Young students' views on mathematical tasks: An analysis of speech functions used in measurement tasks posed by students

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Abstract: In this study, the views of six-year-old students on mathematical tasks are explored through the practice of problem posing. Framed within an educational design research approach and grounded in Systemic Functional Linguistics, 55 tasks posed by students were analysed. The posed tasks consisted of both wording and drawings, and the analysis focused on identifying speech functions: *statement*, *question*, *offer*, and *command*. Although *questions* were expected to dominate, the findings show that *command* was the most frequently employed speech function. This indicates that students often view mathematical tasks as directives for action rather than as inquiries or questions to be explored. Furthermore, tools were provided (*offer*) to the task solver, highlighting the significance of multimodal communication in early mathematics education. The findings contribute knowledge about young students' views on mathematical tasks, views that may influence how problem solving and problem posing are emphasised in early mathematics education.

Keywords: problem posing, early mathematics, measurement, Systemic Functional Linguistics, speech functions.

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1 Introduction

The ability to use mathematics in daily life is one of the key competences highlighted by the EU in its lifelong learning recommendations (EU, 2019). In relation to mathematics in everyday contexts, mathematical problem solving and problem posing are of particular importance. Studies show that young students are capable of mathematical reasoning when engaged in well-designed problem-solving tasks (English & Watters, 2005). Problem solving and problem posing are essential in early mathematics education. They foster both conceptual understanding and mathematical thinking (Cai & Leikin, 2020), enabling students to actively engage with mathematical ideas rather than passively receive information (English, 2003). Such engagement in problem-solving activities has a positive influence on students' perceptions of mathematics beyond the development of their problem-solving skills and their understanding across different mathematical content areas (see, for example, Palmér & van Bommel, 2020; van Bommel et al., 2024).

Recently, several journals and publications have specifically focused on problem posing (see, for instance, Cai & Leikin, 2020), indicating an increasing interest in problem posing as an important part of problem solving. Problem posing, in particular, allows students to generate their own mathematical questions, promoting creativity and ownership of learning. Mathematical content in problem-solving tasks may become clearer when students are not only asked to solve the task but also to pose similar ones (Silver, 1994).

In this paper, we want to broaden the focus from the mathematical content to how problem solving and posing may influence students' views on mathematical tasks in general. The students first worked on a problem-solving task on measurement, after which they continued with a problem-posing task on measurement (Stoyanova & Ellerton, 1996). Drawings and accompanying text framing the posed tasks give insight into what aspects of a mathematical task students draw upon. Analysing the utilisation of language in its different modalities (e.g., speech, written text, drawings) gives an insight into the intention of the author, in this case, the students. (Halliday & Matthiessen, 2013). According to Cai and Hwang (2019), one benefit with problem posing is its capacity to reveal useful insights about students' mathematical thinking. In this paper, we want to see if problem posing can also reveal insights into students' views on mathematical tasks on measurement. The question to be elaborated on is: What views on a mathematical task do students reveal when posing a task on measurement?

2 On measurement

The mathematical content in focus in the problem-solving and posing tasks is measurement. Measurement involves comparing objects directly or indirectly using formal or informal units. Functional measurement requires understanding attributes (what to measure), units (which unit to use), and scale (how units relate to one another) (Wright et al., 2007). When direct comparison is not possible, as in the problem-solving task in this study, a reference object is needed to compare both items, requiring transitive reasoning (Kamii, 2006; Piaget, 1952).

3 Literature review

This study is part of the increasing interest in problem posing as an important part of problem solving. Where other studies within this interest have mainly focused on how to teach problem posing (see for example Cai & Hwang, 2019; van Bommel & Palmér, 2021), students' learning of mathematics when working on problem posing (see for example Singer et al., 2013; Palmér & van Bommel, 2020), students views on problem solving and problem posing (see for example van Bommel & Palmér, 2021; Di Martino, 2019), this study focuses on how students' views on mathematical tasks may become visible in their work on problem posing.

