Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.7, No.10, 2016

Sources of Student Errors and Misconceptions in Algebra and Effectiveness of Classroom Practice Remediation in Machakos County- Kenya

Mary Mulungye M. Dr. Miheso O'Connor Dr. Ndethiu S.

Abstract
This paper is based on a study which sought to examine the various errors and misconceptions committed by students in algebra with the view to exposing the nature and origin of the errors and misconceptions in secondary schools in Machakos district. Teachers' knowledge on students' errors was investigated together with strategies for remedial teaching. Descriptive survey design was adopted on four hundred and thirty form two students and fifteen mathematics teachers. Data was analyzed using descriptive statistics. The findings indicate that students make errors and that they have misconceptions in algebra. In this paper some students' misconceived notions and the root causes of these misconceptions are shared. Opportunities afforded by these feedbacks for instruction of mathematics are also shared. The study posits that teachers' use of student's mathematical ideas when purposely engaged can support teacher student interaction in mathematics classrooms. However, most of the teachers hardly made use of the students' mathematical ideas and this lead to instructional strategies that did not address students' difficulties. So to enhance teachers' use of student's experiences, teacher education will need to focus on encouraging a variety of ways of teacher-student interaction during which students' mathematical ideas should be considered exhaustively.

1. Introduction

Misconceptions and learning Mathematics is a common occurrence across different cohorts. Little attention when provided for remedial action makes many good students regard mathematics as one of the most difficult subject in the school curriculum. This study provides an insight into the misconceptions and remedial work that occur when teaching of mathematics challenging topics such as algebra, indices, calculus just to mention a few. The study focus is specifically on the challenges that students face when learning algebra and the teaching of algebra.

The purpose of the study was to investigate teachers' knowledge on students' errors and to suggest appropriate instructional methods for the remediation of the errors and misconceptions. The reason as to why students make errors and misconceptions in algebra was also investigated.

The knowledge of algebra is vital all through life. This knowledge affects the decision we make in many areas such as finances, technology and other areas in our daily life. The demand for algebra at higher levels, of education is increasing. Wiki Answers (2010), one of the world's leading questions and answers websites, lists some of the uses of algebra in today's world. Algebra is used in companies to figure out their annual budget which involves their annual expenditure. Various stores use algebra to predict the demand of a particular product and subsequently place their orders. Algebra also has individual applications in the form of calculation of annual taxable income, bank interest, and installment loans. Algebraic expressions and equations serve as models for interpreting and making inferences about data. Further, algebraic reasoning and symbolic notations also serve as the basis for the design and use of computer spreadsheet models. Therefore, mathematical reasoning developed through algebra is necessary all through life,

2. Theory of learning of algebra.

Student beliefs, their theories, meanings, and explanations will form the basis of the term student conceptions. When those conceptions are deemed to be in conflict with the accepted meanings in mathematics, then a misconception has occurred (Osborne &Wittrock, 1983).

An error is regarded as a mistake in the process of solving a mathematical problem algorithmically, procedurally or by any other method.

Olivier (1989) observed that theory is like a lens through which one views the facts; it influences what one sees and what one does not see. "Facts" can only be interpreted in terms of some theory. Without an appropriate theory, one cannot even state what the "facts" are. Theory gives one an insight to the problem (misconception).More so; one cannot even discuss the matter without using some theory to explain the situation.

The fact is that our students often make mistakes in mathematics. But unless we can say *why* they make these mistakes, we are unable to do something about it. And in order to say why, we must interpret these mistakes in terms of a theory - a learning theory. Olivier(1988) noted that as teachers, all our interventions in the classroom are guided by some theory - be it conscious or subconscious - of how children learn mathematics. Different teachers hold different learning theories, and address students' mistakes in different ways. Could it be that all our frustrated efforts at eliminating errors are due to embracing an inappropriate learning theory? The behaviorist theory assumes that pupils learn what they are taught, or at least some subset of what they are taught, because it is assumed that *knowledge can be transferred intact from one person to another* Olivier (1988). The pupil is viewed as a passive recipient of knowledge, an "empty vessel" to be filled, a blank sheet on which the teacher can write (Watson &Pavlov,1930). Behaviorists', therefore, believe that knowledge is taken directly from experience, and that a pupil's current knowledge is unnecessary to learning. However, the type of theory (constructivist theory) that the study adopts will determine the importance of misconceptions for learning and teaching. Knowing students misconceptions will help the teachers to teach better. The basic stance that underlies constructivism is the view that all learning involves the interpretation of phenomena, situations, and events, including classroom instruction, from the perspective of the learner's existing knowledge. Constructivism emphasizes the role of prior knowledge in learning. Students interpret tasks and instructional activities involving new concepts in terms of their prior knowledge. Misconceptions are characteristic of initial phases of learning because students' existing knowledge is inadequate and supports only partial understandings (Smith et al., 1993).

