Formative feedback in problem-solving lessons in German primary schools

Yasmin Theile[1] and Benjamin Rott[2]

[1,2] University of Cologne, Germany; yasmin.theile@uni-koeln.de

In this article, we present initial results of the research on formative feedback, which is used by teachers in problem-solving orientated lessons in German primary schools. The analyses of five lessons on problem solving from German primary schools revealed 15 different forms of formative feedback from different levels (Hattie & Timperley, 2007) which will be exemplified. Most of the feedback forms identified relate to the task, results or process. Formative Feedback regarding the level of self-regulation could not be identified.

Keywords: problem solving, primary education, formative feedback

Introduction

We all need people who will give us feedback. That´s how we improve.

Bill Gates

Problem solving (PS) is a one of the main activities of mathematical work and therefore an important skill to be learned in school mathematics. It is uncontroversial that students should learn to solve problems from primary school onwards and to reflect on and, if necessary, adapt their approaches to PS. However, studies have shown that primary school students in particular have problems in performing these skills (Heinrich et al., 2014). As a result, there is an increased need for teacher support to improve students' PS skills. The opening quote supports the importance of feedback for improvement – feedback can therefore be seen as a starting point for promoting problem-based teaching. As the particular complexity of everyday teaching makes diagnosis and specific support for students difficult (Heinrichs & Kaiser, 2018), this study focuses on formative feedback from teachers.

Theoretical Background

Feedback is one of the key strategies of formative assessment (Black & William, 2009), which can be defined as a *practice* that is

> formative to the extent that evidence about student achievement is elicited, interpreted, an used by teachers, learner, or their peer, to make decisions about the next step in instruction that are likely to be better, or better founded, than the decision they would have taken in the absence of the evidence that was elicited (Black & Wiliam, 2009, p. 9).

Feedback can generally be "conceptualized as information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (Hattie & Timperley, 2007, p. 81). In the field of educational research, a distinction is also made between formative and summative feedback. Formative feedback aims to record the current learning status of the students and, based on this, to adapt the teaching and control the learning process of the students (Black & Wiliam, 2009; Polly et al., 2017). Hattie and Timperley (2007) also distinguish between four different levels of formative feedback. Feedback at the personal level is aimed directly at students

and mainly includes praise or motivation and is often unrelated to the task or performance of the student (Hattie, 2012; Hattie & Timperley, 2007). Feedback at the task and product level includes all feedback and information about how well a task has been mastered or performed (Hattie & Timperley, 2007). It is also often called corrective feedback and is the most common form of feedback given in a classroom setting (Hattie, 2012). Feedback at the process level refers to the processes on which the execution of a task is based. It "can lead to providing alternative processing, reducing cognitive load, [or] helping to develop learning strategies and error detection" (Hattie, 2012, p. 119). The highest form of feedback takes place at the level of self-regulation. Feedback at this level refers to the students' ability to monitor their own learning processes (Hattie, 2012). Although the influence of feedback on learning is undisputed, there are so far – especially in relation to problem-based teaching – only a few empirical findings on the implementation of formative feedback in mathematics education (e.g. Green, 2023). Since studies have shown that the positive effects of formative feedback on learning could depend on the subject and specific implementation (McLaughlin & Yan, 2017), studies are needed specifically on problem-based mathematics teaching.

Research question and study design

To be able to make statements about the effectiveness of specific forms of feedback in problem-based teaching, it is useful to identify the forms of feedback that teachers use in everyday teaching. Amongst this background, the aim of the study is to investigate how teachers support their students' solution processes in problem-based lessons. This article will focus on the question which forms of formative feedback can be identified among primary school teachers in problem-based lessons. Tor this study, five lessons were videotaped in different primary schools in which the predefined aim of the lessons was to work on a problem-based task. For this purpose, the teachers were given a catalogue of problems to choose from. Three teachers taught a 2nd-grade class, the other two 4th-grade classes; more lessons are currently recorded and evaluated. Each lesson (45 min) was videotaped using two cameras to cover the classroom and a microphone or GoPro for the teacher. No further specifications were given to the teachers in advance.

The analysis is based on Mayring's (2000) qualitative-content-analysis methodology, allowing for an deductive-inductive category development. To develop a category system, the levels of feedback (Hattie & Timperley, 2007) were used as superordinate categories to provide a basic structure. The various forms of feedback that could be identified in the analysis were then described in detail, categorized by similar characteristics and subordinated to the levels of feedback. The previous analyses were performed by one coder.

Results

We identified a total of 176 situations in which teachers gave feedback to students on their work. These could be summarized into 15 feedback categories, which in turn could be categorized into three of the four feedback levels. Only three, because feedback at the level of self-regulation has not been identified in the so-far recorded data. One category, the feedback form *R_1: Reception signal,* could not be assigned to any of the four levels and was therefore coded as Unspecific reactions (Rx). Typical reception signals that could be observed were *hm, mhm, aha* or emotional expressions such as laughter as reactions. The category *T_1: Correctness of Result* – categorized at the task and product level (T_x) –

is coded when the teacher explains to the students that a (partial) result is correct, incorrect or incomplete without providing further information. As this category could be identified in the lesson of each teacher, it will be shown as an example below. Mrs. P's interaction with a student illustrates this. The students must find the number of squares that can be found on a chessboard (204), which is likely to be a problematic task for many primary school students, as they do not have a suitable solution scheme is not immediately obvious. The student approaches her teacher during the lesson and states:

157 Student Mrs. P. .. I think I'm done, I have 118.
158 Mrs. P.: No its more.
159 Student: What, great.

After the last sentence, the student returns to her seat. The teacher does not provide any further information, such as what has not yet been correct or forgotten by the student. Interactions that could be assigned to this category were identified 24 times.

