The suitability of rich learning tasks from a pupil perspective

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The construction of tasks is important to challenge pupils, but it is rare to explore pupils' perceptions connected to their work with tasks. This paper presents the results of a study using a tool aimed to measure pupils' perception of joy and interest connected to 'rich learning tasks' by comparing the views of mathematically promising pupils and others. Two tasks were pre- and post-evaluated, the first by 139 and the second by 106 pupils from grade 4-9. The results indicate that the tool is suited to explore pupils' views, especially as it can be deduced from the comparison that: mathematically promising pupils perceived both tasks more positively than the other pupils, and that the non-identified pupils became more positive after working especially with one of the tasks.

Keywords: Mathematically gifted, mathematically promising, rich tasks, pupils' perception

Introduction

One of the main goals in research on mathematical giftedness is to identify and foster mathematically promising pupils (Käpnick & Benölken, 2015). The construction of mathematical tasks is seen to be important for both purposes (Fuchs & Käpnick, 2009; Nolte, 2012). It is a consensus that tasks suitable to identify and foster mathematically promising pupils should, for example, be challenging, open-ended, encourage creativity and engagement, and promote enjoyment (Fuchs & Käpnick, 2009; Nolte, 2012; Sheffield, 2003). In Sweden there is no differentiation among students, every classroom is diverse and includes pupils of all abilities. Therefore, it is interesting to explore how the work with specific tasks are perceived by all pupils in the classroom. Of special interest is the perception of the mathematical promising pupils since in a diverse classroom there is a risk that they not are given opportunities to be challenged (Leikin & Stanger, 2011). A task suitable to implement in the whole class should offer a challenge to pupils at every level, which for example rich learning task are said to do (Sheffield, 2003). However, it is rare that the assessment process of the tasks appropriateness is explored, especially from the pupils' perspective. This leads to the question how tasks aimed to support mathematically promising pupils can be evaluated by the pupils. Against the background of this question this paper presents a study aiming to explore a tool in development that investigates pupils' perception of joy and interest connected to specific tasks.

This paper gives a theoretical background on tasks suitable to challenge mathematical promising pupils and other pupils. Further, the aspect of perceived joy and interest for pupils connected to work on mathematics is elaborated. The study and its results are presented and thereafter the tool used and the interpretation of the results are discussed.

Theoretical background

Pupils in a diverse classroom naturally have different levels of knowledge. Engström and Magne (2006) showed that in Swedish classrooms the mathematical knowledge of the 15 percentage lowest achieving pupils in grade nine are on the level of a grade four pupil. Also in a mathematical

classroom there is a mix of pupils, some are highly motivated while others lack motivation, some are high achieving and others are low achieving (Boaler, 2006). All pupils should be given opportunities to learn and develop, and on task level there are ways to differentiate education to meet and challenge all pupils. One way is for example through the use of rich learning tasks, which also fulfills the criteria for tasks seen to be suitable to identify and foster mathematically promising pupils (Sheffield, 2003). Because of the Swedish context with the diverse classroom the aim is to meet and develop all pupils, however, the mathematically promising pupils are of particular interest in this study. Therefore, it is important to elaborate on what is important in a task for a mathematically promising pupil as well as for pupils in general.

First, considering the mathematically promising, it is important to give them challenging tasks to help them develop according their mathematical potential (e.g. Benölken, 2015; Koshy, Ernest, & Casey, 2009; Nolte, 2012). Open-ended tasks, like rich learning tasks, are examples of tasks known to be challenging for mathematically promising pupils (Nolte, 2012; Sheffield, 2003). In addition, the joy factor is stated as important in the development process for the mathematically promising (Fuchs & Käpnick, 2009). The importance of joy in working with mathematics is further consolidated by being strived for in activities aiming to support and foster the mathematically promising, such as for example math clubs (Benölken, 2015).

Second, considering pupils in general, Taflin (2007) states that it is important that pupils perceive the problem solving process of a task as positive, challenging, and that it stimulates their creativity. Taflin actually writes that if they do not perceive this, then it is better not to implement the tasks. As to the perspective of joy, Mellroth (2014) showed that tasks aiming to evoke joy make some pupils achieve highly, even though they do not achieve highly on traditional mathematics tests. In addition, to further strengthen that pupils' enjoyment in mathematics is important, Chen and Stevenson (1995) showed that positive attitudes and interest are significantly related to mathematical achievement. And the results of Skaalvik, Federici, and Klassen (2015) show that pupils' self-efficacy in mathematics is positively and strongly related to intrinsic motivation which they directly connected to pupils' enjoyment when working with mathematics.

