Factors which promote mathematics teaching as a career: Reflections of pre-service students

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The reasons why people choose mathematics teaching as a career are many and varied. This small-scale study examines possible school factors which may play a role in this career choice. These school factors, based on reflections of pre-service students, are outlined in this study. These factors may provide universities and other organisations, which are involved in pre-service teacher recruitment, with possible pointers on recruiting top quality students to their mathematics teacher education programmes.

1. Introduction and background

The teaching and learning of mathematics is both a national and an international problem (de Lange, 1981; Howie, 2001; Centre for Development and Enterprise (CDE) , 2004). Various strategies have been used to address this problem. In South Africa, outreach programmes for learners have been arranged by higher education institutions, the department of education and non-governmental organisations. Universities have also been involved in the massive upgrade of mathematics teachers through various in-service programmes. These initiatives have had degrees of success over the years. However, it has been known for some time that the mathematics teachers at South African schools are aging and new teachers needed to be trained (CDE, 2007).

During an address to delegates at the 17th annual Association for Mathematics Education in SA, at the University of the Witwatersrand, the Minister of Science and Technology Ms Naledi Pandor pointed to “the odds that are seemingly stacked against the country's chances of making a breakthrough in terms of producing competent mathematics teachers” (Mecoamere, 2011).

While the statement by the minister does not inspire confidence to those involved in teacher training, incentives such as dedicated bursaries for those wanting to take up teaching of scarce subjects such as Mathematics and Physical Sciences have been an integral part of teacher recruitment for the past few years. This has encouraged more students to take up mathematics teacher training at various universities in South Africa. However, the biggest challenge facing institutions is drawing top quality candidates.

A study of more than 100 teachers by the NCTM in the USA on why people take up mathematics teaching has relevance to this study. To obtain more in-depth responses to this question, 10 of the teachers in the NCTM study were interviewed. Their responses are categorised broadly as follows:

(a) Helping and explaining mathematics problems to others

Three teachers explained that helping mathematics problems to fellow classmates at school, helping inner-city children with mathematics or wanting to develop children’s thinking prompted them to take up mathematics teaching as a career.

(b) Limited career choices

Some teachers entered the profession because other career options were limited, especially for those who excelled in mathematics.

(c) The beauty of mathematics

Some were attracted to mathematics because of the nature of the subject. The beauty of mathematical patterns and the orderly nature of the subject were given as reasons.

(d) Being inspired by their mathematics teachers

A few of them were inspired by their mathematics teachers and this prompted them to take up the profession.

(NCTM, 2002)

The study by the NCTM targeted practising teachers and sought possible reasons for their entry into the profession.

A study by the World Bank in 2007 showed that many countries in sub-Saharan Africa, find it difficult to attract quality students to mathematics teaching. Although reasons such as wanting to impart knowledge or seeking to develop the young people of their country were given by prospective students, for many teaching was chosen on the basis of the possible benefits it offers, including salary, job security, and opportunities for advancement. There was also evidence to suggest that some people chose to teach because of the lack of other employment options. (Mulkeen, Chapman, DeJaeghere, Leu, 2007).

Although the factors mentioned in the NCTM and World Bank study are likely to have relevance in a South African context, the challenge of recruiting quality students into mathematics teaching remains.

2. Rationale for this study

This study explores the possibility of school factors playing a role in students choosing mathematics teaching as a career. It attempts to gather data about pre-service student teachers' experiences of their school mathematics and to determine whether there is a connection between these experiences and their choice of mathematics teaching as a career. It may provide key indicators in the recruitment of young students into the profession.

3. Research question

To investigate the possible school factors which may play a role in the choice of mathematics teaching as a career, the following research question was formulated.

> Is there a connection between school experiences of mathematics and mathematics teaching as a career choice?

In an attempt to answer the research question, the following subsidiary questions were set.

(1) What were the mathematics school experiences of pre-service mathematics student teachers?
(2) What factors from these school experiences were likely to play a role in their choice of mathematics teaching as a career?
(3) What do these students believe are the "characteristics of a good mathematics teacher"?

4. Sample

This sample consisted of second year Bachelor of Education students studying at an Eastern Cape university. They were training as high school teachers and opted for mathematics as one of their teaching subjects. They had completed their Mathematics 1 modules in the Faculty of Science in their first year. There were 13 students in this sample and all participated voluntarily in this study. The size of the sample made it a small- scale study.

