PRESERVICE INSTRUCTORS' STUDENT-RELATED KNOWLEDGE IN MATHEMATICS

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ABSTRACT

Teachers must be prepared with a variety of information and abilities in order to create and sustain successful teaching environments that allow them to improve students' comprehension and learning. One component of teachers' professional knowledge is knowledge of students, which is defined as teachers' knowledge of what mathematical concepts are difficult for students to grasp, which concepts students typically have misconceptions about, possible sources of students' errors, and how to eliminate those difficulties and misconceptions.

The study's goal was to look at the nature of preservice mathematics instructors' understanding of pupils. Six preservice teachers took part in the research, and data was gathered via observations, interviews, and written documentation. The results demonstrated that preservice instructors struggled to identify the root of their students' misunderstandings and mistakes, as well as to devise effective approaches to eradicate such misconceptions. They often failed to recognise what conceptual understanding the students lacked, and they tended to address students' failures by instructing them on how to carry out the method or apply the rule appropriately to answer the given issue. As a result, preservice teachers should be given opportunities to 1) take content-specific courses in which they can discuss fundamental high school mathematics concepts in depth in order to gain a solid understanding of how mathematical concepts are related and why mathematical rules and procedures work, and 2) analyse an act of teaching by watching videos of classrooms or discussing student work and classroom cases in order to determine how to address students' errors and shortcomings.

Keywords: - knowledge, pedagogical content, mathematics, teacher.

INTRODUCTION

Many academics believe that the primary purpose of teacher education programmes is to assist preservice teachers in improving their knowledge and abilities for successful teaching via coursework and practise (e.g., Borko & Putnam, 1996; Fennema & Franke, 1992). Teacher education programmes emphasise content and general pedagogy courses to help preservice teachers build subject-matter and pedagogical competence. Teachers, on the other hand, must be knowledgeable about curriculum, students, instructional tools, and evaluation, as well as be able to successfully interweave them (Borko & Putnam, 1996; Shulman, 1986). Content-specific methods courses are designed to help preservice teachers strengthen their capacity to integrate various forms of information for successful teaching. Preservice teachers could discuss whether a specific topic is difficult or easy for students, what learning goals are defined for that topic in the curriculum, what teaching strategies and instructional tools facilitate students' learning and understanding, how to tailor instruction to address students' needs, and how to assess students' understanding in such courses. Indeed, in the methods courses, preservice teachers might build what Shulman (1986) referred to as their pedagogical content knowledge (PCK) (Ball, 1991; Grossman, 1990).

Shulman (1986) defined PCK as instructors' understanding of representations, analogies, instances, and demonstrations to help pupils understand a topic. It entails knowledge of certain subjects that may be easy or challenging for pupils, as well as various conceptions or misunderstandings about the issue that students may have. Although many scholars agree that PCK is a special knowledge base for effective teaching, they disagree on what constitutes it (Gess-Newsome, 1999). However, in most studies, knowledge of subject matter, knowledge of pedagogy, knowledge of curriculum, and knowledge of students are accepted as components of it (e.g., An, Kulm, & Wu, 2004; Grossman, 1990; Hill, Ball, & Schilling, 2008; Marks, 1990). That is, in order to effectively educate, instructors must be well-versed in their subject matter and use proper teaching tactics and instructional materials that are linked with the curriculum. They must also understand the peculiarities of a certain set of pupils, such as what they know and do not know, what teaching practises are more suited for them, and what common mistakes or errors they regularly make.

PCK is thought to grow as instructors get more teaching experience since it is closely tied to the act of teaching (Borko & Putnam, 1996; Calderhead, 1996). Studies on teacher education programmes, on the other hand, show that methods courses and field experiences are likely to help to the development of PCK to some level (Ball, 1991; Graeber, 1999; Grossman, 1990; van Driel, de Jong, & Verloop, 2002). Although no generally recognised tool has been devised to assess teachers' PCK, researchers may learn about the nature of teachers' PCK via classroom observations, structured interviews, questionnaires, and journals (e.g., An, Kulm, & Wu, 2004; Even & Tirosh, 1995; Marks, 1990). As a result, I set out to explore the evolution of preservice teachers' PCK, especially students' understanding in the methods course and field experiences.

