USING THE SOUTH AFRICAN MATHEMATICS CHALLENGE TO DEVELOP PRE-SERVICE MATHEMATICS TEACHERS' PROBLEM-SOLVING ABILITIES

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Problem -solving is an integral part of the teaching and learning of mathematics. It is expected that mathematics teachers should be good problem solvers in their own right. However, this is not always the case with teachers, due to a lack of confidence and experience, among other factors. This research, conducted with pre-service mathematics teachers and using the South African Mathematics Challenge as a vehicle, has shown that it is possible to develop problem-solving skills and abilities in pre-service teachers. It may also provide a way in which these skills and abilities could be developed in in-service teachers.

INTRODUCTION

Teacher training in South Africa has undergone a number of reforms since the advent of democracy in South Africa. One of the most significant of these reforms was the decision by the then Minister of Education, Professor Kader Asmal to make teacher training in South Africa a competence of higher education institutions. Thus, from 1998 till 2001, there was a massive restructuring of teacher training, with all Colleges of Education, eventually being closed down.

One of the current challenges in teacher training in South Africa is the recruitment of competent students for such training and the quality of the programmes being offered, especially in subjects such as mathematics and physical sciences. This issue came to the fore in a report by the Ministerial Task Team on Mathematics, Science and Technology. One of its recommendations, listed as priority 2, was to "Address teachers and teaching issues". The fourth bullet under this priority states the following about pre-service teacher education:

> There is a critical need to intervene in pre-service teacher production in order to ensure that HEIs produce competent and credible new teachers of sufficient quality and in sufficient quantities to service the MST needs of the school system. (DBE, 2013:53)

The writer of this paper was involved as a coordinator of a B.ED (Science Option) programme at an Eastern Cape university, from 2011 till 2013. A close scrutiny of the Mathematics Method and Science Method modules revealed a lack of alignment with existing school practices. One of the first tasks was to reorganise the topics or content covered in these modules. At this university, the second and third year method students are exposed to senior phase (grade 7-9) mathematics content; FET content is covered in the fourth year.

Table 1 shows the topics that are included in the second year programme, after this reorganisation:

First Semester	Second Semester
1. Students' school experiences of Mathematics	1. Using pair and group work in mathematics
2. The nature of Mathematics	2. Problem- solving activities
3. Teaching methodologies	3. Overview of the senior phase mathematics content
4. Problem- based learning	4. Assessment
5. The number system	5. Geometry constructions
6. Estimation and number patterns	6. Geometry – investigations
7. Introduction to algebra	7. Ratio and proportion
8. Selected mathematics content: Simple equations; factorisation; word problems	8. Data handling
9. Lesson plans and microteaching	

Table 1: B.ED Mathematics Method Syllabus

A study of Table 1 shows that students are introduced to problem-based learning in the first semester and this is continued in the second semester under the heading "problem-solving activities".

A survey of the second year students revealed that only one of 14 students had taken part in Mathematics Olympiads or competitions while at school. This was, indeed, an alarming and frightening statistic. It meant that these students' lack of exposure to the problems in Olympiads and Mathematics competitions were likely to impact on their own learners in the future. Thus, the inclusion of these topics in their method modules (in the first and second semesters) were designed to change this scenario and make sure these pre-service mathematics teachers were familiar with Olympiad-type problems.

The South African Mathematics Challenge is a competition for grades 4-7 learners of Mathematics. It is an AMESA (Association for Mathematics Education in South Africa) initiated competition which is organised by the South African Mathematics Foundation. The challenge is conducted in various regions of South Africa, with regional coordinators (usually AMESA members) responsible for liaising with schools and collecting statistics (South African Mathematics Challenge, 2014). In 2012, the writer of this paper was the regional organiser of the mathematics challenge in a rural town of the Eastern Cape. In the first round of the challenge approximately 900 learners from five primary schools participated.