5. Theoretical Framework

Hatch (2002) explains that in qualitative work, it is understood that the act of studying a social phenomenon influences the enactment of that phenomenon. Researchers are part of the world they study; the knower and the known are taken to be inseparable.

In this study students had to give a brief account of their school experiences of mathematics, participate in an interactive discussion on good mathematics teachers and then come up with criteria of their own in deciding what constitutes a good mathematics teacher. The data from the students' accounts of their mathematics experiences and the discussions with students produced qualitative data, with the writer being an integral part of this process. Thus, this study was a qualitative study (Hatch, 2002).

The first research sub-question focussed on the school experiences of the students. Their reflections on the class discussion and their own experiences would be key factors in responding to the second and third sub-questions.

Some of the attributes of experience - based learning listed by Andresen, Boud and Choen (2000) such as "involving something personally significant or meaningful to the students", 'students should be personally engaged" and "reflective thought and opportunities for

students to write or discuss their experiences" have relevance for this study since the students in the sample were actively engaged in writing about their school experiences.

The students were engaged in reflection. Moon (1999) defines reflection as a form of mental processing or thinking that is used to fulfil a purpose or to achieve some anticipated outcome. The reflection of students in this study was "reflection-on-action" where the reflection has happened after an event. In this case, they had to reflect on their school mathematics which they had last encountered two or more years previously. They also had to reflect on the class discussion on the characteristics of a good mathematics teacher.

In the light of these discussions, this study could be described as a qualitative study, located in the experiential- reflective research paradigm (Rothwell & Ghelipter, 2003).

6. Data Collection

This study was conducted in three parts. In the first part, students were required to reflect on their school experiences of mathematics. To assist them in structuring their responses, they were given the following headings.

- Highlights of their school mathematics
- Challenges experienced
- What they learnt
- What they were not sure of
- Their performance in assessment tasks
- Their mathematics teacher

The second part consisted of an interactive class discussion on the characteristics of a good mathematics teacher. This discussion was facilitated by the writer. This was important as in the third part of this study students had to reflect on this discussion and their own experiences to come up with their **own** criteria on what constitutes a "good" mathematics teacher.

7. Results

First part of this study

To record the data in the first part of this study, the students were coded using the letters A to L. In the write-up of the results, the focus is on key trends and features. However, in some instances, students' own words are used for emphasis.

Highlights of their school mathematics

For most of the students, mathematics was a fun and interesting subject and made them want to go to school. They did fairly well in mathematics and two of them (students C and J) were chosen to represent their schools in extra-curricular activities such as computer study programme and science quizzes.

These two students' responses are indicated below.

Student C

"I topped the class in a science selection test and was chosen to go to Port Elizabeth for a science quiz. When I arrived there I found that the students were mostly white but I did not look down on myself. I just answered the quiz questions and I also did well. I even received an award"

Student J

"I was one of the top 5 mathematics learners at my school and I was chosen to participate in a new computer study programme. It was the best feeling I ever had as a student"

One student recalled that he performed poorly in grades 10 and 11 and decided to work hard in grade 12. This resulted in him doing very well in grade 12 and he was accepted to study at university. Another student talked about making "*songs about mathematics concepts"* in grades 8 and 9. This helped him understand the mathematics concepts. This student also stated that in grade 11 he wrote a 50 mark test paper in 5 minutes and obtained 100%.

Challenges

The challenges experienced by the students were wide and varied. Three students were very specific about their challenges citing difficulty with trigonometry and financial mathematics. Others explained that they had to go to school early for extra mathematics classes and remain in school in the afternoon for more classes. All their attention was devoted to mathematics and they tended to neglect other subjects. Although this was regarded as a challenge one student said "*Going to school early in the morning; on Saturdays and during the holidays made me realise that mathematics was an important subject"*.

Another student remarked that her challenge was a personal one in that she wrote slowly, was the youngest in the class and her teacher always asked her to respond in class.

