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The Prevalent Rate of Problem-solving Approach in Teaching Mathematics in Ghanaian Basic Schools

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Abstract

Stakeholders of mathematics education decry the rate at which students' performance are falling below expectation; they call for a shift to practical methods of teaching the subject in Ghanaian basic schools. The study explores the extent to which Ghanaian basic school mathematics teachers use problem-solving approach in their lessons. The participants, consisting of five hundred (500) basic school mathematics teachers, were randomly selected from all the ten (10) regions of Ghana. The data collection instruments were self-administered questionnaires, lesson observation checklists, and examination of class exercises. The Chi-square (goodness-of-fit) test indicated that there is a difference between the observed and expected values, and the occurrence of problem solving approach in mathematics lessons is not statistically less than 50% of the time in the basic schools, $\chi 2$ (2, 485) = 184.90, $p < .05$. Thus, a significant proportion of basic school teachers (i. e. 90.1%), do not frequently use problem-solving approach in teaching mathematics lessons. This result adds to empirical evidence available on difficulties in teaching mathematics through practical activities. The study therefore contributes an important idea for teacher training programs to enhance mathematics teaching.

Keywords: Ghanaian; Randomly; Chi-square; Problem-solving; Observed; Expected; Occurrence

Introduction

It is an undeniable fact that problem solving, one of the process standards, is fast becoming a key element for mathematics instruction (National Council of Teachers of Mathematics [NCTM], 2000). In response to this drastic shift, countries are building their students' problem-solving capabilities, in order for them attain the second Millennium Development Goal (i.e., Primary education for all by the year 2015) (UNESCO, 1990). The world conference on education for all in 1990, has urged nations to endeavor to meet students' basic learning needs which are identified as fundamental learning outcomes (such as knowledge, skills, and values), positive attitudes, and essential learning tools (such as literacy, oral expression, numeracy, and problem solving). These learning needs, when given the requisite attention, help students develop the capacity to participate fully in development issues, and to make informed decisions among other alternatives (UNESCO, 1990).

Mathematics teachers recommend the use of problem solving in teaching mathematics for very good reasons. According to Cai and Lester (2012), problem solving promotes students' conceptual understanding, develops students' capacity to reason, enables students to communicate mathematically and cultivates their interests and curiosities. When students focus their attention on problems and understand them thoroughly well, they are able to devise solution plans from which a series of solution steps are tried repeatedly in their attempts to implement such solution plans (Kelly, 2006). By this process, they discover disconnections in their understanding of the problems and this compels them to revisit the problems. Van de Walle (2003), similarly found out that problem solving permeates every mathematical task. As a generic skill needed by all, it builds independent thinking and encourages critical analysis of issues which are important for life-long learning. It is therefore desirable for students to develop mathematical problem-solving skills at the basic school as a sign of readiness for life-long learning and for the job market.

The role of problem solving approach (PSA) in the mathematics curriculum is defined by three interrelated themes: Problem solving as skill, problem solving as context and problem solving as art. For problem solving as skill, mathematics teachers must see problem solving as a mathematical skill that is often taught in school

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(McIntosh & Jarrett, 2000). This theme provides a clear skill orientation where problem solving is arranged in a hierarchy of skills acquired by students. The hierarchy places the solution of routine problems to a lower skill acquired before the solution of non-routine ones are considered as higher skills. This situation diverts attention from non-routine problem solving in school. The consequence is that, only few students who are deemed to have acquired enough skills in routine problem solving, go on to attempt non-routine problems. Therefore, non-routine problem solving has become a restricted activity in the school setting.

Problem solving as context, is based on the idea that problems and their solutions are means to desirable ends in mathematics education. Five subthemes, discussed below, provide the channel to these valuable ends. First, problem solving as justification, leads to the inclusion of some real-world problems in the syllabus to convince students and teachers about the need to study mathematics. Second, problem solving as motivation, whips up students' interest in other mathematical topics. Third, problem solving as recreation, tasks students with problems and allows them to have fun (through mathematical games), with some mathematical skills or ideas they have already acquired. Naturally, such mathematical games lead students to explore other interesting concepts in mathematics. Fourth, problem solving as vehicle, allows students to solve problems to learn new skills or concepts. Fifth, problem solving as practice, helps students reinforce skills and concepts already learned through practice. But, it is worthy to note that all the five subthemes complement each other (McIntosh & Jarrett, 2000).