The writer felt it opportune to use the grade 7 paper (first and final round) in this research as it was in line with some of the mathematics school content which had to be covered within the second year mathematics method module.

RESEARCH QUESTION

Since this research involved ascertaining and improving the problem-solving ability of pre-service teachers, the following research question was posed for this study:

Are pre-service teachers of Mathematics competent in solving Olympiad-type problems?

In an attempt to answer the research question, the following subsidiary questions were formulated in the context of the study:

- How do pre-service students perform in mathematics competitions which target learners?
- Can the performance of pre-service students in mathematics competitions be improved through a structured intervention?
- What are the views of pre-service students on the mathematics competitions such as the Mathematics Challenge?
- Can pre-service students be encouraged to incorporate Olympiad type problems in their classrooms?

SAMPLE

The sample for this study consisted of 14 students, all of whom consented to their participation in this study. Thus, the sample would be classified as "convenience sampling" (Skowronekand & Duerr, 2009).

RESEARCH METHODOLOGY

Both quantitative and qualitative data were collected in this study. The quantitative data consisted of the students' marks in both the first and final round of the South African Mathematics Challenge.

This study was about the experiences of pre-service teachers of mathematics with respect to Mathematics Olympiads and Competitions and to understand how they viewed these from their perspectives, making this study more qualitative in nature (Hatch, 2002).

The qualitative data consisted of the following:

- Students' feedback on the South African Mathematics challenge (this was completed by 10 of the 14 students)
- A classification of the items in the South African Mathematics challenge according to certain categories (completed in groups)
- Comments about the type of questions in the challenge (completed in groups)
- How they would incorporate such questions in their normal classroom teaching (completed in groups)

- How they would prepare their learners for competitions such as the South African Mathematics challenge (completed in groups)

OPERATIONAL STRATEGY

This study involved students writing both the first and final round of the grade 7 South African Mathematics challenge. In the period between the two rounds of the challenge, the students were involved in a number of activities. The students wrote the first round of the grade 7 paper. After completing the paper, they had to provide general feedback on the challenge. At the same time learners from the five primary schools wrote the grades 4 – 7 challenge. These papers were collected and brought to the university.

As part of a follow-up class activity the students marked the papers. From this activity, students became familiar with the types of questions in the challenge and the performance of the learners in the challenge. In the next Mathematics method lesson, students were divided into three groups. Each group had to conduct an in-depth analysis of the grade 7 paper followed by comments on the questions and how they would incorporate problem-solving type questions in their teaching. They also had to indicate how they would prepare their learners for mathematics competitions (see previous section on qualitative data).

CONCEPTUAL FRAMEWORK

This research had both an ontological and epistemological basis (Cohen & Manion, 1985). The ontological basis was primarily about the experience of the students in writing South African Mathematical Olympiads and Competitions. It was known to the writer (via a survey) that only one student in the sample had previously written a Mathematics Olympiad while at school. Thus, it was clear to the researcher that the students in the Mathematics method class would need to be exposed to Mathematics Olympiads. The process of students acquiring this exposure would be in line with the epistemological basis of this research, which was to make the students aware of the nature of Mathematics Olympiads and Competitions. This would be done by using the South African Mathematics Challenge for grades 4 -7. This awareness would be acquired by students marking the papers of around 900 learners from the five primary schools and then making a detailed analysis of the grade 7 papers.

A suitable framework for this study would be in line with experiential learning theory. Experiential learning involves a number of steps that offer students a hands-on, collaborative and reflective learning experience which helps them to "fully learn new skills and knowledge" (Haynes, 2007). Although learning content is important, learning from the *process* is at the heart of experiential learning. During each step of the experience, students will engage with the content, the instructor, each other as well as self–reflect and apply what they have learned in another situation (Haynes, 2007). This was definitely in keeping with the students' engagement with the various activities in this study.

RESULTS

Performance in first round

Table 2 below shows the performance of the students in the first round of the South African Mathematics Challenge for grade 7.

