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To cite this version:
Morten Elkjaer. Identification and diagnosis of students’ mathematical misconceptions in a dynamic online environment. Eleventh Congress of the European Society for Research in Mathematics Education, Utrecht University, Feb 2019, Utrecht, Netherlands. hal-02429751

HAL Id: hal-02429751
https://hal.archives-ouvertes.fr/hal-02429751
Submitted on 6 Jan 2020

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Identification and diagnosis of students’ mathematical misconceptions in a dynamic online environment

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Keywords: Formative assessment, implementation research, misconceptions, diagnostic test.

This poster aims to present the ideas behind the design of a dynamic online tool to assess students’ mathematical misconceptions in lower secondary school. These ideas and this tool are part of an industrial PhD project, which is a collaboration between the Danish School of Education, the doctoral candidate, and the company Edulab.

Edulab is a Danish private company that has developed an online mathematical learning platform for the Danish elementary school. In Denmark, 75% of elementary schools subscribe to this platform. In fact, every day Danish school students answer 1.5 million tasks on this online platform. This creates a unique opportunity to implement didactical research results regarding mathematical misconceptions directly into practice. The industrial PhD project aims to provide Edulab with an evidence-based tool to capture students’ misconceptions, understood as concept images differing from the formal concept definition (Tall & Vinner, 1981). Thereby providing the teachers in lower secondary school with easily accessible formative assessment of their students in the fields of algebra and numeracy in working with equations. Cai et al. (2017) claimed that linking intervention with implementation through iterations of design research is a strong way for researchers to have an impact on practice.

From reviewing the literature on misconceptions, it concludes that the community knows a great deal about mathematical misconceptions and learning difficulties related to algebra, equations and numeracy in lower secondary school (e.g., Booth, McGinn, Barbieri & Young, 2017). Such research-based findings in combination with an online mathematics platform that communicates directly to the end user (i.e., the students) provides a unique opportunity to shorten the implementation time span between the research findings and the end user as was pointed out by Century and Cassata (2016). The project goal is to investigate: How can an online diagnostic tool for lower secondary school be designed, utilizing existing research findings on mathematical misconceptions in algebra and numeracy when working with equations?

To answer the question the aim is to design, and develop an online diagnostic test. Designing an online diagnostic test aimed at lower secondary school students is going to be an iterative process. The literature review will give rise to a categorization of algebraic misconceptions. The idea is to use the ‘Concepts in Secondary Mathematics and Science’ projects diagnostic tests (Hart, Brown, Kerslake, Küchemann & Ruddock, 1985) in algebra and number operations in a modernized, digital version in order to locate students holding misconceptions fitting this categorization. Based on the algebraic tasks the students have interacted with on the platform, it should be possible for machine learning algorithms to create a “platform behavior” fitting the categorization. It is worth noting that students having greater usage of the platform are a preferable choice for diagnosis in order to create a more precise platform behavior for the different categories of misconceptions. Design-Based
Research (e.g., Barab & Squire, 2004; diSessa & Cobb, 2004) will pave the way for the knowledge generated through iterations of the work with the diagnostic tests and the machine learning algorithms. The projects hypothesis is that math teachers in Denmark, based on collected data, have a unique opportunity to organize, plan and complete their teaching. The point of the continuous diagnosis of all students using Edulab’s platform is to catch if students are using the platform as if they are is holding one or more misconception(s). The teachers are provided with a formative assessment report, generated for each student that possibly holds misconceptions, describing the student’s behavior and the misconceptions present. Thereby, providing an in-depth explanation of which algebraic concepts and processes in which the students’ concept image is conflicting with the concept definition may give the teacher the opportunity to aid the student avoid further progress in constructing a deeper rooted and conflicting concept image. Lucariello, Tine and Ganley (2014) emphasize the importance of teachers having access to formative assessment regarding individual student’s misconceptions in order not to impede the student’s future learning. This formative assessment report should contain ideas and guidelines for how the teacher further teaches the student in the form of literature-based explanations of the origin of the diagnosed misconceptions, and how the concept image may be changed.

Ultimately, the industrial PhD project is looking to generate knowledge and perspectives on how mathematical online diagnostic testing together with mathematical online formative assessment can be implemented in order to help teachers, and thereby students in Danish lower secondary school.

References


