From automatic diagnosis to lesson plannings: how teachers use elements of a digital formative assessment tool

Eumann, Anica; Klingbeil, Katrin and Barzel, Bärbel

University of Duisburg-Essen, Germany; anica.eumann@uni-due.de

As the effectiveness of formative assessment depends on the form of implementation in school lessons, we investigate in this study which elements of the digital formative assessment tool SMART teachers use for which purposes. In an exemplary qualitative analysis of two teacher interviews, we found that teachers use the given teaching suggestions and materials for designing their upcoming lessons. Furthermore, they use the test items and didactical information about (mis)conceptions to professionalize themselves by gaining deep insights into students' thinking.

Keywords: formative assessment, digital tool, algebra lessons, teacher professionalization

Introduction

Empirical studies showed that formative assessment (FA) may have positive effects on students' learning, depending on the subject and the concrete form of implementation (McLaughlin & Yan, 2017). For this reason, Schütze et al. (2018) state a high need for research to find out more about different types of realization of FA in classroom practices.

In this paper, we present first results of a study examining the concrete use of a digital FA tool by teachers in algebra lessons in secondary schools in Germany. The tool used in this study is SMART (Specific Mathematics Assessments that Reveal Thinking) that results from a project of the University of Melbourne and is currently being adapted to German speaking countries. This tool aims at giving precise diagnosis of students' thinking and possible misconceptions for specific topics.

Theoretical Background

FA is defined as an activity in which "evidence about student achievement is elicited, interpreted, and used by teachers, learners or their peers, to make decisions about the next steps in instruction". (Black & Wiliam, 2009, p. 9)

In this process, the teacher as a decision maker plays a very important role. In their model of technology enhanced FA, Cusi et al. (in print) differentiate four areas of teachers' practice in FA (sharing goals and criteria, designing and implementing learning activities, fostering the quality of feedback, involving students in peer- and self-assessment) which they combine with the three phases of preparing lessons (pre-paration, paration and meta-paration) as well as with three functionalities of technology in the process of FA (communicating, analyzing and adapting).

The digital tool SMART that is used in this study consists of about 130 multiple-choice-tests in several mathematical topics that elicit students' understanding of mathematical issues by focusing on their conceptual knowledge. Thus, it allows communication through and with technology because information is displayed and submitted but the user may also interact with the elements of the tool. The tool carries out an advanced analysis on the basis of response pattern that is shown in individual stages of understanding and possible misconceptions displayed in the automatic evaluation for the

teacher. Hereby, it allows teachers to get an insight into students' thinking. Adaptation in this tool rests passive because it proposes teaching suggestions and materials for further instruction to the teacher. At least, they decide whether and how they use this supply (Price et al., 2013).

Research Question & Methods

As we have seen, working with SMART demands to a high extend teacher activities. This leads to our research question: How and wherefore do teachers use the components of SMART after the implementation of a test? In this paper, we will focus on the second aspect.

To answer this question, we interviewed teachers after having used the tool in their lessons for the first time. These interviews are part of the project SMART[alpha] in which we investigate in a control-group-design the thinking of students and the development of FA competencies of teachers while working with the tool. In this interview, we followed a guideline consisting of two main issues of discussion: the teachers' impression of the test results and the consequences they draw from it for the upcoming lessons.

In the following, we present first results to this research question, arising from an exemplary analysis of two teacher interviews. These are male teachers that teach in North-Rhine-Westphalia in Germany at two different secondary schools in grades 8 resp. 7. Both teachers were picked from a group that did not participate in a professional development program. The only hints for use provided were on a technical level in the handling of the tool. Thus, they worked with the SMART tool independently and autonomously in their classes and used the automatic diagnosis in their sole discretion for their further lesson plannings.

The data analysis is carried out by a qualitative content analysis following Kuckartz (2018). Hereby, we developed a deductive-inductive category system, in which the deductive categories arise from the four areas of FA practice as well as the three phases of preparing lessons (see Cusi et al., in print).

Results

The data analysis led to three essential aspects of using the tool which will be explained and illustrated by examples.

The first aspect, the *lesson design*, is realized on three different levels that are part of the three deductive categories arising from the phases of preparing lessons. On the level of *pre-paration*, Teacher 1 explains that in the future he will treat typical errors and misconceptions more explicit. Teacher 2 reports that he will use the given material much earlier in future lessons. On the level of *paration*, Teacher 1 reports on the one hand that he uses particular teaching material unchanged and on the other hand that he adapted information on misconceptions and some questions of the test items to discuss them in the classroom. Here, he focusses primarily on the results of the whole class. In addition, teacher 1 also develops new ideas for teaching as for example to work out strategies and rules with the students that might help to avoid typical errors. In contrast, teacher 2 reports that he used the material only in the form in which it is contained in the tool. An adaption or development of new ideas does not take place. Apart from these results, the interviews with both teachers also show that the tool encourages them to reflect their own teaching, which is part of the level of *meta-paration*:

“well, as I now knew a bit what is in the tool, and payed a bit more attention to it, also in discussions in class, I noticed more.” (Teacher 1).