The third theme emanates from Polya's (1945) study. It introduces a deeper and more comprehensive form of problem solving, referred to as art. It revives the art of discovery and sees mathematics as information and know-how. Polya believes that irrespective of how well mathematical information is imparted to students, they are bound to forget it, if they are not taught how to use that information. In line with the foregoing, Polya lays emphasis on the need for teachers, not only to illustrate the techniques of problem solving in class, but also to discuss and practise with students. Polya further points out that, although routine problems play certain important pedagogical functions of leading students to practise specific procedures and use definitions correctly, the development of students' ability to solve problems can only come through the judicious use of non-routine problems. Polya draws a connection between problem solving as art and teaching as art. For that view, problem solving is seen as a dynamic exercise requiring experience, taste and judgement, so practising it cannot be programmed or mechanized. The sensitive teacher who can set worthwhile problems and provide the appropriate guidance to solving them is key to students' success in mathematical problem solving.

The dividing line between problem solving as art and problem solving as context is very thin. In fact, the latter is a subset of the former, to the extent that the goals of problem solving as context cannot be achieved if it is not allowed to interplay with Polya's dynamic ideas of solving problems as art. Similarly, problem solving as skill is closely related to the other two major themes, in that, skill practice is a subset of problem solving as context.

Judging from Polya (1945), problem-solving approach in teaching can be seen as a strategy that provides a natural environment for learning. Thus, the use of problem-solving approach plays a pivotal role in mathematics instruction. Unfortunately, routine skill practice is the common approach to teaching mathematics in Ghanaian schools, to the neglect of the dynamics in problem solving (Anamuah-Mensah, Mereku & Ghartey-Ampiah, 2008). This situation could be a contributing factor to poor students' performance in mathematics at the basic school level.

The weak performance of Ghanaian Junior High school students in mathematics, as indicated by Trend in International Mathematics and Science Study (TIMSS) (2007), suggests that basic school teachers may not be adequately applying problem solving strategies in teaching mathematics lessons. For instance, Mereku and Cofie (2008) and Sekyere (2010), attribute the generally appalling performance of Ghanaian students in mathematics to weaknesses in their ability to solve basic problems at both the primary and junior high schools. Despite the call from these and other researchers that teaching through problem-solving approach must be an integral part of the mathematics curriculum, the practice is not very popular at the basic schools (Anamuah-Mensah et al., 2008).

Literature Review

Theoretical Framework

The theoretical framework for this study is based on Schoenfeld's (1987) four major categories of knowledge for investigating mathematical thinking namely: belief systems, cognitive resources, heuristics, and control processes. This framework is linked to Polya's four stages of problem solving as well as Schulman's (1987) Pedagogical Content Knowledge (PCK) of teaching mathematics.

Schoenfeld (1987) refers to cognitive resources as the knowledge of mathematical facts, concepts, and algorithms possessed by an individual. Thus, cognitive resources represent the requisite background knowledge for solving a given problem. This fits into the constructivist's learning theory, as stated by Sadker and Sadker (2003) and NCTM (2000). All affirm that learning is knowledge-dependent, this means that effective students use current knowledge as foundation upon which they build new knowledge. Cognitive resources are therefore the tools that help problem solvers to understand problem situations. This understanding in turn enables problem solvers to convert problems into mathematical terms and symbols, thereby leading them to develop possible solution paths.

