary) who had lower score than international average in pedagogical content knowledge.

Table 11 Level of Adequacy of the Number of Methodology Units Learnt

	Observed Frequency (O)	Expected Frequency (E)	$\frac{(O - E)^2}{E}$
Adequacy of Methodology Units learnt.			
Adequate	39(55.7)	28	4.32
Inadequate	24(34.3)	28	0.57
Undecided	7(10.0)	14	3.50
Total	70	70	8.39

$$\chi^2(2) = \sum \frac{(O - E)^2}{E} = 8.39, p = .015$$

Note: Percentages in parentheses

H10: There is no statistically significant difference in the number of teachers who perceive number of methodology units learnt in preservice training as adequate and those who perceive as not adequate based on their initial academic qualifications.

Further analysis of the adequacy of methodology units learnt was conducted in relation to teacher initial qualifications (Table 12). From Table 12 we can see that the number of respondents who considered very adequate or adequate are higher for Diploma and Bachelor of Education initial qualifications as compared to those who considered very inadequate or inadequate. For the BA/BSc with PGDE both extremes are comparable.

Table 12 Frequencies for the Adequacy of Methodology Units Learnt per Initial Qualifications

Initial Qualifications	Adequacy					Total
	Very Adequate	Adequate	Undecided	Inadequate	Very Inadequate	
Diploma	6	10	2	6	0	24
BEd	3	19	4	14	2	42
BA/BSc with PGDE	0	1	1	0	2	4
Total	9	30	7	20	4	70

Note: BEd = Bachelor of Education; BA = Bachelor of Arts; BSc = Bachelor of Science

We further determined whether initial qualifications of mathematics teachers influence their perception on the adequacy of methodology units learnt through a Freeman-Halton test (Table 13). This tests whether the number of mathematics teachers who perceived methodology units in their initial preservice training as adequate, not adequate or were undecided is significantly different based on their initial qualifications. The results indicated that there is no statistically significant difference in the perception of adequacy based on initial qualification ($p = .400$).

Therefore, we conclude that perception of the adequacy of methodology units learnt in preservice training does not vary with respect to teacher initial qualifications. The Science and Learning Expert Group (Department of Business Innovation and Skills, 2010) report stresses the importance of providing subject specific training in initial teacher training, in this study demonstrated as being adequate. Geddis (1993) also supports the same view by noting that to be an effective teacher of mathematics, it is necessary to know not only the content of various topics, the subject knowledge topics but also the topic specific pedagogy.

Table 13. Adequacy of Methodology Units Learnt Based on Initial qualifications

Initial Qualifications	Adequacy			Total
	Adequate	Inadequate	Undecided	
Diploma	16(66.7)	6(25.0)	2(8.3)	24(100.0)
BEd	22(52.4)	16(38.1)	4(9.5)	42(100.0)
BA/BSc with PGDE	1(25.0)	2(50.0)	1(25.0)	4(100.0)
Total	39	24	7	70

Note: BEd = Bachelor of Education; BA = Bachelor of Arts; BSc = Bachelor of Science

IV. Conclusion

Our work has shed some light on a number of aspects as relates to secondary school mathematics teachers' perceptions on relevance, adequacy and confidence in their preservice training in relation to their practice. From the results of this study, the following conclusions are deduced: First, majority (72.9%) of the mathematics teachers perceive their preservice mathematics content as not relevant to teach secondary school mathematics compared to those who perceive as relevant (27.1%). Furthermore, those teachers with initial academic qualifications of diploma perceived as relevant are more (62.5%) than those with BEd (4.8 %). Second, significant majority of teachers were not confident (67.1%) compared to those that are confident (28.6%) with a few undecided (4.3%). Moreover, teachers with diploma (62.5%) and BA/BSc with PGDE (75.0%) were more confident than those with BEd (4.8%). Third, significant majority of teachers attributed the content they teach to their secondary school mathematics teacher (71.4%) compared to those who attribute to college mathematics (12.9%) or both (15.9%). However, these differences are not dependent on teacher initial academic qualifications. Fourth, significantly higher number of teachers (78.6%) perceived general methods of teaching taught in college are applicable to their practice than not applicable (15.7%) or undecided (5.7%). Though, these differences are not dependent on teacher initial academic qualifications. Fifth and final, significantly more teachers (55.7%) perceived general methods of teaching taught in college adequate to their practice than inadequate (34.3%) or undecided (9.6%). Nonetheless, these differences are not dependent on teacher initial academic qualifications.

V. Recommendations

The following recommendations are made:

1. Diploma Teacher training colleges and schools of education in the universities should constantly review their curricula to ensure that what they are teaching correlates well with what their students will teach in the secondary schools. During their curriculum review; they should involve the mathematics teachers who are teaching in the secondary school at the time of the review. This ensures that they produce graduates who can competently implement the curriculum in their place of work.
2. Diploma Teacher training colleges and schools of education in the universities should devote more time to the teaching methods in a particular subject and more so Mathematics. This is the area where teacher trainees are practically guided on how to handle various topics or concepts in the subject which various researches have proved to be difficult for the teachers to handle.
3. Mathematics subject content and its methodology should be integrated and taught together as one course.
4. The commission of higher education should ensure that the same course content is offered in all the universities for the same course to ensure uniformity in the quality of graduates since they are all going to implement the same curriculum.

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