Based on the perspectives of researchers and studies on the nature of PCK (e.g., Ball, Thames, & Phelps, 2008; Grossman, 1990; Shulman, 1986), I determined that PCK comprises four components: subject-matter knowledge, pedagogical knowledge, student knowledge, and curricular knowledge. Teachers' understanding of what mathematical topics are difficult for students to comprehend, which ideas students commonly have misconceptions about, probable origins of students' mistakes, and how to alleviate such problems and misconceptions are all examples of knowledge of students.

METHODOLOGY

The study opted for a qualitative approach. Data was gathered primarily via the use of a questionnaire, in-person observations, written assignments, and interviews with preservice instructors. Researcher observed a secondary education mathematics methods course and field placement. The researcher kept all paper and digital records relating to the methodology and fieldwork training. The researcher also made sure to get a hold of a copy of the training manual for future educators. Although there was no overarching goal for the preservice teachers to accomplish by taking the methods course, they did learn about lesson planning, engaging students in conversation, using manipulatives, and assessing student progress. They visited four classrooms and filed reports on teachers' questioning techniques, students' cognitive load, classroom assessments, and students' mathematical thinking.

From a pool of 29 prospective educators, Researcher selected six sample students to participate based on a pre-semester questionnaire. Sections of the survey asked future educators to rank their familiarity with the various facets of professional content knowledge. Two preservice teachers were selected from each of three groups based on their replies to a questionnaire measuring their perceived levels of professional content knowledge (PCK). Each participant was interviewed thrice by the researcher throughout the course of the semester.

After reviewing the interviews, field notes, and homework, the researcher sorted them into categories. Researcher adopted the following categorization system because knowledge of students was described as instructors' repertoire of students' mathematical misconceptions and problems, and their ability to effectively erase them. All conceivable issues or misunderstandings were either successfully recognised by the preservice teachers, some were accurately diagnosed (if there were more than one), or the preservice teachers failed to appropriately identify the problems or misunderstandings.

They then suggested either disclosing the relevant rules and procedures for dealing with the situation at hand or offering an option to erasing such rules and procedures.

RESULTS

In order to learn about the nature of preservice teachers' understanding of pupils, Researcher employed several content-specific challenges throughout the interviews. The activities required an improper answer to a specific issue, and Researcher posed questions about the various causes of and solutions to this faulty solution. The most striking discovery about the preservice instructors' understanding of students was their incorrect identification of the origins of student challenges and mistakes. Many believed that pupils' mathematical struggles stemmed from a lack of understanding of, or an erroneous application of, established processes and norms. So, instead of trying to eradicate students' conceptual faults, they tended to rectify mistakes by reiterating how to carry out the processes or explaining how to apply a rule. Therefore, majority of them either "diagnosed some of the possible difficulties or misconceptions correctly" or "suggested telling the rules and procedures to solve the given problem correctly."

During the second interview, I displayed student work in which the student solved an equation for 3 by adding 18x2 to the opposite side of the problem, dividing both sides by 2x2, and then multiplying by 3. What Researcher wanted to know was how they could justify saying that the answer was wrong.

Examine the examples of student writing provided. How do you explain to a pupil why their response is incorrect?

$$2x^4 - 18x^2 = 0$$

$$2x^4 = 18x^2$$

$$x^2 = 9$$

$$x = \pm 3$$

Fig 1. Task involving the solution of polynomial equations.

The future educators, with the exception of one, missed the student's mistake. They said that they would advise the student to utilise factoring since it allows one to discover all solutions to the problem, including zero. Before cancelling out the x words, one of the panellists said he would urge the pupil to make sure that x is not zero. The responses of the future educators showed that they did not see the gap in their pupils' knowledge of solving polynomial problems. Instead, they emphasised the mechanics of the process and proposed an alternative approach they were certain would find all answers.

In the third interview, Researcher posed the question, "How would you advise a student who had made the mistake of not reversing the inequality when dividing the coefficient of the x term by a negative number?" (see Figure 2) to a group of future educators. Everyone polled said they would teach the pupil to invert the inequality sign when dividing by a negative value. They would urge the student to verify the reasonableness of the result by setting x equal to a value from the solution set in order to persuade her that the answer is wrong. Except for one participant, all of them knew there was a mathematical rationale for why they needed to switch the inequality sign but couldn't articulate it.

