BASIC MATHEMATICAL ERRORS MADE BY EXTENDED DEGREE PROGRAMME STUDENTS IN ENGINEERING

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Extended abstract

After 1994 the Department of Education (DOE) had concerns that many learners did not obtain the necessary problem solving and reasoning skills during their learning processes (DOE (2000) taken up in Engelbrecht, Harding & Phiri (2010)) and introduced Curriculum 2005 in 1998 (Engelbrecht & Harding 2008). By 2001 most universities had introduced academic development initiatives to support students from historically disadvantaged backgrounds in science and/or engineering (Pinto (2001) taken up in Grayson et al. (2011)).The Engineering Augmented Degree Programme (ENGAGE) was introduced in 2010.

ENGAGE is a structured, 5-year programme at the University of Pretoria that helps students make the transition from high school to university and cope with the demands of an Engineering degree. Additional Mathematics is one of the developmental modules. The objectives of Additional Mathematics are to develop mathematical ways of thinking and conceptual understanding that underpin the mainstream Mathematics module, and to supply background knowledge students may have missed at school.

In April 2012 ENGAGE students wrote their second semester test in Additional Mathematics after ten weeks of teaching. The occurrences of basic mathematical errors in three questions on the evaluation of limits in the semester test lead me to investigate the situation further. The errors in algebraic manipulation were based on mathematical content knowledge that should have been mastered in high school.

The research study is based on data collected from students' answers in 288 test scripts. I investigated the following research questions:

- What are some of the basic mathematical errors made by ENGAGE students in an Additional Mathematics semester test?
- What is the prevalence of these errors?
- Do students that achieve 70% or higher in Grade 12 Mathematics make some of the basic errors as described in the study?

After analysing the student answers on the question on limits, a number of errors were noted. Amongst these errors, eight errors were specifically chosen for analysis since they related to algebraic manipulation and occurred most frequently. The focus was not on the possible error with regard to the actual evaluation of the limits, but rather on the algebraic manipulation needed in order to simplify the expression before

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the limit is evaluated. I categorised the errors in three categories drawing on the curriculum guidelines (National Curriculum Statement, 2002, 2003) and Kilpatrick's strands for mathematical proficiency (Kilpatrick, Swafford and Findell, 2001). The basic mathematical errors identified were broadly placed in three categories relating to composite trigonometric functions, manipulations with fractions and factorisation.

The mathematical errors and their prevalence are presented. The errors were found in 85 of the total number of scripts suggesting that approximately 30% of the students made basic algebraic manipulation errors in the analysed questions. Feedback is given on how conceptual misconceptions could be illustrated when the student errors are discussed in class.

The presence of certain errors suggests that these students are not mathematically proficient in topics that should have been mastered at high school level. The inclusion of a mathematical topic in the school curriculum does not ensure student understanding of the topic or proficiency in associated procedures, even when students obtain fairly high Grade 12 marks (≥60% for most ENGAGE students). Furthermore, it is suggested that matric examination marks for mathematics might not to be a true reflection of the mathematical knowledge gained at high school level.

Recommendations are made for further research. The recommendations include investigation on whether/how the newly acquired mathematical content on the topic of limits influenced the errors students made, for example, did the awareness of known limits such as $\lim_{x\to 0}\frac{\sin x}{x}=1$ influence students' answers?

Further research recommendations are on teaching practices that could lead to improved mathematical understanding and proficiency. These practices include:

- the use of different representations, e.g. algebraic, graphical and verbal when teaching mathematics (Ball et al. 2004)
- a focus on the development of conceptual understanding, reasoning and critical problem solving skills in mathematics vs. rote learning and procedures (sometimes involving contextual problems)
- an emphasis on the lateral connections between mathematical topics (algebra, trigonometry and geometry) which are traditionally taught separately since they are kept separate in the curriculum (NCS 2002, 2003).

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