Based on the theory it can be assumed that pupils' perception of interest and their positive attitudes towards the task have effect on their motivation on working with the task. This is valid for both mathematically promising pupils and for others. Therefore, it is interesting and important to explore how pupils perceive working with specific tasks, especially by comparing promising and other pupils. A developed tool, easy to use, could help teachers choosing tasks that challenge and interest all pupils.

Aim

The aim of the presented study is to investigate how to identify mathematical tasks that can stimulate all pupils in a diverse classroom, including the mathematically promising. Utilizing a pupil perspective, which stresses the importance of pupil interest and joy when working with mathematics, the study provides a comparison of data from promising children and others.

The study is conducted in Sweden within the frame of a professional development program on mathematical promise for seven in-service teachers, teaching mathematics for pupils from grade 4 to 9 (Mellroth et al., 2016).

Method

Two tasks that fulfilled the criteria of rich learning tasks were implemented in seven classrooms, i.e. all pupils in "regular" classes worked with the tasks aiming to solve them. The pupils went in grade 4 (age 10) to 9 (age 15), all grades covered. The tasks considered to be suitable to challenge all pupils, specifically mathematically promising, were chosen (Sheffield, 2003), see Figure 1 (*Task 1*) and Figure 2 (*Task 2*). In the first intervention *Task 1* was implemented: 139 pupils responded on the evaluation of the task, among them 32 pupils were identified as mathematically promising[1].
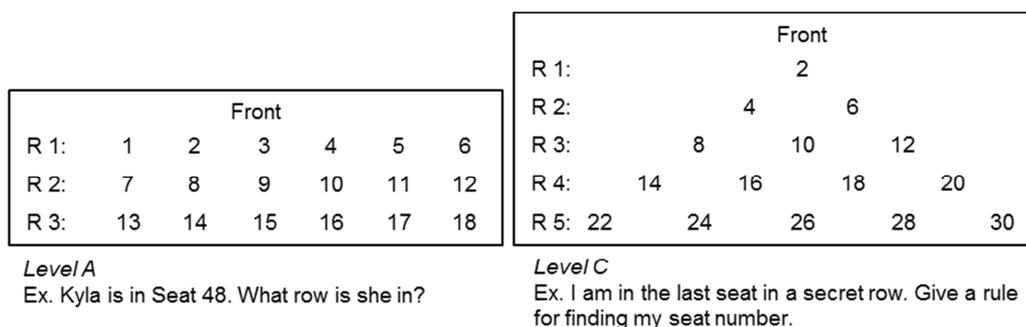
Figure 1: Example from *Task 1*, named Where am I? (Sheffield, 2003).

In the second intervention *Task 2* was implemented: 106 pupils responded, among them were 20 pupils identified as mathematically promising.
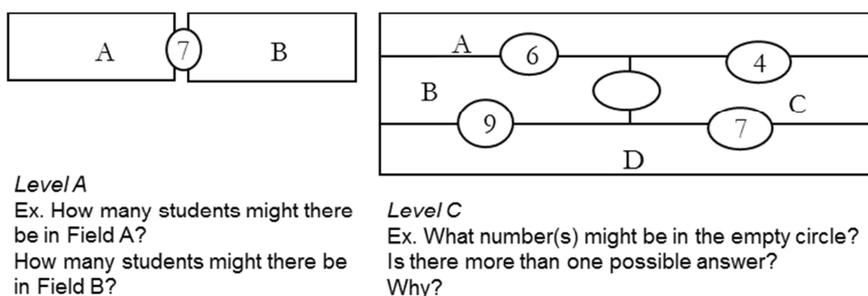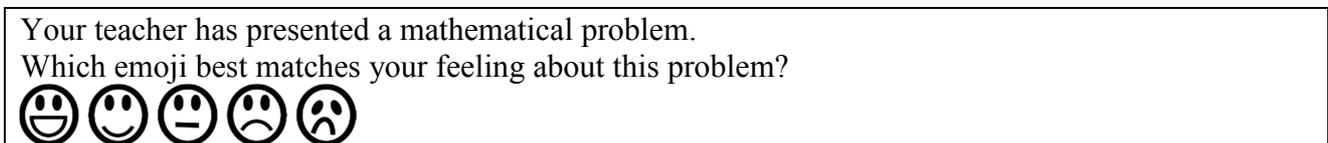

Figure 2: Example from *Task 2*, named Field of dreams (Sheffield, 2003); The number in a circle, denotes the total number of students in all adjoining fields.