Similarly, the next two of the general strategies of solving mathematical problems (Devising a plan and Carrying out the plan) as proposed by Polya, match Schoenfeld's heuristics. Without problem-solving heuristics, it would be difficult to devise or select a good plan to solve a problem. Problem-solving heuristics come from experience as a result of repeated investigations and explorations of mathematical concepts (Schoenfeld, 1987). It is the art of discovery involving taste and judgment on the part of a problem solver. This art can be acquired only if students are encouraged to take responsibility for their own learning. This is in line with another constructivist view that, learning is a process of knowledge construction in which students become active participants (Sadker & Sadker, 2003; NCTM, 2000).

When carrying out a solution plan and looking back to check for correctness of results (the third and fourth steps in the problem-solving procedure), as suggested by Polya, Schoenfeld's control processes come to play. This involves meta-level decision processes such as monitoring and evaluation. In order to go through Polya's third and fourth stages of problem solving successfully, students must develop the capability of outlining alternative solution paths, making reasonable decisions about which path to choose and why. Control processes help develop mathematical processing skills such as information transformation, computation, and encoding. Again, in the view of constructivism, students need to be aware of the processes of cognition and should be able to control them (Sadker & Sadker, 2003; NCTM, 2000). Simply put, effective problem solvers are conscious of their thinking in the problem-solving process. This implies that problem-solvers can direct their thinking to the desired end, otherwise, referred to as meta-cognition (NCTM, 2000).

In view of the above discussion, it is clear that Polya's (1945) general procedure for solving problems and the constructivist theory of learning focus mainly on how students use prior knowledge and experience to solve problems, and in the process construct new knowledge. These have some implications for the mathematical knowledge needed for teaching. Empirical studies, such as Cohen (2007), on mathematics teachers' reactions to calls for reforms in their teaching have identified teacher knowledge as foremost contributor to how teachers structure and deliver mathematics lessons. Cohen's study focuses on how poor mathematical background of teachers prevents them from building favorable environments for learning mathematics. For example, the study argues that poor mathematical background, such as shallow content knowledge affects, not only teachers' questioning skills, but also their mathematical arguments and explanations of mathematical concepts. Schulman's (1987) pedagogical content knowledge for teaching mathematics therefore fits into the discussion of the conceptual framework of this study.

Two major types of knowledge that define Schulman's (1987) PCK are formal knowledge and practical knowledge (Richardson, 2001). Formal knowledge, according to Richardson, is the knowledge of experts such as mathematical content knowledge which is found in sources like textbooks and research articles. On the other hand, practical knowledge is displayed in what teachers do in the classroom (Richardson, 2001). It is a description of how teachers understand the classroom situation. This type of knowledge is acquired through experience and therefore, is contextual, personal and unusual (Richardson, 2001).

While Richardson (2001) describes PCK as a combination of formal and practical knowledge, Schulman (1987) sees it as a way of knowing the subject matter, which allows it to be taught effectively. Schulman goes on with the explanation that, PCK is grounded in the subject matter but adds an understanding of how to convert formal knowledge of the subject into the curriculum in the context of teaching. Thus the knowledge of the subject matter itself combines with the knowledge of students' learning, their preconceptions that can interfere with the learning process and the act of representing concepts of the subject matter in a form that students can understand. Ever since Polya's (1945) classic work on problem solving became known, experts in mathematics education have recommended that teaching through problem solving be an integral part of the mathematics curriculum. But the practice is not popular in the basic schools (Anamuah-Mensah et al., 2008), even though

Ghanaian mathematics teachers are fully aware of this recommendation. This supports why these researchers feel that there are challenges in shifting the focus to problem-solving approach in mathematics teaching.

Due to mathematical, pedagogical and personal factors, teaching through problem-solving approach can prove very difficult for teachers. Teachers are expected to have the necessary mathematical content knowledge in order to understand the various problem-solving approaches students might use to solve given problems. Without this, teachers find it difficult to guide students successfully in the problem-solving process. The challenge is that, many basic school teachers are generally trained to teach all subjects and this often denies them of the strong mathematical background required to teach the subject through problem-solving approach (McIntosh & Jarrett, 2000).