In addition to the observations above, the response of four students are highlighted below. Firstly, student E wanted to help his colleagues in class but was denied the opportunity. He said:

"*I always wanted to be given a chance in the mathematics class to help my classmates but the teachers would do everything on their own. Some teachers were not approachable so it was not easy to ask questions"*

Student F complained about the shortage of resources at her school stating:

"*There was a shortage of resources where now we should share sometimes five to one textbook."*

This challenge was also echoed by student I who said:

"*We had to go outside the school looking for textbooks because there weren't any at school".*

Student Js comment was rather disturbing when he said:

"My Mathematics and Biology teachers had to further their studies and we were left to study on our own during the 12th grade. It was really tough but we made it".

What they learnt

Most students stated they learnt to be hard working as "*practice makes perfect*" with one adding that "*your practice must also be perfect for you to be perfect*". They would go over their work every day and not waste time. They also spoke of the need for effective revision such as going over past year papers and working through all types of questions. Two students spoke positively about group work as it was very helpful when studying mathematics. One stated that "*when you work alone you won't know if you are correct"* and the other saying that "*one must prepare for group discussions"*

Once again student J came up with a very interesting response saying:

"A person's mind is more powerful than one can imagine because we were left to study on our own; we knew we had no choice but to make it and pushed beyond our limits and got through. Also I have learnt that Mathematics is the best subject that mankind has ever come up with as it can change the way we think for a better one"

What they were not sure of

Some students pointed to specific mathematics sections such as financial mathematics and trigonometry (also stated under challenges) and tended to put them under great stress. Financial mathematics was a new section in the curriculum and it is possible that teachers, themselves, were not sure of how to teach it. Others were not sure of how they could apply mathematics to "real life" but decided to persevere with it as they realised that mathematics was an important subject. One student remarked that his grounding in mathematics up to grade 10 was not up to standard and he had to use old textbooks to help him understand the basics in mathematics.

Their performance in assessment tasks

All students claimed to have done very well in their mathematics assessment tasks. They were usually in the top 5 in their classes and always strived for high marks. This was so because they loved doing mathematics and worked hard in the subject. One student was hard on herself, stating that she regarded getting 68% in one of her tests as a *"fail*". Another student stated that he did poorly in

the Grade 12 June examination, obtaining an H symbol. He wanted to give up but decided to carry on and ended up doing well in the final examinations.

Their mathematics teachers

Most of the students were very complementary of their mathematics teachers. Their teachers were hardworking and dedicated to mathematics. They would teach them in class using a variety of different approaches. They also had weekend and holiday classes. This was in addition to the morning and afternoon extra classes. Their teachers would always encourage them in the classes with one student stating that their teacher told them to "*challenge mathematics rather than be challenged by it"*

Only two of them complained about their teachers. One stated that their teacher was not good at explaining and they had to form study groups. These study groups were successful as they shared ideas and became competitive with each other. The other student said their teacher expected them to know their work even if they were not taught. This put them under pressure.

Second part of this study

As stated earlier, the second part consisted of an interactive class discussion on the characteristics of a good mathematics teacher. It was a very exhaustive discussion and placed a high priority on the role of the teacher. This discussion was intended to give students some direction on the issue. The following points were highlighted during the discussion:

- The creation of learning environment where learners are active participants as individuals and as members of collaborative groups.
- Motivation of learners and nurturing their desire to learn in a safe, healthy and supportive environment which develops compassion and mutual respect.
- Appreciating different cultures and valuing diversity
- Encouraging learners to accept responsibility for their own learning
- Displaying effective and efficient classroom management
- Providing learners with equitable access to technology, space and time
- Allocating learners time to engage in hands-on experiences and classroom discussions
- Creating an environment where learner work is valued and appreciated
- Providing opportunities for learners to share mathematical ideas and to solve problems
- Displaying passion when teaching so that learners are aware that the teacher loves the subject
- Being creative in the classroom to cater for differing ability levels
- Showing some flexibility when learners do not perform well and being supportive at all times
- Teaching mathematics in an integrated manner by showing how mathematics is used in other subjects and in society
- Forming a solid connection with each learner by being interesting and having other interests and sharing this with learners in order to encourage them

During this discussion, students tended to identify with many of the characteristics, using the contexts of their own experiences with their mathematics teachers. This was in keeping with their earlier responses about their own teachers. All students contributed to this discussion, either voluntarily or through probing by the writer. This discussion also served as preparation for the third part of this study.

