# PRIORITY DESIRES OF PRE-SERVICE MATHEMATICS STUDENT-TEACHERS IN METHODS COURSES AT THE UNIVERSITY OF BOTSWANA

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**Abstract:** *This study, a survey of University of Botswana mathematics pre-service student-teachers taking introductory methods courses, was conducted to find aspects of the courses they perceived to be their priority learning desires. It aimed at evaluating whether student-teachers perceived ideas could be tapped into towards improvement of the teacher preparation programme. The analysis compared and ranked identified possible learning desires to determine how student-teachers' views may be employed to develop a prudent programme. The identification of possible student-desires was informed by course aims, objectives, and learning materials. The study further identified aspects of the programme that student-teachers may need to subsequently develop flexible mind-sets ready to adapt to the dynamics inherent in their future career as teachers despite held pre-conceived ideas of what teaching entails. This study is of significance in informing the design and delivery of mathematics education programmes making them relevant and attractive.*

**Key words:** teacher preparation, pedagogical content knowledge, teacher knowledge, pre-conceived ideas, teaching philosopies

## Introduction

The task of preparing pre-service teachers is a complex process that involves a blend of several types of knowledge (Chappell & Thompson, 1994). Despite these complexities, it is essential that teacher educators continue to explore the impact of their teaching on student-teachers towards finding ways of improving teacher preparation (Kesianye, 2002). For teacher preparation to move in this direction educators need a window through which to understand how the recipients of their services, the student-teachers, consider of utmost importance in their learning process. Consequently, it is critical for teacher educators to have ways of learning what is expected of them by the recipients of teacher preparation. One way to learn about these expectations is to explore student-teachers' perceptions and beliefs about what is important for them to learn as future teachers. It is in methods courses that student-teachers are exposed to the demands of the art of teaching. Therefore, in such courses, they are expected to display some sense of inclination towards certain aspects of teaching and that they hold beliefs about prior to and by the end of the preparation. Student-teachers, like other students at all levels of education, do not enter learning institutions as empty vessels according to the constructivist theories of learning. They have pre-existing knowledge and beliefs from past experiences. Student-teachers arrive into teacher education with certain conceptions of teaching, some of which may be vague and difficult to articulate and which appear resistant to substantial change (Haggarty, 1995). Regardless of the nature of these conceptions and beliefs, they are perceived to have an impact on teachers' instructional actions (Brown, Askew, Baker, Denvir, & Millet, 1998). Furthermore, student-teachers progress in their learning to become teachers and consequently their future actions as teachers would be impacted by these perceptions. In some cases these conceptions and beliefs are found to continue to exist throughout teacher preparation (Braiher, 2011) despite the fact

that they may not be the most desirable concepts for one's growth in the profession.

## Statement of the Problem

All teacher education programmes are intended to bring about desirable outcomes. However, quite often teacher preparation programmes are designed and implemented without input from student-teachers in their methods courses. This study regards such an omission as a missing link in reforms on teacher preparation and that ignoring it would ultimately render any efforts for improvement meaningless. It is from this perspective that this study is set out to address the research questions:

1. What are priority learning desires of pre-service mathematics student-teachers from methods courses?
2. Which fundamental aspects of methods courses require more emphasis for student-teachers to understand their criticalness in teacher development?

## Conceptual and Theoretical Underpinning

Teachers are believed to draw from several complex forms of knowledge in performing their instructional activities (Holton et al., 2009). These researchers presented a model of teachers' knowledge as shown below in Figure 1 in three dimensions: Sources of Knowledge, Types of Knowledge, and Conditions of Knowledge:

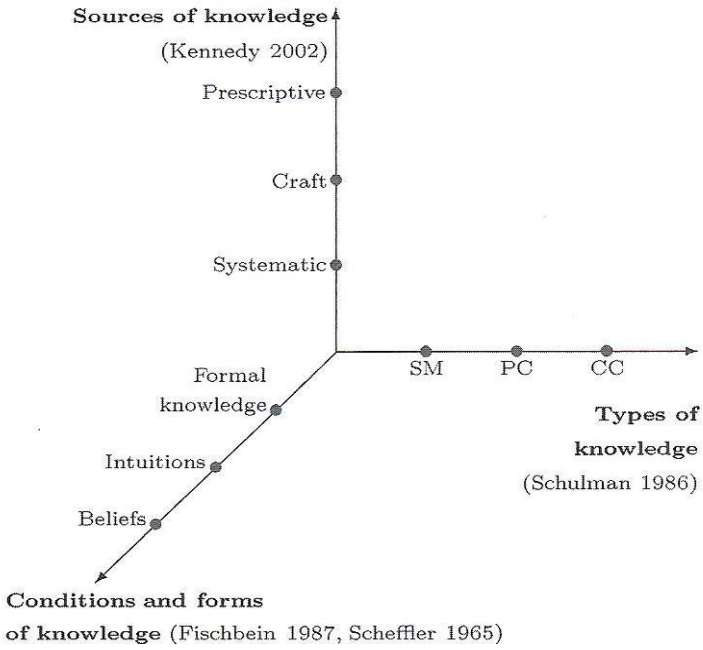


*Figure 1*. The three dimensions of teachers' knowledge (cited in Holton et al. adapted from Leikin, 2006)

The axis 'Sources of knowledge' represents teacher knowledge that is systematic, intuitive, and prescriptive. This type of knowledge would be acquired from reading related literature, classroom experiences, and institutional policies. Such a form of teacher knowledge would not necessarily be expected to be at the disposal of pre-service student-teachers, not because it is found less important, but due to the fact that it is likely acquired on the job.

The axis 'Conditions and forms of knowledge' represents teacher knowledge connected to formal teaching experiences as in planned actions, intuitive or not premeditated actions, and held beliefs about what teaching entails. Certain aspects of this dimension of teacher knowledge would be found in student-teachers, particularly that to do with beliefs which they would have formed while observing the way they were taught during their schooling.

The axis 'Types of knowledge' represents subject content being the mathematics pedagogical content knowledge or instructional know how and curricular content knowledge or that related to curricula understandings. Again, student-teachers would be expected to have some ideas of what it is they are intending to teach as such be found to be interested in this dimension of teacher knowledge.

Figure 1 above indicates that teachers draw knowledge from different sources and the synergy of these sources determines the instructional actions decided upon for classroom practice. These instructional actions are basically what Shulman (1987) wrote about in defining pedagogical content knowledge as "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (p. 8). Pedagogical content knowledge is taken to be inclined to instructional actions for the simple reason that they are to do with how content is addressed as opposed to other actions that teachers perform while teaching. Furthermore, Marks (1990) outlined components of pedagogical content knowledge, as:

- Subject matter for instructional purposes
- Students' understanding of the subject
- Media for instruction in the subject matter
- Instructional processes for the subject

From these components it suffices that instructional actions may be taken to mean those actions that are informed by pedagogical content knowledge more than anything to do with teaching.

For the purpose of this study, the element of *instructional processes* for the subject is described in detail because of its immediate relevance to the study. However, the four elements are viewed as interrelated but separated for better understanding. The instructional processes for the subject component require educators and student-teachers to focus on three identified areas as shown in Table 1.

Table 1 *Instructional Processes Element of Pedagogical Content Knowledge*

| Student Focus | Presentation Focus | Media Focus |
|---|---|---|
| Learning activities<br>Questions to students<br>Assessment of students<br>Remediation<br>Motivation | Topic organisation<br>Teaching strategies<br>Lesson organisation<br>Explanations | Instructional use of the text<br>Instructional use of materials |

These areas of focus are often used to form the basis of teacher preparation because they are closely related to teachers' core business of teaching and are not usually acquired through other means. In other words, their inclusion in teacher

preparation is justifiable as it is the sole forum in which one can learn to be a teacher and get to understand the logistics behind good teaching. Based on this observation, it is not surprising to find institutions entrusted with teacher preparation responsibilities such as the University of Botswana, Department of Mathematics and Science Education, design pre-service teacher education programme objectives correlating with these components.