The pupils involved in the two interventions all came from the same seven classes, 44 pupils did *Task 1* but not *Task 2* and 11 pupils did *Task 2* but not *Task 1*. Therefore 95 pupils participated in both interventions, 20 of those were identified as mathematically promising. Since the suitability of the tasks in the classroom was of interest, evaluations from all participating pupils were used in the analysis for each intervention.

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[1] Selected through a synthesis of different tools, see Mellroth et al. (2016).
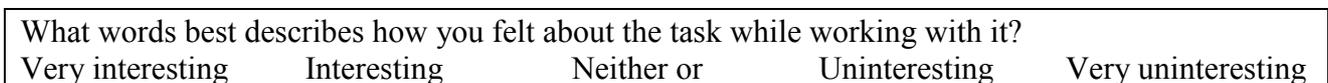
Within the frame of the professional development program a tool how to measure pupils' perceptions on interest and joy connected to working with specific tasks was developed. In the development process experts on motivation and attitudes in mathematics education, and in educational psychology were consulted. The tool resulted in a pre-evaluation that utilized an emoji-note, Figure 3, and a post-evaluation, in which the emojis were changed to words, Figure 4. The reason for the change from emojis to words was to decrease the risk that pupils would chose the same emoji twice due to the short time, the time of one lesson, between the pre- and post evaluation.

To collect data each teacher presented a power point slide with a picture related to each task[2] in their specific classes, without revealing the actual task. Before the task was handed out to the pupils, they were asked to mark how they felt about the task by choosing an emoji on a paper given to each one of them, see Figure 3. Thereafter the pupils were given time to work with the task.

Your teacher has presented a mathematical problem.
Which emoji best matches your feeling about this problem?
😀 🙂 😐 🙁 😧

Figure 3: Evaluation note before starting to work with the task, adapted from Mellroth et al. (2016).

When the teacher ended the pupils work with the task, but before the task was discussed orally in the whole classroom, pupils were asked to evaluate the task again. This time by choosing words, see Figure 4.

| What words best describes how you felt about the task while working with it?				
Very interesting	Interesting	Neither or	Uninteresting	Very uninteresting

Figure 4: Evaluation note after completing working with the task (Mellroth et al., 2016).

Data from all classes were collected and summarized. For the summary process pupils identified by the teachers as mathematically promising were separated from the non-identified pupils. The evaluations, see Figure 3and Figure 4, were translated to numbers from 1 to 5, where 1 was the most positive evaluation and 5 the most negative. Thereafter, a descriptive analysis was conducted. For further details of the method see Mellroth et al. (2016).

Results

The results from each task are presented in Figure 5 and Figure 6: the graphs show the distribution of pupils' perception of the task before they started to work on it. Each bar in the graph is also split to show pupils change in perception of the task after they completed working with it. For example, in the left-hand graph in Figure 5, the bar on number 2 shows that 12 pupils, identified as mathematical promising, chose the second most positive emoji before they started to work on *Task 1*. Further, the same bar shows that of those 12 pupils, five gave the task a more negative judgement, two gave it a more positive judgement and five still gave them the second most positive judgement after they completed the work with the task.