Generally, teachers must make decisions on how to match the level of students to the level of difficulty of the problem assigned; when and how to assist students as well as ensure that they retain the sense of ownership of the strategy used to solve the problem (McIntosh & Jarrett, 2000). Without professional training and experience to equip teachers with the required pedagogical content knowledge in mathematics, it would be most difficult, if not impossible, to make these complex decisions. Unfortunately, many teachers in Ghanaian basic schools, do not have strong professional qualifications to teach mathematics; this raises issues about teachers' understanding of the topics in the curriculum (Anamuah-Mensah, Mereku, & Ghartey-Ampiah, 2008).

According to McIntosh and Jarrett (2000), departing from the traditional roles teachers have played in the classroom requires experience, confidence, and self-awareness. Some teachers might not have any experience of being taught mathematics through problem solving. Yet, they are often required to teach topics in mathematics they have never encountered in their student days. Additionally, a good problem for students may sometimes pose a challenge to such teachers who find themselves in the tight corner of not knowing any immediate solution strategy. These situations are potential sources of challenges in terms of discouraging teachers from teaching through problem solving as an approach. The study was guided by these hypotheses: (1) Sample data are not consistent with a hypothesized distribution, or there is a significant difference between the observed and the expected values. (2)The occurrence of Problem Solving Approach (PSA) in mathematics lessons is not statistically less than 50% of the time in the basic schools.

Methodology

Design of the Study

The design for the study was a survey design employed specifically to determine the extent to which mathematics teachers integrate problem solving approach into their mathematics lessons.

Participants

Five hundred mathematics teachers (300 males and 200 females), consisting of fifty (50) randomly selected mathematics teachers from each of the ten (10) regions of Ghana participated in the study. The teachers' mean age was 32 years, 4 months and their teaching experiences ranged between 2 years and 21 years. The sample further consisted of two hundred and fifty (250) teachers each at the primary school and junior high school levels in the basic schools. Out of the number of teachers who received the questionnaires, 485 completed and submitted their questionnaires, recording a response rate of 97%. Of this number, 49.6% were bachelor of education holders, and 1.6%, were master of education holders.

Research Instruments

Three (3) instruments, a questionnaire, a lesson observation checklist, and, examination of students' class exercises was used for data collection. The use of these instruments, as much as possible, helped to offset the weaknesses inherent in the use of a single data source (Saunders, Lewis & Thornhill, 2007).

Questionnaire

The questionnaire consisted of thirteen (13) close-ended items with five alternative percentage (%) responses. The first seven (7) items collected participants' demographic data. The next six (6) items measured the prevalence of participants' problem-solving practices during mathematics instruction. Participants responded in percentage terms, how frequently they used problem solving activities in their mathematics lessons. The alternative responses were put into five percentage categories: 0% – 19%, 20% - 39%, 40% - 59%, 60% - 79%, and 80% - 99%.

Lesson Observation

A checklist of twelve (12) items sought to evaluate problem solving activities in mathematics lessons (see Table 1). The checklist was developed by the University of Education, Winneba (Centre for Teacher Development and Action Research [CETDAR], 2005). The items were put into two groups to collect data from two inter-related aspects of mathematics lessons: Problem solving activities during lessons and communication in problem solving. The items represented the desired criteria or standards measured in problem-solving lessons. These standards were scored on a scale of 0 to 2, where 0 represents criterion not observed, 1 represents criterion partially observed and 2 represents criterion fully observed. The maximum total score on a lesson was 24. This score was converted to percentage, which represented how much problem solving approach was involved in a lesson (See Table 1).