Student	First Round
A	9
B	24
C	4
D	7
E	6
F	6
G	7
H	10
I	13
J	7
K	19
L	16
M	18
N	14
Average	**11,43**

Table 2: Performance (out of 25) in the first round of the Mathematics Challenge

Learners who participate in the Mathematics Challenge require 60% (15 out of 25) in the first round to qualify for the final round. By applying these criteria to the students in this sample, one finds that only four students would have qualified for the final round.

At the outset, these marks reflect poorly on the students. These students had passed grade 12 Mathematics (with a minimum of 50%), and also completed all the modules for first- year university mathematics. Yet, they were unable to perform well in a grade 7 paper. Clearly, these students had very little experience in working through problem-solving type questions and this lack of experience probably contributed to their poor performance.

STUDENTS' FEEDBACK ON THE FIRST ROUND

The views of the 10 students who provided feedback on the paper are recorded here. The words written here are the words of the students. Some editing has been done to correct spelling and grammatical mistakes. The students are named A, B, C, etc. to ensure confidentiality.

Student B:

> The test required a proper understanding of the basic concepts of mathematics. It made you think of better strategies that one should use when teaching these concepts. Such a test would also be designed to enable school children's ability to think and assess their level of understanding of basic mathematics, prior to going to high school.

Student C:

> The paper was very challenging. It was difficult to answer some questions and I resorted to guessing. I must work harder and put in more effort to answer a grade 7 paper (at my level). Every question required logical reasoning and the use of mathematical skills. I did finish the paper but did not have time to check.

Student E:

> Some of the questions may be confusing to grade 7 learners. I believe it is above their level of understanding and may be a bit abstract or complicated to them. They have to apply their knowledge and skills they have acquired from their experiences. They will perform well if they are exposed to these types of questions and can work on their own. These questions develop their level of understanding and problem-solving skills.

Student F:

> It was a challenging paper. It is good for developing the student teachers' knowledge and skills in respect of problem -solving. They would be able to become better at problem -solving and can pass on these problem- solving skills to their learners.

Student H:

> The first few questions were easy and this could have been to draw the learners' interest and to change their attitude. If learners were negative then they would think that the test was too difficult. The paper kept learners active and helped develop learners' calculating, analysing, observation and measuring skills.

Student I:

> The paper is good for learners but they should get enough practice in these problems. The first few questions got the interest of the learners. Teachers must play an important role in teaching learners about problem -solving strategies and problem -solving.

Student J:

> I found the word problems to be difficult. I tried my best but have developed a "negative" attitude towards word problems. I still have this problem up to this day. I thought that the paper was going to be easy but I was very surprised at the level of the paper. It involved critical thinking, knowledge of basic algebra and some abstract concepts. It was quite a high standard. The paper was good for learners' cognitive development and would make them better mathematics learners if they were exposed to these type of questions in their earlier grades.

Student K:

> The test was fair and simple. It consisted of topics which learners were supposed to know or understand by grade 7. However, learners had to think critically and creatively and use various problem- solving skills when working through the questions in the paper. They had to deal with a number of questions involving patterns and had to use different strategies when working through these questions.

Student L:

> The test was not what I expected. I was expecting less of a challenge but it was hard and challenging. It required logical reasoning and I thought the standard to be higher than that which was expected for primary school learners. The test did not require the use of a calculator. Learners needed to have a solid foundation in mathematics. I think the teaching of mathematics at the primary school is of a low standard and does not prepare learners for competitions such as the Mathematics Challenge. Even though the test appeared to be difficult, I believe it will "sprout" an awakening call to teachers to raise their standards in their mathematics classrooms.

Student M:

> The paper was not easy. I struggled with geometric patterns. I believe that the paper would be difficult for grade 7 learners, especially if they have not been exposed to these questions. The challenge is good for them as they get exposed to different concepts. Teachers should incorporate these questions in their lessons and this would be beneficial to learners.