## Methodology

### Setting

The pre-service mathematics teacher education investigated in this study is a four year Bachelor of Education (Science) programme in which student-teachers are prepared to become mainly senior secondary school mathematics teachers. During their first year, these student-teachers study mathematics content courses only to acquire advanced mathematics concepts with the intention of making them to be better grounded in the subject they are being prepared to teach in future. These student-teachers are taught the same mathematics content with Bachelor of Science students and at this stage student-teachers do not study education courses. After a year of studying mathematics content courses only, student-teachers are introduced to mathematics education or enroll in methods courses and foundations of education courses. The methods courses are aimed at exposing student-teachers to pedagogical content knowledge in mathematics and science disciplines. The student-teachers proceed to study these education courses together with some mathematics content courses until they complete their study programme. This study is focused on student-teachers studying introductory methods courses called "Basic Teaching Methods in Secondary School Mathematics" coded ESM 261 and "Practicum in Secondary School Mathematics" coded ESM 262. The first course is a prerequisite of the second one. Both of these methods courses are offered during the first year of the Bachelor of Education (Science) programme.

During an orientation at the beginning of the academic year an overview of the two courses, ESM 261 and ESM 262, was provided by the researcher who has also been the lecturer for the two courses for the past eight academic years. The orientation exercise is always conducted with a purpose of getting student-teachers to have some sense of what to expect from both courses. Furthermore, it provides a platform in which student-teachers learn about their expectations from the lecturer and also aims at getting them settled in a new learning environment within the Faculty of Education after spending a year in the Faculty of Science. The orientation exercise also aims at collecting information on student-teachers' cultures which obviously vary since they come from different ethnic groups with diverse cultures and traditions. This step is important because according to Vygotsky culture is perceived to determine what content to learn and how learning is conducted (Kozulin, Gindis, Ageyev, & Miller, 2003).

### Participants

A total of 13 student-teachers registered for the introductory methods courses participated in the study. All the student-teachers were pre-service mathematics student-teachers. Although these student-teachers were being prepared to teach mathematics, some of them also study special education for purposes of teaching mathematics to secondary school students with special learning needs. It is necessary to point this out here because such student-teachers may have drawn ideas from special education perspective in

prioritising their learning needs from the mathematics methods courses.

**Instrumentation**

The study employed a data collection instrument formulated from ideas borrowed from Brahier's (2011) study, which was a comparative study on beliefs of sophomores and those of their seniors about methods courses. A questionnaire designed from expected outcomes from the methods courses was employed to collect data for the study. The questionnaire comprised of 15 items derived from the course outlines of the methods courses offered as introductory methods courses (see Appendix A). These items are concerned with teacher knowledge and skills as explained above and in particular, mathematics pedagogical content knowledge. Student-teachers were asked to rank the questionnaire items according to their priority learning needs from the methods courses at entry in methods courses. The items were ranked from 1 to 15, where 1 represented the highest priority with 15 representing the least priority learning desire. The items were listed in a random manner after writing them on pieces of paper of the same size which were put in a box and then picked one at a time for recording on the questionnaire. This was done to ensure that student-teachers would not be guided in any way by the arrangement of items especially that they had not seen the course outline for ESM 262 which is offered during semester 2. The whole idea was to minimise the likelihood of student-teachers being guided by the fact that the learning outcomes would have been stated in the course outline of the semester 1 course. Furthermore, the questionnaire was administered ensuring that student-teachers did not have access to any other sources but just relied on their thoughts and beliefs.

Another data collection instrument for the study was student-teachers' teaching philosophy statements. Student-teachers were briefed about what a teaching philosophy aims to achieve and that it is likely to change as they progress within their teacher preparation programme. They were then requested to write their teaching philosophies and submit within a week. The teaching philosophies were collected from all student-teachers on the due date. Student-teachers' teaching philosophies were also employed as a method of data collection with an aim of getting further ideas of the extent to which they understand the expectations of a teaching profession as potential teachers. This in a way would make them think seriously about the kind of teachers they would like to be and the mathematics education concepts that they believe would be essential to learn from methods courses.