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[2] The process of choosing and analyzing the tasks are described in Mellroth et al. (2016)
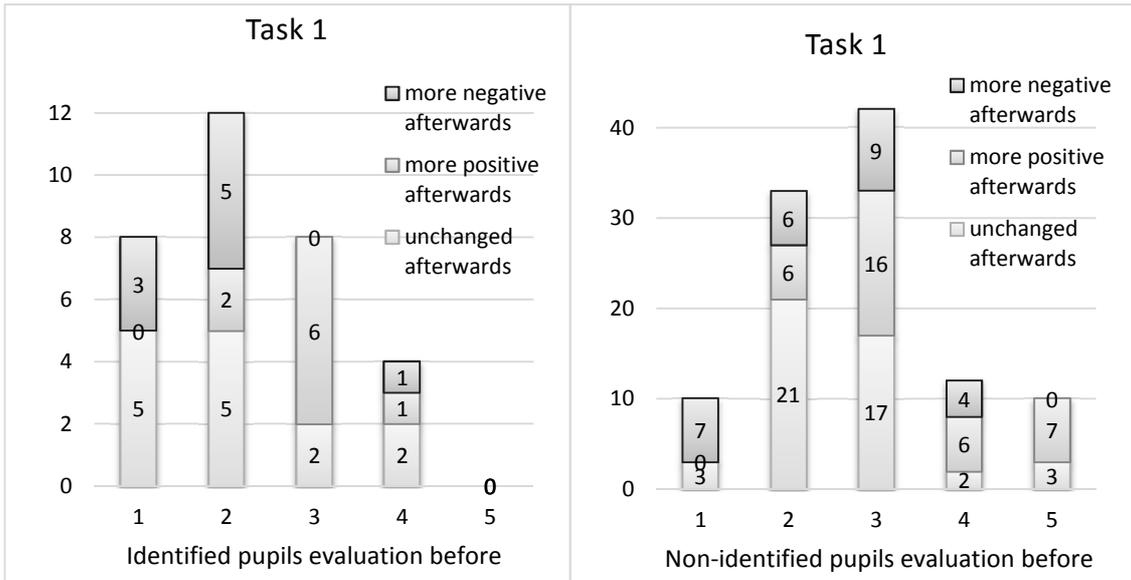
Figure 5: Pupils evaluation of *Task 1*, before starting their work on the task and after they completed their work (Figure adapted from Mellroth et al, 2016, p. 19).
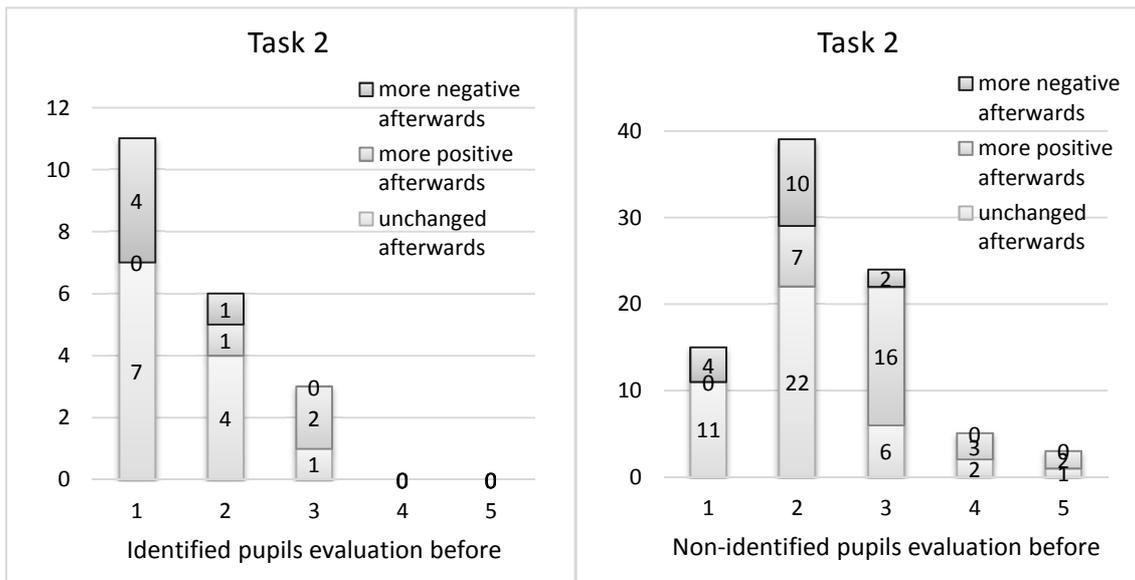
Figure 6: Pupils evaluation of *Task 2* before starting their work on the task and after they completed their work (Figure adapted from Mellroth et al, 2016, p. 19).

As both Figure 5 and Figure 6 show, through the concentration of the bars to the left, pupils identified as mathematically promising perceive both tasks more positively compared to the non-identified pupils before they started to work with the tasks. Considering *Task 1*, the two groups of pupils, identified and non-identified, did not differ much in how they changed their evaluation of the task after they completed it. 28 percent compared to 33 percent judged the task more positively after they completed it, 28 percent compared to 24 percent judged it more negatively, and 44 percent versus 43 percent judged it the same as before. As to *Task 2*, and the results of comparing identified and non-identified pupils and how they changed their evaluation of this task after they completed it show: 15 percent compared to 33 percent gave a more positive judgement afterwards,

25 percent compared to 19 percent gave the task a more negative judgement afterwards and 60 percent compared to 49 percent did not change their judgement of the task.