Table 1. Checklist for evaluating mathematics lessons

	Score		
PROBLEM-SOLVING ACTIVITIES DURING LESSON	0	1	2
1.Relates lesson to real-life problem (discusses context, content and vocabularies)			
2.Guides students to reflect and monitor their own problem-solving steps			
3.Exposes students to multiple problem-solving strategies			
4.Helps students to recognize and articulate mathematical concepts and notations			
5.Encourages the use of visual representation of problems			
6.Allows students to work in groups			
COMMUNICATION IN PROBLEM SOLVING	0	1	2
1.Uses good questioning strategies for higher-level thinking			
2.Allows students to communicate freely with each other while solving problems			
3.Motivates students to persevere on problem solutions			
4.Incorporates students' opinions and ideas into solution strategies			
5.Engages students in discussions based on demands of problems and solutions strategies			
6.Allows students to present their solutions to the rest of the class			
GRAND TOTAL=(1×frequency of 1) and (2×frequeny of 2)			

GRAND TOTAL= (1×frequency of 1) and (2×frequeny of 2)

Adapted from CETDAR (2005); Percentage $= \dfrac{(GrandTotal \times 100\%)}{24}$

Note: 0 = criterion not met, 1 = criterion partially met, 2 = criterion fully met

A lesson was observed if it was on the time-table on the day we visited the school and if the teacher taught that lesson. In general, we observed teachers during lesson delivery from classes ranging from Primary 4 to JHS 3.

Examination of Class Exercises

For each lesson observed, a number of mathematics exercise books were randomly selected from the class and examined. A checklist (see Table 2), was designed to collect information from the selected exercise books on the extent to which students' exercises involved the following qualities of a mathematical problem: Skill practice; application of skills in standard situations; application of skills in non-standard situations; extended investigative projects; varied solution methods or to the same problem; and, varied solution answers to the same problem. The checklist for examining class exercises consisted of five (5) columns (see Table 2). The criteria column described the specifications observed and graded. The number of exercises column, recorded number of exercises in the students' exercise book. The tally column, indicated the frequency of observations for each criterion. The frequency column recorded the numerical value of the total tally. The percentage score column, contained the percentage score for each criteria (for each exercise book examined). This was calculated as (frequency ÷ number of exercises × 100%).

Table 2. Checklist for identifying problem solving in students' exercise books

CRITERIA	Number of exercises (n)	Tally	Frequency (f)	Percentage score(f÷n×100)
1.Skill practice under specific topics				
2. Application of skills in standard situations				
3. Application of skills in non-standard situations				
4. Extended investigative projects				
5. Varied solution methods for the same problem				
6. Varied solutions (answers) for the same problem				

Validity and Reliability Check on Instrument

The content and face validity of the items on both the checklists for measuring the use of problem solving in observed lessons and that for identifying problem solving in students' exercise books were examined and certified by experienced researchers at CETDAR (2005) . The questionnaire was piloted among twenty (20) teachers who were not part of the actual sample. To ensure the questionnaire was reliable, a Cronbach's alpha of 0.77 was computed to measure the internal consistency of the items.

Results

The following assumptions were met for before the use of the Chi-square test. The variable percentage, is a categorical variable. Selection of participants was by simple random sampling, while the expected value of the number of sample observations in each level of the variable was at least 5. The categories, 60-79% and 80-99%, were not included since they did not satisfy the assumptions.

Chi-square (goodness-of-fit) was then used to test the hypotheses that: (1) Sample data are not consistent with a hypothesized distribution, or there is a significant difference between the observed and the expected values. (2)The occurrence of Problem Solving Approach (PSA) in mathematics lessons is not statistically less than 50% of the time in Ghanaian basic school. In other words, the Chi-Square (goodness-of-fit) test was used to find out the frequency distribution of teachers in each percentage category on how often PSA is used in teaching mathematics in Ghanaian basic schools. The results indicated that there is a difference between the observed and expected values, and the occurrence of PSA in mathematics lessons is not statistically less than 50% of the time in Ghanaian basic school, $\chi 2$ (2, 485) = 184.90. $p < .05$ (see Table 3).

Majority of the sampled basic school mathematics teachers used PSA in their lessons less than 50% of the time. Specifically, 291 of the sampled teachers used PSA up to 19% of the time, while 146 of them used the approach up to 39% of the time. This gives a total of 437 who integrated PSA into their lesson up to 39% of the time, out of the 485 teachers who responded to the questionnaire. The researchers therefore concluded that the use of PSA in mathematics lessons is statistically less than 50% of the time among Ghanaian basic school teachers. The results also imply that, 90. 1% of the teachers, who responded to the questionnaire, used less than 50% of their mathematics teaching periods, integrating PSA in their lessons.