Third part of this study

In the third part of this study, students had to come up with what they believed were characteristics of a "good" mathematics teacher. They had to use their own experiences and the discussions above to come up with these characteristics. This was then handed in. The students' responses were analysed carefully with an emphasis on key trends and features. There appeared to be some synergy with the discussion in the second part of this study. The following points emerged from this analysis.

- Each mathematics teacher has his or her own teaching style and philosophy and this should be consistent with helping learners study the subject in a safe, stimulating environment.
- Mathematics teachers should be passionate about mathematics. If learners see this passion in their teachers, they are likely to develop a positive attitude to mathematics.
- They should have strong knowledge of the mathematics content to enable them to teach mathematics with confidence.
- Good mathematics teachers respect their learners and effectively engage their learners by treating teaching as a collaborative process and valuing their thoughts and opinions.
- They should challenge their learners and encourage them to be creative and inquisitive when working through mathematics problems.
- They should understand that their learners come from different backgrounds and use a variety of teaching methods to cater for different ability levels.
- A good mathematics teacher should be available to assist learners who have difficulty with mathematics with one-on-one sessions and extra classes.
- Mathematics teachers should be motivated to get the best out of learners and promote the motivation to learn in them. This could be done by being positive role-models and by making their lessons more interesting through creative and innovative approaches.

8. Discussion

The students took part in all parts of this study with great enthusiasm. The data they provided appeared to support the notion of them being comfortable with their career choice of becoming mathematics teachers. This could be attributed be attributed to their school experiences of mathematics. To emphasise these experiences, key factors are highlighted in bold.

They found mathematics to be a **fun and enjoyable subject** and usually performed well in the subject. In fact, most of the students in the sample were in **the top 5** in their mathematics classes. It would seem that not all top mathematics opt for careers in medicine,

engineering and other such like careers. Some of the top mathematics learners also **choose to become mathematics teachers.**

The challenges expressed by the students would appear to be serious in the case of those without textbooks and student J whose teachers were more focused on personal studies. Despite these challenges, they **worked hard** to get to university and decided to choose mathematics teaching as a career. The other challenges expressed such as going to school early in the morning and leaving school late could also be a **rallying point for students** to see the **importance of mathematics** as a school subject as a lot of time and effort needs to be put into the subject. The fact that they were part of these classes and did well may have made them realise that their **hard work and effort were worth it**. It probably **motivated them** to take up mathematics teaching.

In terms of what they learnt, students gave a number of useful points such was **working every day**, **using time effectively**, **revising past year papers** and **working in groups**. It would appear that this learning was effective as they did well in mathematics. These ideas are usually **used by seasoned teachers** to motivate learning in their classes. It would seem that these students, without realising it, were using ideas of seasoned teachers. This made their choice of **mathematics teaching as a career all the more appropriate**.

Although students listed some areas which they were not sure of, such as **how one would use the mathematics** they studied in real life, their **determination** to do well in mathematics, overcame this lack of surety. All students, except two, were very **complimentary of their teachers**. Their teachers were h**ardworking** and were always **encouraging them** in class. As stated earlier, the teachers gave them **additional support** with extra classes in the mornings, afternoons and during holidays. Their teachers' **dedication to teaching** mathematics may have **inspired them** to take up mathematics teaching as a career.

In the second part of this study, students **contributed very constructively** to the discussion on what the characteristics of a good mathematics teacher should be. This served them well as they were able to come up with their **own characteristics** in the third part of this study. All students indicated that they would work very hard to **develop these characteristics** during their undergraduate study years.

9. Findings

It would appear from the results in this study and the discussion in the previous section that there is a connection between school experiences and choice of mathematics teaching as a career. In this regard, there are some school factors which may promote mathematics teaching as a career. These are highlighted in the following findings:

- Learners who take up mathematics teaching usually have an **aptitude** for the subject and have **done well** in the subject.
- Learners who do well in school mathematics do not only go into careers such as medicine, engineering and other science careers. Some of them **opt for mathematics teaching** and schools (and the department of education) should continue to **encourage such learners to take up mathematics teaching.**

- Learners who tend **to help other learners** with mathematics **in and outside class and enjoy working in groups** are likely to become mathematics teachers as they would like to share their mathematics knowledge with others.
- Learners who work with **mathematics every day**, **use time effectively** and **revise past examination papers** tend to do well in the subject. Some of them (as seen in this study) **take up mathematics teaching**.
- Teachers can become **role models to their learners**. This is usually through **their actions in class** by showing their love for mathematics and wanting their learners **to enjoy the subject**. Giving their classes **extra support** in the form of morning and afternoon classes, is likely to encourage their learners to do well in the subject. This can also serve as **inspiration to learners** to become mathematics teachers.

