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The impact of lecture notes on an engineering student's understanding of mathematical concepts

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ABSTRACT

In large group lectures in mathematics at tertiary level, it is common practice to make notes of the teacher's comments and blackboard notes. This paper reviews a study of such notes along with other written materials. The aim was to investigate the process of approaching written texts from a competency perspective to interpret the impact note-taking may have on indicated rationales for learning and types of understanding. The interpretative case study reviewed notes made by an engineering student and notes provided to the students by the teacher. In order to trace development, the written material included lecture notes along with notes for task solving presentations and solutions to mini-tests. Results showed that instances of relational understanding were traced, but the main strategy was instrumentalism – aiming for use of rules. By identifying gains and losses of self-made and provided notes, a further illumination of rationales for learning was obtained.
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"Qui scribit bis legit" – He who writes reads twice
Latin quote

1. Introduction

Despite a vast and growing literature supporting the use of active learning in college classrooms (Smith, 2001), lecturing is still a common way of teaching students at university level. In a typical mathematics course the introduction to a topic is carried out by the lecturer using a blackboard. There are often large numbers of students present and they are usually taking notes (Alsina, 2001; Bligh, 1972). Since making notes is a common activity, there is value in knowing more about what the notes written during lectures might 'tell'. In the present paper the 'telling' is interpreted in terms of indicated mathematical competencies which by Niss is given in eight forms; thinking, posing and solving, modeling, reasoning, representing, handling formalism, communication and using aids and tools (Niss, 2003a, 2003b). Lecture notes represent only one of a number of inputs that students have to their learning of a mathematical concept, but the students themselves typically stress that notes are important to their study. This was experienced in the present class, but taking notes has also been asserted as a helpful strategy by other researchers (Carrell, Dunkel, & Mollaun, 2004). However, few research results are found that analyze the impact of lecture notes on students' study.

The present study includes written materials produced by a female engineering student, Nora, in an introductory mathematics course at a university college. The materials comprise lecture notes, notes for task solving presentations and solutions to mini-tests – in this particular order. Nora's dealings with four different mathematical concepts were selected. The material was analyzed by means of mathematical competencies (Niss, 2003a, 2003b), which proved to be a useful descriptive

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framework. The interpretations indicated which types of understanding of the concepts Nora had achieved by the time she completed a mini-test reviewing the knowledge gained. Two meanings of the notion 'understanding' were drawn upon; relational and instrumental, as defined by Skemp (1976) and clarified by Mellin-Olsen (1977). Put simply, relational understanding is knowing both what to do and why, instrumental understanding is what Skemp describes as memorizing and using rules (Skemp, 1976). By examining the analysis results about the concepts of the present paper, gains and losses of note-taking, as opposed to being provided with notes, were illuminated. The result might improve our knowledge about the role notes can have to students' understanding of mathematics.

The initial research question was formulated as follows: What impact does note-taking have on the understanding of the subject matter in mathematics?

As a part of this, and due to the students in the present study having access to two types of notes, a secondary-question was:

What are the gains and losses when lecture notes are made by – as distinct to provided to – the students and used as a resource for learning a concept?

The next section considers the theoretical background of the study. This mainly concentrates on mathematical competencies, types of understanding and discussions about lecture notes. A description of the mathematics course in an engineering education is given in brief in the third section before the research methodology is elaborated upon. In the result section, written materials about all four concepts consecutively are analyzed, followed by discussions about what this may tell us about Nora's understanding of the concepts. Finally, gains and losses when different types of lecture notes are used as a learning resource are discussed.

2. Theoretical background for the study

2.1. Mathematical competencies

The main focus in the present paper was on mathematics; how selected mathematical concepts are dealt with and apparently grasped by a student, as interpreted through her written material. Thus, in analyzing the student's texts, an analysis framework that considers mathematical knowledge was needed. Competencies defined by Niss (2003b) is such a framework, specific to mathematics. The main object is to answer the question "What does it mean to master mathematics?", and to hold a mathematical competency is defined as insightful readiness to respond to certain mathematical challenges (Blomhøj & Jensen, 2003). In sum there are eight defined competencies, divided in two groups of four. One group concerns the ability to ask and answer questions in mathematics and comprises competencies in mathematical thinking and problem handling, along with modeling and reasoning mathematically. Competencies in *thinking mathematically* means "mastering mathematical modes of thoughts" (Niss, 2003a, p. 184). This is about knowing how to pose characteristic questions in mathematics and which kind of answers are to be expected. It is about possessing understanding of mathematical concepts; their scope and limitations, abstractions and generalized results. It is also about distinguishing between mathematical statements of different kinds. Statements could be definitions, theorems, conjectures, assumptions and cases. A competency in *posing and solving mathematical problems* is about identifying, posing and specifying such problems and solving different problems. A vital concept within this competency is a 'mathematical problem'. In (Niss, 2003b) this notion is specified as "pure or applied, open-ended or closed" (p. 121). In the present paper the notion mathematical problem is reserved for situations in which a mathematical examination is necessary in order to give an answer. This is in accordance with Niss and Jensen's definition of the concept (Niss & Jensen, 2002). The notion 'problem' is used more generally about any type of task – mathematical or not – that creates a difficulty. Analyzing and building models is given as *modeling competency*. This is both about analyzing properties and foundations of existing models, decoding their accordance with reality, and about performing active modeling in a given setting. Active modeling is complex, ranging from structuring and mathematizing the situation to work with, validating and analyzing the obtained model. Finally, the entire modeling process must be monitored and controlled. The forth competency in this group is *reasoning mathematically*. This means being able to follow and assess others' mathematical reasoning, understanding what a proof is and uncovering main ideas in lines of mathematical arguments, including proofs. In addition, it is also about devising arguments and working out mathematical proofs.

The other group of four competencies concerns the ability to deal with mathematical language and tools, and include competencies in representing mathematical entities, handling symbols and formalism, communicating about mathematics and using aids and tools. Possessing a *representation competency* means being able to handle different representations of mathematical objects and situations. This comprises understanding and utilizing these representations by decoding, interpreting and distinguishing between them. It also means exploiting relations between such representations, choosing and switching between them and knowing about strengths and limitations. *Symbols and formalism competency* is "being able to handle symbolic language and formal mathematical systems" (Niss, 2003a, p. 185). It is about decoding and interpreting symbolic and formal language and understanding the nature and rules of syntaxes and semantics. It also includes translations back and forth between symbolic and natural language and handling statements and expressions that contains symbols and formulae. *Communicating* in, with, and about mathematics is competency based on understanding others' 'texts' – written, oral or visual – having a mathematical content; and it is about expressing oneself by such 'texts'. This includes different levels of technical and theoretical precision due to different types of audience. The last competency is *making use of aids and*

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