This statement also indicates the second aspect of use, the *professionalization*. This is shown on two levels arising from two inductively developed categories: first the level of reflection of one’s own thinking and practice and second on the level of an intentional knowledge acquisition. Both teachers describe trying to find explanations for particular answers in individual students’ results, which is a form of *reflection on their own thinking and practice*. Teacher 2 explicitly names that he is aware of these reflection processes: “Also, ehm, I felt catched, to be honest, so that means, objectively spoken, I reflected obviously.” In a similar way, Teacher 1 describes a non-intended professionalization as an “aha-effect” concerning his own language practice in classroom. He formulates the consequence that in future lessons he will pay more attention in the class to being a role model in the use of language and to pay more attention to the students’ use of language as well.

Teacher 2 also shows a process of reflection in his work with the teaching suggestions and the information about the levels of understanding and misconceptions. He reports that first he was a little bit annoyed by the length of the texts, but then admits: “I would also say afterward, that I have taken some time to look at it, I think it’s great that there is some didactical background. Ehm, I have to admit, that I also took a lot with it.” This citation also shows the professionalization on the second level of *intentional knowledge acquisition*. Teacher 1 also mentions this very specifically in the report that he initially had very few ideas about misconceptions, but in the end, recognized them in his own lessons. The most intensely the aspect of knowledge acquisition becomes obvious in the end of the interview with Teacher 2 when he states that the work with the tool was very helpful for him on different levels and that he would use the tool once again but with constraints. The decision to work with the tool depends for him on two factors: the subjective relevance as well as his own pedagogical content knowledge of the concrete topic. This leads to the conclusion that he actively and intentionally uses the tool to gain new knowledge.

The third aspect, the *exploration of the automatic diagnosis,* also arises from inductively developed categories. On the one hand, teacher 1 tries to retrace the automatic evaluation by trying to find connections between different response options in the items and the information about the stages of understanding and misconceptions. On the other hand, he notices that some students do not show the results he would have expected so that he develops explanations that take into account students’ thinking: “Well, I found that very fascinating. […] that you can somehow understand what could be the way of thinking that a student had.” Teacher 2 also recognizes a high discrepancy between the results of the automatic diagnosis and his own observations in classrooms. This is why he looks at some individual answers given by students to comprehend the automatic analysis. He looks deeply into the content of the items and the didactic information which allows him to understand that it is not the number of correct answers that leads to a certain stage of understanding but the type of answers given. Thus, he also gains deep insights into students’ thinking that he tries to put into relation with his own practice in classroom.

All in all, we find that both teachers put into effect similar activities while working with the tool that differ clearly in their concrete specification. While Teacher 1 focuses on the teaching suggestions and

materials to design upcoming lessons by planning new impulses and developing new ideas out of the given materials, Teacher 2 concentrates on the test items and the didactical information to understand the automatic diagnosis, reflect his own practices and educate himself on a didactical level. But in both cases, we can see an active change of lesson design and a process of teacher professionalization.

Discussion & Outlook

The results give a hint that the teaching materials are actively used in mathematics lessons but that we have to differentiate between an unmodified and an adapted use. Moreover, the case of Teacher 1 shows that the test items as well as the didactical information about students' (mis)conceptions are used to plan and reflect lesson practices. Particularly, the information is able to encourage teachers to develop their own new ideas of lesson activities. We have also seen that the test items as well as the teaching suggestions and materials support teachers in gaining new pedagogical content knowledge and reflecting their own thinking and practice so that the work with the elements of the tool may contribute to teacher professionalization.

Didactically deep founded diagnostic items as well as didactical background information and fitting teaching suggestions and material therefore seem to be important elements of digital FA tools that teachers use intensively. It is to be underlined that the passive adaptation of SMART is sufficient for such an intensive use.

The presented study nevertheless underlies some restrictions. At the moment of the interviews, the teachers temporarily had a restricted access to the results of the diagnosis so that they had to reconstruct some aspects based on their memory. Moreover, these are all only self-reported practices where it is impossible to check their real implementation. But this also offers a new research perspective to a project in which teachers will be attended in their work with SMART and the use and implementation of the tool will be examined by lesson videography.

References

Cusi, A., Aldon, G., Barzel, B. & Olsher, S. (in print). Rethinking teachers' formative assessment practices within technology-enhanced classrooms. In B. Pepin, G. Gueudet & J. Choppin (Eds.), *Handbook of Digital Resources in Mathematics Education, Ed 1*.

Black, P. & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5–31. https://doi.org/10.1007/s11092-008-9068-5

Kuckartz, Udo (2018). Qualitative Inhaltsanalyse. Methoden, Praxis, Computerunterstützung. Beltz Juventa.

McLaughlin, T. & Yan, Z. (2017). Diverse delivery methods and strong psychological benefits. A review of online formative assessment. *Journal for Computer Assisted Learning, 33*, 562–574.

Price, B.; Stacey, K.; Steinle, V. & Gvozdenko, E. (2013). SMART ONLINE ASSESSMENTS FOR TEACHING MATHEMATICS. *Mathematics Teaching, 235*, 10–15.

Schütze, B.; Souvignier, E. & Hasselhorn, M. (2018). Stichwort – Formatives Assessment. *Zeitschrift für Erziehungswissenschaften, 21*(4), 697–715. https://doi.org/10.1007/s11618-018-0838-7