What Can Mathematics Education Contribute To Preparing Students For Our Future Society?

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Abstract

Mathematics education has to prepare students for society, work and further study. One of the goals of education is to support students in developing mathematical skills and understandings that can be used flexibly in new or unfamiliar problem situations. Characteristics of support that contribute to this goal appear to be the integration of open problems and rich contexts that evoke inquiry by students in textbooks, and the careful use of didactic models that link up with students' intuitive inventions. Teachers have an important role in guiding students through these open problems and in introducing these didactic models. To support teachers, such open problems can be accompanied with lesson plans and suggestions for meta-cognitive prompts.

Mathematics education has to prepare students for society, work and further study. However, international studies show that much of what is taught in school seems to be lost when you assess it not immediately after the lessons or in different contexts. An example is a question about fractions in the TIMSS 2003 Study for grade 8 students: A scoop holds 1/5 kg of flour. How many scoops are needed to fill a bag with 6 kg of flour? The international average of a full credit for this item was 38%.

Such low scores must have us reflect on what we teach and how we teach it. Obviously, citizens in current society should not be able to solve this scoop problem by heart, but you would expect that students are able to solve it with pen and paper at hand. The steps underlying the calculation are rather elementary and fundamental for proportional and algebraic reasoning in a wide range of topics in mathematics education at secondary school. Why are students lost when they don't remember the algorithm?

An approach to mathematics education that tries to provide for learning trajectories that support students in understanding and tracing concepts and skills is Realistic Mathematics Education (RME). Rather than beginning with abstractions or definitions to be applied later, this approach starts with rich contexts that ask for mathematical organization [1]. Well-chosen problems offer opportunities for students to learn to inquire and to develop informal, highly context-specific models and problem solving strategies. These informal solving procedures then function as foothold inventions for formalization, generalization and inquiry-strategies. Didactic models that link up with students' inventions are introduced in generalizing activities to promote level raising [2]. As a consequence, during these activities the model and the situations being modelled co-evolve. Modelling in this view is a process of reorganizing both activities and the situation and drives the learning process of the students [3]. The aim of this approach is that students are involved in the (re)invention of

mathematics and that they are able to trace the structure and representations of mathematical concepts and skills.

In addition to this learning-oriented importance of the use of rich contexts, the relevancy of what is learned can also be highlighted. Research findings show that students experience and understand the functionality, purpose and utility of disciplinary knowledge in the workplace [4]. For this to happen however, it is important that tasks within workplace contexts also fit the goals of the curriculum. In the context of work the use of science and mathematics can emerge from the activities and tasks of the workplace [5].

Both RME and the connection to the world of work will make mathematics and science more meaningful and relevant to students. In a classroom where students inquire problem situations create mathematical inventions, students take an active role, pose questions, explore situations, find their path to solutions and communicate their reflection. Such approaches aim to promote students' curiosity, engagement and learning in-depth [6]. For this to happen, teachers need to extend their teaching repertoire. One of the challenges for professional development is to connect the learning of new teaching strategies or pedagogies with teachers' practices within the classroom. Teachers should feel the need and have the resources to adopt new ideas and to implement them in their daily practice. Classroom materials, like tasks for students, can play a crucial role in this implementation process.

Tasks have the potential to reflect innovative aims and to inspire and support teachers in implementing these aims [7]. However, whether a teacher recognizes and exploits this potential of a task and how she/he transforms it into her/his teaching is a complex process and highly depends on the adaptability of the task to his or her practice [8]. Well described lesson plans and meta-cognitive prompts appeared to be powerful tools for supporting teachers in implementing new and innovation-oriented tasks [9].

In the Netherlands RME influenced the current textbooks in primary education. The full credit score of Dutch students on the above scoop-item was 74%. This cannot fully attributed to the implementation of RME, but it strengths the feeling that this approach contributes to the quality of mathematics education.

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