**Data Analysis Procedures**

The aim of the analysis was to identify the most highly ranked or priority areas in the methods courses and those that are not found as priority learning desires by student-teachers. This was done to address the first research question of 'What are priority learning desires of pre-service mathematics student-teachers from methods courses?' Student-teachers' rankings of the aims and objectives of methods courses, as captured in the statements in the questionnaire, were first numbered and compiled using tally marks, and the totals captured in a table that showed all the statements and the rankings. These were then subjected to simple computations of mean (average) scores in which the minimum score indicated the highest ranking or priority area while a maximum score indicated the lowest ranking or priority area. The mean scores were then arranged starting with the smallest in order to identify the items ranked as the top four (4) and those ranked as the bottom four (4). These were then

cross-checked by another researcher. The structured section of the questionnaire that consisted of one item in which pre-service student-teachers were to freely indicate any teacher preparation aspects they wish to be exposed to in the methods courses was subjected to a qualitative analysis procedure. This involved reading and classifying the indicated aspects into categories informed by the conceptual and theoretical underpinnings of the study. Data from the teaching philosophies were analysed using a qualitative procedure since these are more of anecdotes from student-teachers. The qualitative analysis procedure of the grounded theory by Strauss (1987) was applied loosely to identify emerging themes as guided by the teacher sources of knowledge referred to in Figure 1 above. This analysis approach involved reading and categorising the statements into themes that seemed to emerge from the data.

## Findings and Discussions

In this study pre-service mathematics student-teachers identified the top four highly ranked priority learning desires from methods courses from the list shown in the questionnaire (see Appendix A), and these are presented together with their mean scores in Table 2 below:

Table 2. *Top four priority learning desires*

| Statement Number | Description | Mean Score |
|---|---|---|
| 1 | Acquire knowledge about the effective teaching and learning of mathematics | 2.5 |
| 11 | Recognize that each student has individual needs and illustrate how a variety of teaching approaches can be used to appeal to the learning style of each student | 6.2 |
| 13 | Use various teaching methods and assessment to inform and improve mathematics learning | 6.2 |
| 7 | Recognize the essential components of a lesson plan and prepare a mathematics lesson plan which includes an introductory motivating activity, development of concepts, a logical conclusion, and a plan for assessment | 7.2 |

It is evident that student-teachers are more concerned with learning about ideas that would enable them to practically apply their knowledge in their daily practice of teaching rather than being interested in issues which do not have immediate application such as those related to policy matters. This does not imply that policy issues are not important but rather that student-teachers are at a professional development stage in which they cannot think beyond the immediate classroom related issues. The bottom four priority learning desires are presented in Table 3 below.

Table 3. *Bottom four priority learning desires*

| Statement Number | Description | Mean Score |
|---|---|---|
| 2 | Give examples of questioning strategies for the classroom that promote mathematical thinking and dialogue (discourse). | 9.5 |

| | | |
|---|---|---|
| 14 | Identify and study problems in the teaching and learning of mathematics in schools | 9.5 |
| 8 | Acquire practical knowledge and develop practical skills of transfer from their own learning to a classroom teaching situation | 10.1 |
| 4 | Write instructional objectives at the knowledge/skill, conceptual, and application levels | 10.2 |

The structured section of the questionnaire attracted a total of 24 responses, some of which were addressing the same or similar issues. These responses were grouped under the three different dimensions of teacher knowledge of Sources of Knowledge, Types of Knowledge, and Conditions of Knowledge as presented in Figure 1. There were some overlaps but for purposes of this study, the groupings are as follows:

**Sources of Knowledge**

Sources of knowledge is basically systematic, intuitive, and prescriptive, and normally acquired from reading related literature, classroom experiences, and institutional policies:

- Unity in teachers
- Effective teaching
- Classroom conduct
- Helping students with disabilities.

It is not surprising that this dimension did not attract many responses because it is by nature about knowledge that is gained through experience once one has become a teacher. However, the fact that some pre-service mathematics student-teachers actually think about these issues is an encouraging step because the lack of knowledge in this dimension has the potential to result in a lot of friction between the teachers and relevant stakeholders that may lead to poor reforms implementation in schools. It is crucial that potential teachers are for instance exposed to policy studies during teacher preparation for them to be able to act in informed ways and to influence policy development effectively for such policies to have a positive impact in the overall education system. Nonetheless, further interrogation of how these issues may be included in teacher preparation programs without necessarily being seen to be diverging away from the mandate of the programme.