Please review the following examples of student writing. What's the best way to break the news to the kid that his or her answer is wrong?

$$-2x+5 \leq x-1$$

$$-3x \leq -6$$

$$x \leq 2$$

Fig 2. The exercise of resolving equations of inequality.

The student was not convinced by the arguments presented by three of the preservice instructors who advised graphing the supplied disparity to support shifting the direction of the inequality. However, one individual gave a lucid explanation of the procedure's rationale. She explained that if a number is less than a negative number, it is also negative. She reasoned that because -3x was negative, it must be the case. She then brought up the concept of integer multiplication again, pointing out that the sum of two numbers if one of the integers is negative, and only if it is. Since -3 is a negative number, x must be a positive. Since -3 multiplied by a number larger than 2, like 5, should still be less than -6, this expression must be higher than or equal to 2. In addition, she inferred that x is positive; otherwise, the inequality would be invalid since -3x is positive.

To assist their pupils evaluate their own knowledge and learn from their errors, several preservice instructors claimed they would have them describe their answers first. For instance, I assigned one of my students some task in which they were to randomly reduce the amount of variables and numbers in a rational expression (see Figure 3). A phrase cannot be simplified when it is related with another term through addition or subtraction, as all of my preservice instructors informed me they would first question the student why she simplified the statement in that manner.

Examine the examples of student writing provided. What's the best way to break the news to the kid that his or her answer is wrong?

$$\frac{2x^3y^2-6xy}{3xy^2-x^3y^3}=\frac{2x^3\cancel{y^2}\cancel{-}6\cancel{xy}}{3\cancel{xy^2}\cancel{-}x^3\cancel{y^3}}=\frac{2-6y}{3-y^3}$$

Fig 3. Rational expression simplification practise.

They pointed out that the rule for simplifying rational expressions dictates that both the numerator and the denominator must be put in factored form before the common terms may be cancelled. Some of them recommended giving an example to help the learner see the fallacy in her thinking. The provided equation might be rewritten as the subtraction of two fractions (i.e., (a-b)/(c+d)=a/(c+d) - b/(c+d)), and the student's technique of simplification could be used to the terms of each fraction. The learner would obtain a different outcome after combining the new phrases than what they got at first.

The preservice instructors in the aforementioned three examples were clearly seeking for any means to persuade the student that her answer was incorrect and were placing an emphasis on the application of mathematical principles. However, such efforts would only provide a short-term fix for the students' problems and misunderstandings, since they may still lack an understanding of why such principles are valid or how to apply them in other contexts. Therefore, future educators should ensure that their explanations aid pupils in fully comprehending the material and eliminating any and all confusion.

CONCLUSION

This study examined how the methods course and field activities taught preservice teachers about their students. The preservice teachers in this study studied lesson planning, classroom management, student evaluation, and manipulatives in the methods course. Field trips allowed them to watch teachers in action, kids' responses to activities, and teachers' progress evaluations. Thus, students may compare techniques course subjects to classroom applications. They couldn't make inferences from their teaching and field experience about students' misconceptions, obstacles, and blunders. Student educators may not have internalised their methods class and student teaching expertise. They may not have enough practise as teachers. Tamir (1988) noted that microteaching may improve preservice teachers' professional subject knowledge (PCK). Microteaching was only presented once to preservice teachers in this study, but they found it valuable, indicating that methods courses should employ it more regularly.

Future instructors' content-specific questions revealed how much they knew about the students. Teachers couldn't detect pupils' misconceptions that caused errors due to their weak conceptual knowledge. Due to resource constraints, they used procedures and rules to teach maths. This study found that the preservice teacher did not comprehend her prospective students' mathematical thinking. They didn't know how youngsters acquire new concepts or how to help them.

Preservice teachers' subject-matter and pedagogy knowledge affected their replies to content-specific questions, demonstrating that the methods course and field experiences were required but inadequate to enhance their understanding of students. To boost student-knowledge, we must strengthen preservice teachers' subject-matter and pedagogical ability. Preservice teachers need content-specific courses to study the foundations of high school mathematics concepts and their relationships. In the techniques course, preservice teachers may watch videos of classroom scenarios to discuss teaching approaches and assess student work to understand student thinking and develop their pedagogical skills. They should work with pupils individually to understand their thinking and possible issues.

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