TRENDS EMERGING FROM THE STUDENTS' VIEWS

There appeared to be some correlation between the students' marks in the paper and their comments. Those who did well had favourable comments while others found the paper to be difficult and challenging. Some of the key issues raised were:

- The paper was challenging for them and would be beyond the ability levels of primary school learners.
- The teacher is the key role player in the developing of thinking and problem- solving skills in learners. They should know more about critical thinking and problem- solving strategies and be able to expose their learners to these crucial mathematical skills.
- Problem- solving should be incorporated into mathematics lessons. If learners are exposed to problem-solving type questions in earlier grades, then they should have no trouble in working through these types of questions.
- The importance of a solid foundation in mathematics cannot be underestimated. In this regard, primary school teachers should raise their standard of teaching and making sure that their learners are assisted to achieve this standard.
- It is important for schools to encourage their learners to participate in mathematics competitions such as the Mathematics Challenge.

MARKING OF THE PAPERS

The students were given an opportunity of marking approximately 900 first- round papers. They attempted this task very enthusiastically as they felt it would give them some practice in marking as part of their professional development. The marking was made easier for them as it was a multiple-choice paper and learners had to fill in their responses on a given template. A marking template of correct solutions for each of grades 4 -7 was developed. The marking of the papers proceeded smoothly with no issues. The only concern of the students was the poor performance of the learners. Only 18 learners had achieved the 60% cut-off to write the second round.

Such poor primary school performance in mathematics has been in the news lately with primary school learners not performing up to expectations in the grade 1 – 6 Annual National Assessments (ANA) for mathematics. The second part of the statement by student L, shown below, is relevant in this regard.

> I think the teaching of mathematics at primary school is of a low standard and does not prepare learners for competitions such as the Mathematics Challenge. Even though the test appeared to be difficult, I believe it will "sprout" an awakening call to teachers to raise their standards in their mathematics classrooms.

It is possible that primary schools with a culture of participation in mathematics competitions have raised their standard of teaching mathematics and have probably had good ANA results in mathematics. This needs to be investigated further.

ANALYSIS OF THE GRADE 7 PAPER

The students were divided into groups (on a random basis) and had to analyse each question and classify the question according to given categories. This activity was to enable students to become more familiar with the broad mathematics content that is covered in competitions such as the Mathematics Challenge. This would also serve as good practice in locating questions into the content areas of the Senior Phase curriculum (DBE, 2011). These broad categories and possible alignment to the Senior Phase mathematics curriculum (CAPS) is shown in table 3.

	Broad category for the mathematics challenge (grade 7)	Alignment to content areas of the Senior Phase mathematics curriculum
1.	Numbers and number sense (whole numbers)	Numbers, Operations and Relationships
2.	Numbers (fractions)	Numbers, Operations and Relationships
3.	Numeric and geometric patterns	Patterns, Functions and Algebra
4.	Geometry and measurement	Space and Shape; Measurement
5.	Other	

Table 3: Mathematics Challenge categories and alignment to the curriculum

According to the classification all content areas of the Senior Phase, with the exception of Data Handling, were covered in the grade 7 paper. The writer had worked out a possible classification for the grade 7 paper, according to the categories shown in table 3. This classification is shown in table 4.

	Broad category	Number of questions	Actual questions
1.	Numbers and number sense (whole numbers)	5	1, 7, 8, 22, 23
2.	Numbers (fractions)	4	2, 5, 6, 16
3.	Numeric and geometric patterns	7	12, 13, 14, 19, 20, 21, 25
4.	Geometry and measurement	8	3, 4, 9, 10, 11, 15, 17, 24
5.	Other	1 (calculation of days). This question could have been classified under “measurement”.	8

Table 4: Possible classification of Mathematics Challenge questions (grade 7)

The writer does not claim that the classification given is the most definitive one. However, it does give a clear indication of the content covered in the paper. Students had to come up with their own classification of questions by working in groups. The groups were numbered group1; group 2 and group 3. These classifications are shown in tables 5 – 7.