**Conditions and Forms of Knowledge**

This knowledge represents teacher knowledge connected to formal teaching experiences as in planned actions, intuitive or not premeditated actions, and held beliefs about what teaching entails. Some aspects of this form of knowledge would have formed while observing how one was taught during their schooling and these would include:

- Good presentation of concepts to students
- Creating flexible environment that would be conducive for learning
- Letting learners to participate in class
- Allowing comments and being able to correct students' mistakes
- To be able to identify students who need help
- Skills of dealing with classroom settings
- Classroom management
- Teachers being friendly but in an acceptable manner
- To develop confidence to talk in public and have high self-esteem.

As stated in previous sections, student-teachers enroll in teacher education programmes with pre-conceived beliefs and knowledge which teacher educators need to be cognisant of for them to be able to decide how they may address the issues instead of being seen as not caring. It is well known that such beliefs are often

difficult to abandon and as such require exerted effort from teacher educators to establish ways of dealing with them that would be beneficial to all.

**Types of Knowledge**

This knowledge represents subject content being the mathematics pedagogical content knowledge or instructional know how, and curricular content knowledge or that related to curricula understandings. It is possible for student-teachers to hold views on some aspects of this dimension of teacher knowledge because they are expected to have some thoughts about what their future practice entails as reflected by the following responses:

- Helping students with disabilities
- To be exposed to different groups of students to be able to teach
- Ability to tell the different kinds of students and use different teaching methods to teach them
- Learn different ways of teaching mathematics that will engage students
- Mathematics assessment
- Use of pictures for illustrations
- Use of various teaching methods and assessment of students
- Recognising strengths and weaknesses of students
- How students tend to adapt to different tasks concerning mathematics
- Student monitoring
- Theories of learning in order to make informed decisions in choosing teaching methods.

Categorising these responses in this manner should not be viewed in a rigid and exclusive fashion because there are various possibilities. However, they are done this way because they are related to the conceptual and theoretical ideas discussed in this paper.

**Student-teachers' Philosophies**

The pre-service mathematics student-teachers wrote their teaching philosophies. The responses from the student-teachers' anecdotes was categorised according to the three focus groups of student focus, presentation focus, and media focus for the component of instructional process for the subject as advocated by Marks (1990) as follows:

**Student focus.** This represents pedagogical content knowledge that addresses learning activities, questions to students, assessment of students, remediation, and motivation. The student-teachers indicated these aspects in their teaching philosophy in statements such as:

- Diagnose students' abilities
- Be patient, loving, and caring; care about students' learning
- Motivate students so that they understand importance of learning mathematics; mathematics in our daily lives; mathematics knowledge makes us function better in the society
- Communicate well with colleagues and parents
- Professionalism: punctual, marking and submitting on time, thorough planning, punctual to class
- Remedial lessons to help struggling students
- Nurture students' talents even outside the classroom
- Advise students to play an active role in their learning; encourage students to like mathematics
- Allow students to ask questions; students feel free to ask questions
- Listen and respond positively to students
- Observe how students learn and track their progress; varied assessments

- Challenge all students so that they learn more than they thought can; help students achieve their maximum potential.

This category of student focus was the one that was most dominant in the student-teachers' philosophies. This dominace may be because it affected them directly as students and therefore reflecting on it was more natural for them. The student-teachers see the learner as being central to the teaching process. Thus, they indicated that the learner must be taught effectively and nurtured irrespective of their abilty level.

**Presentation focus.** This represents pedagogical content knowledge that addresses topic organization, teaching strategies, lesson preparations, and explanations. These elements focus on teacher preparedness for the lesson. The student-teachers reflected these elements in their teaching philosophy statements as:

- Ensure meaningful learning takes place
- Foster conducive learning environment
- Clarify concepts for better understanding, explain concepts well, show students how and why; students acquire problem solving skills (encounter problems in our lives daily)
- Good teacher student interaction; interact well with students
- Come up with better teaching strategies
- Teach each student according to their ability and pace; understand students capabilities;
- Group work, individual work, demonstrations, independent learning, cooperative learning; drill and practice, oral work
- Design activities that students will enjoy.