3. Methodology

Descriptive survey design was employed. It involved collection and analysis of both quantitative and qualitative data. This helped in making descriptions of students' errors and misconceptions in algebra and it sought to discover their effects towards learning and performance in algebra. The study population was on four hundred and thirty form two (432) students and fifteen (15) mathematics teachers of the respective classes. The study was carried out in Machakos district in Machakos county.-Data was analyzed using descriptive statistics.

4. Findings

The findings indicated that students make certain categories of errors based on identifiable misconceptions in algebra. Some of the students' misconceived notions and the root cause of these misconceptions and the opportunities afforded by this feedback for instruction of mathematics are shared in this paper.

The findings shows some of the most frequently occurring class of errors in the high school, which Matz (1980) calls linear extrapolation errors, are illustrated by the following examples:

- $(a+b)^2 = a^2 + b^2$
- $3x + 3x = 6x^2$
- $3x - (x - 5) = 2x - 5$
- $(x + y) = 3xy$
- $3x + 5 = 8x$

The errors and misconceptions shown by the students when, for example, they expanded $(a+b)^2$ as $a^2 + b^2$ was the misinterpretation of the power of bracket. This error can be categorized as evolving from the application of the distributive law intuitively. The distributive property states that $a (b + c) = ab + ac$. Therefore the student used this rule in a new situation where it was inappropriate. The formal distributive property of multiplication over addition was deeply deposited in their mind so that they intuitively misapplied the rule in similar situations

Another common error that was observed was when the students simplified 3x+8 as 8x. The error was made due to the duality of mathematical concepts as process or objects. The student could not make an object out of a process. Due to the dual nature of mathematical notations as processes and objects students encountered many difficulties. This dual conception caused students to confuse between 3x+5 as a process, because its interpretation is "add three times x and five" or as an object. So they simplify 3x+5 as 8x when 3x+5 is an object (for example, in a final answer). The student perceived that the answer should not contain **an operator symbol**. The student perceived that the "+" sign **"as an invitation to do something**" and the student went ahead to do it. Students also perceived open algebraic expression as "incomplete" and they tried to finish them by oversimplifying

To counteract these errors the study revealed that teachers' use of student's mathematical ideas when purposely engaged can support teacher student interaction in mathematics classrooms.

However, most of the teachers hardly made use of the students' mathematical ideas. The findings indicated that 62% of the teachers used subject based methods while 38% used student based methods. The study revealed that the major difficulty seems to lie with the teachers' ability to make use of the knowledge they have on student error, rather than their awareness of the errors. This lead to instructional strategies that did not address students' difficulties and it also revealed that there are deficiencies in the teaching of algebra.

The study showed that teachers need assistance not only in error identification but also how the errors would be built in the whole process of learning.

5. Conclusion

The teachers did make attempts to counteract errors in algebraic class. 38% of the teachers' diagnosed difficulties and misconceptions involved while 62% of the teachers were interested in assessing manipulations. The suggestions given by the teachers pointed out the fact that teachers appear to identify errors mainly for the purpose of emphasizing algorithms rather than developing understanding since error identification did not necessarily lead to the teacher strategies that address students' difficulties.

So to enhance teachers' use of student's experiences, teacher education will need to focus on encouraging a variety of ways of teacher-student interaction during which students' mathematical ideas should be considered exhaustively.

References

Matz, M. (1980).Towards a Computational Theory of Algebraic Competence.*Journal of Mathematical Behavior,* 3(1), 93-166.

Olivier, A.I. (1988). *The Construction of an Algebraic Concept through Conflict*.In A. Borbas (Ed.).Proceedings of the Twelfth International Conference for the Psychology of Mathematics Education (pp. 511-518).

Olivier, A.I. (1989). Introductory Algebra.In-Service Education Course, Cape Education Department.

Osborne, R. J., &Wittrock, M. C. (1983).Learning science: A generative process.*Science Education, 67*(4), 498-508.

Smith, J. P., Disessa, A. A. &Roschelle, J. (1993). Misconceptions reconceived: A constructivist analysis of knowledge in transition, *The Journal of the Learning Sciences, 3*(2), 115-163.

WikiAnswers (2010).*What is the importance of algebra in today's world?* Retrieved 17 September, 2010 from http://wiki.answers.com/Q/What_is_the_importance_of Olivier, A.I. (1988). *The Construction of an Algebraic Concept through Conflict*.In A. Borbas (Ed.).Proceedings of the Twelfth International Conference for the Psychology of Mathematics Education (pp. 511-518). algebra_in_today's_world