Broad category		**Number of questions**	**Actual questions**
1.	Numbers and number sense (whole numbers)	2	1, 18
2.	Numbers (fractions)	3	2, 5, 6
3.	Numeric and geometric patterns	18	3, 4, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 21, 22, 23, 25
4.	Geometry and measurement	1	24
5.	Other	1	8

Table 5: Classification compiled by Group 1

Broad category		**Number of questions**	**Actual questions**
1.	Numbers and number sense (whole numbers)	6	1, 7, 18, 19, 20, 21
2.	Numbers (fractions)	4	2, 5, 6, 16
3.	Numeric and geometric patterns	6	8, 12, 13, 14, 17, 25
4.	Geometry and measurement	6	3, 4, 9, 10, 11, 15
5.	Other	3	22, 23, 24

Table 6: Classification compiled by Group 2

Broad category		Number of questions	Actual questions
1.	Numbers and number sense (whole numbers)	3	1, 7, 18
2.	Numbers (fractions)	5	2, 5, 6, 10, 16
3.	Numeric and geometric patterns	8	8, 12, 13, 14, 19, 20, 21, 25
4.	Geometry and measurement	6	3, 4, 9, 11, 15, 17
5.	Other	3	22, 23, 24

Table 7: Classification compiled by Group 3

COMMENT ON THE CLASSIFICATION BY GROUPS

The writer did not expect the groups to provide the same classification as was expected. It would appear that students used their own experiences and intuition when classifying questions. Although the students were able to classify some of the questions in the paper correctly, they may not have had the necessary experience or background knowledge to classify all the questions. This prompted the writer to lead a class discussion on the classification of the questions to correct any misconceptions that students may have had. This was appreciated by the students.

STUDENTS COMMENT ON THE TYPES OF QUESTIONS IN THE PAPER

The responses of students in their initial feedback did cover some comment on the type of questions in the paper and this was discussed earlier. In this activity, students had to discuss this matter in their groups. The students in group 1 stated that the questions were not easy. There were a lot of analyses involved and according to them the standard was very high for grade 7 learners. They complained that the questions were “complicated” and learners would become confused and frustrated when they did not know how to work out a problem.

Similar views were expressed by group 2. They commented on the “challenging” nature of the questions. Learners would spend too much time on the questions and probably get frustrated. Learners would then resort to guessing. These students complained about the phrasing of some of the questions claiming that this would be a deterrent to second-language learners. Learners who have not been exposed to these types of questions would find the questions difficult. This might lead them to think that they did not know anything.

Group 3 had a different view from the other two groups. They felt that the paper was not that difficult and that it was set at the right standard. They believed that the paper tested learners’ critical thinking and problem- solving skills and learners should have been taught the relevant content. Participation in the challenge would be a way of inculcating a love for mathematics.

The comments by the groups appeared to triangulate well with the individual feedback of the students stated earlier. This probably ensured that the data collected from the individual students and the groups were both valid and reliable.

INCORPORATING PROBLEM-SOLVING TYPE QUESTIONS INTO LESSONS

Mathematics Olympiads or competitions should not exist as "stand-alone" events. Rather, problem- solving type questions should be incorporated into classroom lessons so learners are aware of problem- solving throughout the year, not only at Olympiad time. It was with this in mind that the groups were asked how they would incorporate problem-solving type questions into their lessons.

Group 1 stated that these problems could be given as projects or assignments and then be discussed in class. The teacher would provide solutions once these are handed in. These problems should be given more often so learners get used to these problems. The students in group 2 stated that class lessons should allow for the inclusion of one or two of these questions. These could be taken from past year papers and discussed in class. Learners should be taught the different problem-solving strategies so they could attempt these problems with confidence. These questions could also be given in homework. Group 3 expressed similar views to group 1 and 2. They believed that posters of geometric figures, number patterns and other content areas may help learners develop problem- solving skills.