The views held by the student-teachers indicate that they see teacher preparedness as been very important for effective teaching. They put a great emphasize on usage of varied teaching methodologies that would cater for the different students as they have varying abilities. These views are consistent with constructivists theories of learning which are recommended in mathematics education.

**Media focus**. This represents pedagogical content knowledge that addresses instructional use of the text and/or materials. These elements indicate the usage of instructional resources by teachers. The student teachers reflected these elements in their teaching philosophy statements as:

- Look for better teaching aids
- Use teaching aids
- Use relevant manipulatives
- Varied teaching aids to cater for different learning styles

The analysis indicates the student-teachers have an understanding of the importance of teaching aids. This is because they wrote that varied and relevant teaching aids must be used in the classroom.

All in all, analysis of student-teachers' philosopies indicates that student-teachers hold views that are important to the teaching process. They clearly come to the methods courses with positive elements of the teaching process. They were pronouncing a linkage in the three focus areas of student, presentation, and media. Thus, teacher educators can take advantage of these views held by the student-teachers and use them in the methods courses.

## Limitations of the Study

Because the population size was small, the results obtained may not necessarily be generalizable to the wider community of pre-service mathematics student-teachers.

Although triangulation of the data was done through the written teaching philosophies by the respondents, there may have been some biasness in their responses because one of the authors was their methods course lecturer.

## Conclusion

The results of this research show that student-teachers come to school with pre-conceived ideas of what teaching entails. Participants in this study indicated an idea of teacher's expectations and would like to be taught more often in methods courses. It should be the duty of the mathematics educator to gather their naive thoughts and put them into something tangible. Where there is need for correction, educators should do it more diligently, and where there is need for addition, it has to be done as well. We recommend that a large scale research be conducted to find out if different contents influence student-teachers' views of their educational needs in the methods courses.

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## Appendix A

### A questionnaire of student-teachers priority learning desires from mathematics methods courses upon entry

1. Please, rank the following aims and objectives of the methods courses of the Bachelor of Education programme according to your priority learning desires from the courses. Use the numbers 1 to 15 **once only** where 1 stands for the most priority learning desire and 15 stands for the least.

| **Methods courses aims and objectives for mathematics student-teachers as derived from ESM 261, ESM 262, ESM 561 and ESM 562 course materials** | **Priority learning desire number** |
|---|---|
| Acquire knowledge about the effective teaching and learning of mathematics | |
| Give examples of questioning strategies for the classroom that promote mathematical thinking and dialogue (discourse). | |
| Develop an understanding of various strategies for presenting mathematics learning activities | |
| Write instructional objectives at the knowledge/skill, conceptual, and application levels | |
| Develop multiple views about mathematics teaching and learning in secondary schools | |
| Develop an understanding of assessment in mathematics | |
| Recognize the essential components of a lesson plan and prepare a mathematics lesson plan which includes an introductory motivating activity, development of concepts, a logical conclusion, and a plan for assessment | |
| Acquire practical knowledge and develop practical skills of transfer from their own learning to a classroom teaching situation | |
| Prepare schemes of work that illustrate connections between topics and what is required in teaching such topics | |
| Identify and study problems in the teaching and learning of mathematics in schools | |
| Recognize that each student has individual needs and illustrate how a variety of teaching approaches can be used to appeal to the learning style of each student | |
| Describe a variety of strategies that teachers can use to promote positive classroom management and the role that effective lesson planning has on classroom environment | |
| Use various teaching methods and assessment to inform and improve mathematics learning | |
| Describe popular learning theories that attempt to explain how students learn mathematics | |
| Develop skills of dealing with classroom management issues | |

2. List any aspects that you desire to be exposed to through methods courses for the development of flexible mind-sets ready to adapt to the dynamics inherent in your future career as a teacher.

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