Interpretations and discussion

The aim of the study was to investigate how to identify mathematical tasks that can stimulate all pupils in a diverse classroom, including the mathematically promising. The two tasks used in the study were chosen because they were rich learning tasks and said to be suitable to challenge all pupils, including the mathematically promising (Sheffield, 2003). The positive evaluation given by especially the mathematically promising pupils were expected, therefore the results can be seen to verify the developed tool.

For *Task 1* the results show that the majority of the mathematically promising pupils, before starting to work on it, evaluated it as more positive: 63 percent choose the most, or the second most positive emoji, compared to 40 percent of the non-identified pupils. For *Task 2* the comparable percentages are 85 and 63 respectively. This indicates that the mathematically promising, especially, perceived the tasks interesting and joyful already before they knew the associated question. The results show that *Task 2* has this effect to a higher extend for all pupils, also the non-identified. The post evaluation of *Task 2* shows a relatively large shift to a more positive judgement of the task for the non-identified pupils, Figure 6 right graph. Altogether the results indicate that considering pupils' perception of joy and interest, *Task 2* is suitable for all pupils in the diverse classroom, including mathematically promising pupils.

The results also indicate that *Task 1* is not as suitable for all pupils. However, even if *Task 1* is not as good as *Task 2* according to the results, the mathematical promising pupils perceived it relatively positively before starting to work on it. In addition, just as many of them judged the task more negatively as those who judged it more positively afterwards. Also slightly more pupils of the non-identified judged it more positively after the completed work compared to the number that judged it more negatively. Therefore, *Task 1* might also be a suitable task in a diverse classroom even if it is not as good as *Task 2*.

According to the chosen frame for this study, tasks challenging and stimulating for mathematically promising pupils lead to that they feel joy and develop learning (Fuchs & Käpnick, 2009; Nolte, 2012; Sheffield, 2003). The identified pupils positive evaluation of the tasks, especially *Task 2*, can be a sign of that they felt the tasks challenging and stimulating. The results for the promising pupils can also be interpreted as an indication of that the developed tool fulfills its purpose to measure pupils joy and interest in a rich learning task. Furthermore, it is indicated that the tool can grade the suitability of different tasks, concerning joy and interest, in this case *Task 2* is perceived slightly more positive than *Task 1*.

It has been found that teachers rarely provide mathematically promising pupils with learning opportunities that benefit them in the diverse classroom (Leikin & Stanger, 2011), and also that positive attitudes towards working with mathematics make pupils achieve better (Chen & Stevenson, 1995). Based on this, the results show that the tasks might provide mathematical learning opportunities for all kind of pupils. Further development and verification of this tool can

provide teachers with a simple way to find tasks that provide learning opportunities for all pupils in the diverse classroom, also for the mathematical promising.

Even if the simple tool has proven its use in principle, there are, of course, several limitations in this study, the investigation is simple and the tool used is not statistically verified. Nor does the investigation consider in depth how joy and interest is perceived by the pupils. In this study, pupils' motivation to work on a task is assumed to be connected to the perceived joy and interest. The teachers' evaluation of how the pupils worked with the implemented tasks is another important aspect, which this paper does not address. Within the frame of the professional development program the teachers observed and interviewed some pupils connected to their work with the investigated tasks; inclusion of this data would have strengthened the results (Mellroth & Benölken, 2016; Mellroth et al., 2016). Also, to be able to compare different groups of pupils like for example mathematically promising and others (non-identified), teachers need knowledge on how to identify the different groups. In this study the teachers who collected the data participated in a professional development program on mathematical promise, their knowledge on how to identify those pupils can be considered as relatively deep. But it is needed to highlight this for someone who wants to repeat the study.

If further research is done to develop and validate the tool used here, it could provide in-service teachers with an easy and quick way to evaluate the suitability of tasks from a pupil's perspective. In turn this might result in mathematically promising pupils being presented with tasks that help them to develop according to their potential. In addition, complex single-case studies might explore specific aspects of tasks that are assessed highly by the pupils applying the tool presented in this study.

Acknowledgment

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