PREPARING LEARNERS FOR MATHEMATICS OLYMPIADS OR COMPETITIONS

Despite the majority of these students being new to Olympiads, the idea of this research was to point out the importance of Olympiads in the mathematics development of children. Thus, when they started teaching they should encourage their learners to participate in Mathematics Olympiads. Thus, as part of the group discussions, students were asked how they would prepare their learners for Mathematics Olympiads.

Group 1 emphasised the importance of reading and understanding. Learners would have to gain much needed practice by going through past year papers. They also stated that exposure to Mathematics Olympiads would help in developing "curiosity in learners". Group 2 expressed similar sentiments to group 1. In addition, learners would need to know the basics and could work out problem-solving questions in groups. Group 3 also emphasised the need for practice and working in groups. By working in groups, learners would be able to share ideas and learn from each other. They could be given similar papers in class to determine their understanding of certain topics.

PERFORMANCE IN THE FINAL ROUND

After the marking and analyses of the first round challenge paper, students were now more prepared for the final round. They wrote the final round approximately a month after the first round.

Table 8 shows the performance in the first round and final round.

Student	First Round	Final Round	Difference
A	9	22	+13
B	24	23	-1
C	4	24	+20
D	7	17	+10
E	6	19	+13
F	6	14	+8
G	7	15	+8
H	10	21	+11
I	13	19	+6
J	7	16	+9
K	19	21	+2
L	16	16	-
M	18	18	-
N	14	19	+5
Average	**11,43**	**18,85**	**7,42**

Table 8: Performance in the first and final round

COMMENT ON FINAL ROUND PERFORMANCE

For 11 of the 14 students, performance in the final round (meant to be more difficult than the first round) improved. For one student there was a negligible drop of 1 while the other two student's marks remained the same. The overall average increased by 7, 42 marks. The performance in the second round is probably due to students paying more attention to problem-solving after the class activities where the questions were classified and analysed. The fact that the classroom activities also involved students discussing possible ways of incorporating these questions in their teaching and examining ways of preparing learners for Olympiads and Competitions may have also contributed to their improved performance in the final round.

DISCUSSION

This research was prompted by a survey of the Mathematics Method students which revealed that only one of them had participated in a Mathematics Olympiad while at school. This was indeed a frightening statistic and did not bode well for any future learners taught by these teachers (once they qualified). It was highly likely that none of these students would expose their learners to Mathematics Competitions or Olympiads. The writer, a teacher trainer at the time, decided to intervene, starting at a more elementary level. In this regard, the South African Mathematics challenge was used as a vehicle to ascertain how the students approached problem- solving. Their performance in round 1 showed that these students definitely required more assistance with problem-solving.

In their feedback after writing round 1, most claimed that the paper was difficult and that they struggled with the paper. They had never expected it to be set at such a high standard for grade 7 learners. Clearly, their lack of experience in understanding and working through Olympiad type questions showed with their poor performance in round 1. This led to a structured intervention which the writer implemented during the Mathematics Method class periods. This intervention included marking the papers of about 900 learners, then dividing the students into groups and asking them to classify the questions in the grade 7 paper according to certain categories. They also had to comment on the types of questions in the paper, state how they would introduce problem-solving type questions into their lessons and indicate how they would prepare their learners for Mathematics Olympiads and Competitions.

The last part of the intervention involved the students writing the final round of the grade 7 paper of the South African Mathematics Challenge, about a month after round 1. It would appear that the intervention strategies were successful as there was a very substantial increase in their performance in the final round of the challenge. This is significant as the final round usually consisted of more difficult questions when compared to round 1.

FINDINGS

This research was carried out in a structured manner with a view to helping the students develop their problem-solving abilities. These students had passed grade 12 mathematics with a minimum of 50% and had also completed all their mathematics 1 modules at the university. Thus, it would appear that they had the necessary knowledge and skills for problem-solving and the intervention was designed to bring these abilities to the fore.