Table 3. Chi-square test on the frequency of PSA use

				Test statistics		
Categories	Observed frequency	Expected frequency	Residual	Chi-square	*df*	Asymptotic sig
0-19%	291	161.7	129.3	184.90	2	.000
20-39%	146	161.7	-15.7			
40-59%	48	161.7	-113.7			
Total	485					

Categories from 60%-79% and 80%-99% have expected frequencies less than 5 because their observed frequencies are each less than 10. The minimum expected cell frequency is 161.7.

Further Evidence Supporting the Chi-Square Result

The outcome of inspection of lessons on problem solving activities as reflected in students' mathematics exercise books by nine (9) randomly selected teachers were used to support the results of the Chi-square test. The result of the Chi-square test was consistent with outcomes of inspection by these teachers, T1–T9, in their lessons (see Table 4). The Symbols T1, T2 … T9, represent mathematics teachers from primary 1 to JHS 3.

Table 4. Summary of scores from lessons observed

ACTIVITY	T1	T2	T3	T4	T5	T6	T7	T8	T9	Average score	Percentage average score
Student-centered activities in PSA	3	9	4	10	3	32	1	1	1	3.7	15.4
Teachers' verbal contribution in PSA	5	9	2	11	2	3	3	3	3	4.6	19.2
Total score out of 24 (for PSA use)	8	18	6	21	5	5	4	4	5	8.3	34.3
Total percentage score (for PSA use)	33	75	25	88	21	21	17	17	21	34.6	

The average score on the use of PSA from T1 to T9 is 34.6%, which is less than 50%. This does support the hypothesis that the occurrence of PSA in mathematics lessons is not statistically less than 50% of the time in the basic schools. It can also be seen that 7 out of the 9 teachers scored less than 50% on the use of PSA in their lessons. Only T4 and T2, with scores of 88% and 75% respectively, were above 50% on the use of PSA. Further, student centered activities in PSA scored 15.4%, while teachers' verbal contribution in PSA scored 19.2%. The implication is that; the observed teachers could have done more talking than allowing student centered activities to occur in their lessons. Also, the total percentage scores seem to follow a trend which clearly suggests that problem solving activities decreased in mathematics lessons at the higher grade levels in the basic schools. Data gathered by inspection of students' exercises indicated that, PSA is used in the basic schools mostly to help students practice specific routine mathematical skills already learnt. In Table 5, five criteria of good mathematical problems or tasks and the frequencies of their occurrences in students' exercise books, from Primary 1 exercise books (B1) to JHS 3 exercise books (B9), are displayed (in percentages).

Table 5. Criteria of mathematical problems observed in students' exercises

	Percentage Scores								
CRITERIA	B1	B2	B3	B4	B5	B6	B7	B8	B9
1.Skill practice under specific topics	94	80	91	90	90	60	60	50	50
2. Application of skills in standard situations	6	15	9	10	10	30	40	50	50
3. Application of skills in non-standard situations	0	5	0	0	0	0	0	0	0
4.Extended investigative projects	0	0	0	0	0	0	0	0	0
5. Varied solutions methods/answers for the same problem	0	0	0	0	0	0	0	0	0

Table 5 indicates that, Criterion 1, which is Skill practice under specific topics, obtained a frequency of occurrence ranging from 50% to 94%; for Criterion 2, Application of skills in standard situations, the frequency of occurrence ranged from 6% to 50%, while criterion 3, Application of skills in non-standard situations, had frequencies of 5% and 10% in B2 and B6 respectively. In the case of Criterion 4 and 5 Extended investigative projects and Varied solutions methods/answers for the same problem, the frequencies of occurrence were 0% in all the grade levels (from B1 to B9).

