Self-assessment in long-term problem solving STEM contexts

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MINTco@NRW a project fostering long-term problem solving

MINTco@NRW is a cooperation between the University of Siegen and the University of Cologne. This project is a follow up of the extracurricular project "Authentic-STEM" (Stoffels, 2024). Its aim is to integrate systematically long-term problem solving in authentic contexts into regular classrooms at secondary level in North Rhine-Westphalia. To make this possible, companies collaborate in the project and provide several authentic mathematics related unsolved problems that are solved by German and U.S. students in solver-teams. During a cycle the students work four months on the problems. At the end of each cycle, the solutions developed are presented to the companies. Through MINTco@NRW this activity will be transferred into regular classrooms. Therefore, there is a need for tasks and materials fitting the curriculum as well as testing adequately the participating students for grading. Both need to be connected to the core ideas of the project. These are, that through long-term and intensive engagement with authentic problems the students deepen their 21st century skills (Radmehr & Vos, 2020), enhance their mathematical and STEM competencies (e.g. problem solving, modeling, using theories and communicate) and explore their self-efficacy (Bandura, 1997).

Self-assessment for testing more than mathematical and STEM competencies

Various studies have already shown that there is a strong correlation between students' learning, performance, and formative assessments. Feedback and its quality also play a central role in the above-mentioned context. Feedback should point out the main errors and their probable causes and explain how to avoid those errors in the future. All three aspects can be addressed by students' self-assessment, since self-criticism and self-evaluation have a major influence on students' own learning processes (Shepard, 2005). Also, self-evaluation plays a central role in many mathematical metacognitive processes, e.g. the verification phase in mathematical problem solving (Rott et al., 2021) or the validating phase in mathematical modeling (Blum & Borromeo-Ferri, 2009). The long-term approach of this project (Stoffels & Holten, 2022) as well as the complexity of the real problems, give many opportunities for the students to evaluate their own problem solving activity. Also, the setting with multiple stakeholders involved can add other perspectives to the students' self-assessment. An example for this aspect is the evaluation of the students' own views about the mathematicality of the problems. Similar questions are raised in the sociologically informed conceptualization of authenticity given by Vos (2018).

The main research questions are: how adequate self-assessment formats look like, which capture both more general skills and competencies as well as the quality of mathematical processes; and who, among the stakeholders, should take part in which way to strength the capability of students' self-assessment? Therefore, during the project period, one focus of the self-assessment will lay on the students' zone of proximal development (Vygotsky 1978) also monitoring the project's environment.

Methodological considerations and expected outcomes

The project consists of a half year pilot cycle in Spring 2024, which is still in an extracurricular format. During this cycle material (e.g. logbooks, Impulse formats) for supporting the students' problem solving are evaluated using structuring content analysis. Parallel to this identification formats for the self-assessment of students and tests for grading are identified and adapted to the core ideas of the project. In the following two years starting summer 2024, the program will be implemented in at least six regular classrooms in North-Rhine Westphalia, so two design research cycles will be carried out to improve the formats and evaluate their effectiveness. Over each cycle, portfolios are kept as "digital logbooks", which might be a candidate for examination formats.

The presented project aims to contribute to the development of adequate assessment formats for long-term cooperative problem solving as well as the evaluation of the adequacy of these formats regarding their ability to foster students' self-assessment and self-regulatory processes.

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