It is now possible, using the data from this research and the discussion in the previous section, to come up the findings in this research. This would be written within the context of the research sub-questions and the research question.

How do pre-service students perform in mathematics competitions which target their learners?

It is evident from the performance in the first round of the South African Mathematics Challenge that these students performed poorly. They provided various reasons for this performance. Despite these students being good mathematics students at various levels, their lack of experience in working with Olympiad- type questions probably caused this poor performance. However, this was done before the structured intervention.

Can the performance of pre-service students in mathematics competitions be improved through a structured intervention?

The strategy for the structured intervention consisted of students giving initial feedback, marking papers, classifying the grade 7 questions, commenting on the types of questions, stating how they would incorporate such questions in their lessons, and saying how they would prepare learners for Mathematics Olympiads. This strategy appeared to change the way these students viewed problem-solving, with them becoming more confident and positive.

This was clearly evident when they wrote the final round of the Mathematics Challenge, with nearly all students improving their marks. The improved performance of students, especially in a more difficult paper, would probably point to the structured intervention being classified as successful.

What are the views of pre-service students on the mathematics competitions such as the Mathematics Challenge?

Despite the initial poor performance of the students and their views that the Mathematics Challenge was difficult for primary school learners, there was agreement that the standard of teaching and learning mathematics in primary schools was not at the level it should be. In this regard, learners would not be able to confidently participate in competitions such as the Mathematics Challenge. However, raising the standard of teaching and learning in the primary schools would make learners better equipped for Mathematics Competitions.

Unlike their own lack of experience with regard to participation in Mathematics Olympiads, these students believed that all learners should be given the opportunity of participating in competitions such as the Mathematics Challenge. This would help the learners' mathematical development. With the current focus by the Department of Basic Education on improving teaching and learning in the primary schools through the introduction of Annual National Assessment (ANA) in mathematics and language, it would be interesting to compare learner performance in the Mathematics Challenge and their performance in the ANAs.

Can pre-service students be encouraged to incorporate Olympiad type problems in their classrooms?

The data in this research suggests that the response to this question would be in the affirmative. These students were able to outline a number of ways in which they could incorporate Olympiad-type problems in their classrooms. They realised the importance of these problems in helping with children's mathematical development.

These students also indicated how they would help their own learners prepare for Mathematics competitions. This is an important breakthrough in their own training as it showed that these students were likely to introduce their learners to Mathematics competitions when they started teaching. This would be a far cry from their own lack exposure when they, themselves, were at school.

The research question: Are pre-service teachers of mathematics competent in solving Olympiad-type problems?"

An interrogation of the marks from round 1 of the Mathematics Challenge suggests these students were not competent in solving Olympiad-type problems. This lack of competence was probably due to a lack of experience in working with these problems.

However, other data from this research showed that this lack of competence could be changed through a structured intervention. This structured intervention made the students aware of the need to expose their learners to Mathematics Competitions and Olympiads. This could only be done if they themselves were competent at solving these types of problems.

CONCLUSION

This study was conducted with a group of 14 pre-service mathematics students. 13 of these students had never taken part in a Mathematics Olympiad or Competition before. In line with the theories on experiential learning, these students would not have been able to pass on these experiences to their own learners. The writer attempted to address this with a structured intervention, using the South African Mathematics Challenge as a vehicle. This intervention was able to turn things around. The students became well-versed in problem-solving and problem-solving strategies. There is no doubt that these students would be able to promote Mathematics Olympiads and Competitions at their schools.

This study has great significance on the future of Mathematics Olympiads and Competitions in South Africa. The majority of our mathematics teachers have had little or no exposure to Mathematics Olympiads and Competitions. It is more than likely that their learners have not been exposed as well. This may mean that the majority of learners are not given an opportunity to enrich their mathematics knowledge and skills. The structured intervention described in this study provides a possible way in which this could be addressed.

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