The indications of the data in Table 5 reveal an interesting trend; as the quality of the standards/criteria of mathematical tasks improved, the frequencies of their occurrence reduced drastically in students' exercises. This implies that, good problems, especially non-routine ones are not common in the sampled schools. This supports the Chi-Square test result that problem-solving approach is infrequently used in the sampled basic schools.

Discussion

Data gathered on use of PSA are not consistent with a hypothesized distribution and the study demonstrates that teachers at the basic schools use problem-solving approach infrequently, because teacher centered methods, where teachers determine the instructional pace, could still be dominating basic school mathematics classes. This finding is in support of Anamuah-Mensah et al. (2008), who declare that the use of problem-solving approach in mathematics lessons is limited in Ghanaian basic schools, because teachers spend most of the mathematics teaching time to lecture and write notes for students to copy. Factors such as lack of qualification for teaching mathematics, lack of experience in teaching mathematics and the newness of PSA as a concept in the basic school curriculum could contribute to the finding.

Most teachers who teach mathematics do not have qualifications in the field of mathematics. These teachers may be having degrees other than mathematics. Lack of requisite teaching qualification in the field of mathematics constitutes one of the major professional weaknesses of the basic school mathematics teachers in this study. This could lead to infrequent use of PSA and other professional challenges such as lack of formal knowledge in mathematics, expert knowledge that can be found only in textbooks and research articles (Richardson, 2001). This finding is consistent with Cohen's (1990) work on how teachers' poor mathematical background thwart their efforts of constructing favorable mathematics learning environments. Cohen (1990), argues that poor mathematical background, such as shallow content knowledge, affects mathematics teachers' questioning skills, arguments, and explanations of concepts. These teacher qualities are needed for effective use of PSA.

Apart from poor mathematical background of teachers, the study finds that majority of mathematics teachers may few years of teaching experience. Low levels of mathematics teaching experience in basic schools can affect teachers' practical knowledge in the teaching of the subject, especially where PSA is concerned. This supports Schoenfeld's (1987) assertion that teachers' use of problem-solving approach comes from experience as a result of repeated investigations and explorations of mathematical concepts with students yield a greater benefit and gives meaning. Thus, practical knowledge, is acquired through experience (Richardson, 2001).

This study has clearly demonstrated that most mathematics teachers do not have the requisite pedagogical content knowledge (PCK) to use PSA effectively in their lessons. This may be due to that fact that most mathematics teachers hold qualifications in disciplines outside of mathematics, coupled with low levels of teaching experience. This is consistent with Schulman's (1987) assertion that PCK is a special knowledge, grounded in the subject matter to give a special understanding, which guides the teacher to convert formal knowledge of the subject into the context of teaching it effectively. Similarly, PCK is the combination of formal and practical knowledge which come from expert knowledge and experience, respectively (Richardson, 2001).

Teachers lacked PCK, because according to McIntosh and Jarrett (2000), problem-solving lessons in mathematics require the teacher to make complex decisions such as: matching the level of students to the level of difficulty of problems to be assigned; choosing the appropriate time and strategies to assist students as well as ensuring that students retain the sense of ownership of the strategy used to solve problems. Without professional training and experience to equip the teacher with the required pedagogical content knowledge (PCK) in the subject, it would be most difficult, if not impossible, to use PSA in mathematics (McIntosh & Jarrett, 2000).

Perhaps teachers in Ghanaian schools infrequently use PSA because it has now been fully introduced in the mathematics curriculum. Cai (2003) draws a connection between the infrequent use of PSA to its newness as an approach in the basic school curriculum and concludes that, teaching mathematics through the use of problem-solving approach is new in the school curriculum, because it has so far not been receiving much research attention.

Conclusion

The results of the study are additions to empirical evidence available on the difficulties in the teaching of mathematics through problem solving and practical activities in Ghana. To this end, the study contributes important ideas to teacher training programs that could improve the teaching of mathematics, not only as tools for problem solving but also as ways of thinking.

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