Some of the school factors above such as wanting to help others, liking mathematics and being inspired by their teachers, were very similar to the NCTM study, with one big difference; the students were in **their second year** of their four year degree programme while the NCTM study focussed on **experienced teachers**.

It is, thus, very important for those who teach Mathematics Method (or Mathematics Didactics) to under-graduate students to make use of their **prior learning experiences** in the subject as this can play a significant role in their development as mathematics teachers.

In the second part of this study, students **contributed very constructively** to the discussion on the characteristics of good mathematics teachers. They used their experiences with their own teachers as a point of reference. This discussion also served to **motivate students** who came up with their own characteristics of good mathematics teachers. These students also stated they would **work very hard** towards **developing some of these characteristics** while they were still at university and develop further when they started teaching.

10. Conclusion

Although this was a small scale study, it provided some rich data to work with. The study attempted to examine possible school factors which may play a role in the choice of mathematics teaching as a career. These factors were identified and could provide universities with strategies on the recruitment of future mathematics teachers. Schools could assist with recruiting such students from their midst. This would mean that the number of learners doing mathematics should increase rather than decrease. Only then would the number of quality learners who take up mathematics teaching as a career increase. This would depend on mathematics teachers doing even more than what they are currently doing.

This study does, however, prove that not just anyone can take up mathematics teaching. In fact, mathematics teaching requires special competences and skills which could be nurtured when learners are still in school.

11. References

Andresen, L., Boud, D., and Cohen, R., 2000. Experience-Based Learning , *in* Foley, G., Understanding Adult Education and Training, second edition, Allen & Unwin, Sydney

Centre for Development and Enterprise (CDE) report, 2004. In: Science in Africa magazine. *From laggard to world class. Reforming maths and science in South Africa's schools* [online]. *Available* from http://www.scienceinafrica.co.za [accessed 20 March 2012].

Centre for Development and Enterprise (CDE) in-depth report, 2007. *Skills, growth and migration policy. Overcoming the fatal "constraint".*[online]. *Available* from http://www.cde.org.za *[accessed 20 March 2012]*

De Lange, 1981. *Teaching of Natural Science and Mathematics*. Pretoria: Human Sciences Research Council.

Hatch, J. A., 2002. *Doing qualitative research in education settings*. Albany: State University of New York Press.

Howie, S. J., 2001. *Mathematics and Science Performance in Grade 8 in South Africa 1998/1999: TIMSS-R 1999 South Africa*. Pretoria: Human Sciences Research Council.

Mecoamere, V., 2011, July 13. Level of maths teaching in SA low. Sowetan. [online]*Available* from http://www.sowetanlive.co.za *[accessed 28 February 2012]*

Moon, J., 1999. *Reflection in Learning and professional development*. Kogan Page, London

Moon, J., 2001. PDP Working paper 4. Reflection in Higher Education. LTSN Generic centre

Mulkeen, A., Chapman, D.W., DeJaeghere, J.G., & Leu, E., 2007. World Bank paper number 99. Recruiting, retaining and retraining secondary school teachers and principals in Sub-Saharan Africa.[online] *Available* from http://siteresources.worldbank.org/INTAFRREGTOPSEIA/Resources/No.4Teachers.pdf *[accessed 18 March 2012]*

NCTM ,2002 . Mathematics Education Dialogues). What motivates teachers of mathematics to enter and remain in the profession?[online] *Available* from http://www.nctm.org.za *[accessed 2 February 2012]*

Rothwell, A & Ghelipter, S., 2003. The Developing Manager: Reflective Learning in Undergraduate Management Education, Reflective Practice: International and Multidisciplinary Perspectives, 4(2), 241-257.

Schon, D. ,1987. *Educating reflective practitioners*. Jossey-Bass, San Franscisco.