A complete list of all categories that could be identified is given in figure 1. It also shows how often each category occurred in the analyses. The letter in the abbreviation stands for the level to which the categories have been assigned – personal level (S_x), task and product level (T_x) and process level (P_x). The complete coding agenda will be gladly provided on request.

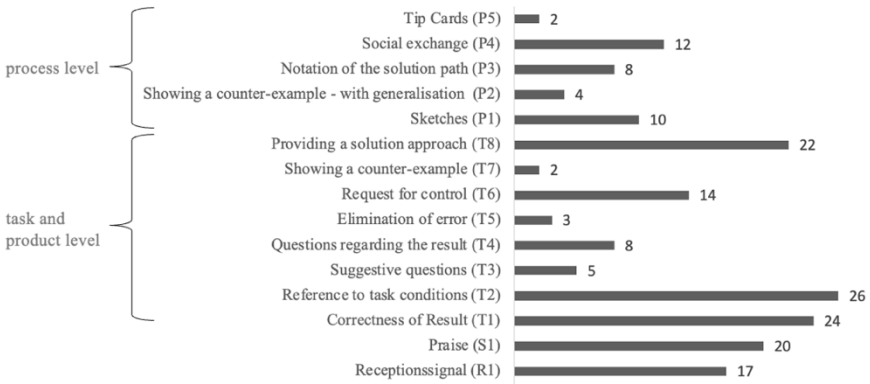

Figure 1: Categories of formative Feedback in problem-based lessons

It is noticeable that some forms of feedback such as *T_2: Reference to task conditions* and *T_8: Providing a solution approach* were identified very frequently and with every teacher, while others such as *P_5: Tip Cards* occurred only with individual teachers. However, it should be noted that these results may be due to the small amount of data in this study. The analysis of further lessons will provide more in-depth findings here. The results presented support the findings of Hattie (2012) that most feedback is given at the task and product level. Overall, it is noticeable that the teachers in this study most frequently chose forms of feedback that address the product level, although problem solving is a process-related skill and therefore the actual process should be the focus.

The study also revealed that certain forms of feedback were identified as recurring for a teacher. An exemplary case of this is Mrs. T. In the evaluation of her lesson, 40 feedback situations were identified in which she responded with one of three forms of feedback in around 64% of cases (T_1, T_2 and T_8). All other identified categories occurred only sporadically. While this phenomenon was recognizable

among all teachers, the categories that occurred particularly frequently differed between the individual teachers. This will be analyzed in greater depth in further analyses.

Discussion

The aim of this study was to identify and analyze different forms of formative feedback which are used by German primary school teachers in lessons regarding problem solving. It was possible to identify 15 different categories, which can be assigned to three levels of feedback. The catalogue of criteria resulting from this study is currently being further tested for its applicability by expanding the data by analyzing additional lessons – including external analyzes by other coders. It should be noted that there may be further changes to the list of categories in the subsequent analyzes. In particular, categories at the level of self-regulation (Hattie & Timperley, 2007) that could not be identified in the current analyzes are conceivable here. Based on the findings so far, further analyses should also focus on exploring possible recurring preferred forms of feedback that occur across lessons for individual teachers. In the long term, it seems particularly interesting to examine what effect the forms of formative feedback used by the teachers have on students' problem-solving processes in order to allow specific conclusions for teaching practice.

References

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

Green, J. (2023). Primary students' experiences of formative feedback in mathematics. *Education Inquiry*, *14*(3), 285–305. https://doi.org/10.1080/20004508.2021.1995140

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. Routledge.

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Heinrich, F., Jerke, A., & Schuck, L.-D. (2014). "Fehler" in Problembearbeitungsprozessen von Grundschulkindern. In J. Roth & J. Ames (Eds.), *Beiträge zum Mathematikunterricht 2014* (pp. 499–502). WTM.

Heinrichs, H., & Kaiser, G. (2018). Diagnostic Competence for Dealing with Students' Errors: Fostering Diagnostic Competence in Error Situations. In T. Leuders, J. Leuders, & K. Philipp (Eds.), *Diagnostic Competence of Mathematics Teachers. Unpacking a Complex Construct in Teacher Education and Teacher Practice* (pp. 79–94). Springer International.

McLaughlin, T., & Yan, Z. (2017). Diverse delivery methods and strong psychological benefits: A review of online formative assessment. *Journal of Computer Assisted Learning*, *33*(6), 562–574. https://doi.org/10.1111/jcal.12200

Polly, D., Wang, C., Martin, C., Lambert, R. G., Pugalee, D. K., & Middleton, C. W. (2017). The Influence of an Internet-Based Formative Assessment Tool on Primary Grades Students' Number Sense Achievement. *School Science and Mathematics*, *117*(3–4), 127–136. https://doi.org/10.1111/ssm.12214