Investigating students' views on mathematics is of importance as these views influence their engagement, motivation, and long-term learning outcomes (Op't Eynde et al., 2002). A positive view can foster confidence and a willingness to explore mathematical ideas, whereas negative views may have the opposite effect (Larkin, 2010). Previous studies have shown that integrating problem solving and problem posing in early mathematics may allow students to experience mathematics as creative, meaningful, and collaborative (English & Watters, 2005), which in turn has been linked to increased motivation and a more positive attitude toward mathematics (Silver & Cai, 2005). This, however, has not been investigated with students as young as those in this study.

Problem solving and problem posing are often conducted in (small) groups and closely linked to mathematical reasoning. Thus, when investigating students' views on mathematics, the importance of mathematical reasoning through different modes of representation becomes evident. The multimodality of such reasoning in collaborative problem solving has been investigated by Wathne & Carlsen (2024), who found that students used a range of communicative modes, including gestures, speech, inscriptions, and gaze, to negotiate mathematical meaning. Their results show that reasoning is not only verbal but also includes several other modalities. Also, Norberg (2019) has focused on multimodality, however, not in problem solving situations but in tasks presented in textbooks. She found that the design and interplay of images, symbols, and written text significantly influence how students interpreted and approached mathematical tasks. Her study shows the importance of considering multimodal design in instructional materials. A recent study on the multimodality of students' drawings of their classroom (Ebbelind et al., 2024) showed that aspects of students' views on mathematics can be identified in these drawings, for example, what mathematical content students foreground and how they view that mathematics education is conducted.

4 Theory

Over the last thirty years, mathematics education research has drawn increased attention to the study of language and its importance as a medium for teaching and learning, often referred to as the “linguistic turn” (e.g. Lerman, 2009). In this paper, we follow this line of research and utilise aspects of Halliday’s social semiotic perspective, specifically Systemic Functional Linguistics (SFL), with a focus on the notion of speech function. SFL conceptualises language as an activity or practice rather than as an entity with a predetermined meaning. In this paper, we analyse young students’ utilisation of language while posing a task. That is the potential the posed task has in a problem-solving setting.

Language, used in various modalities, is employed to communicate and interact. The one initiating the ’conversation’ (speech or written text) makes a demand or request of the listener. The ’language’ used (in this case, drawings and words in the task) can be analysed using speech functions to determine what the author intended to accomplish. The four primary speech functions are *statement*, *question*, *offer*, and *command* (Halliday & Matthiessen, 2013) and reveal (in this study) a student’s view on how a task in mathematics is formulated and what aspects a task on measurement should contain. SFL, and more specifically the four speech functions, provides an appropriate framework for analysing multimodal communication, as the different speech functions capture different aspects of young students’ communication. A task can contain multiple speech functions and can be multi-coded. In this study, speech functions were defined through the formulations (i.e., grammar) used in the task. *You have* five minutes to solve this – grammar of the speech function statement; *how long is…*? – grammar of a question; *use* the ruler *to…* – grammar of a command (Holmberg & Karlsson, 2006). In Swedish, there is no specific grammar concerning the speech function offered. Therefore, language and expressions with a focus on having a more supportive role are considered, in line with Holmberg and Karlsson (2006). For all speech functions, alternative formulations can be used as well, and in such cases, an expected response can identify the speech function (Holmberg, 2011).

5 Method

As mentioned, this study was framed within an educational design research approach (Bakker, 2018). This article focuses on one design cycle, where students first worked on a problem solving task related to measurement, and then continued with a problem-posing task (Stoyanova & Ellerton, 1996).

5.1 Participants

This study was conducted in the Swedish preschool class. Five teachers, four researchers and six-year-old students in four classes participated in the study. The Swedish preschool class is a unique form of schooling aiming to bridge the gap between preschool with its play-based pedagogy and primary school. Since this year is the first compulsory school year, not all students can yet read or write. This affects how teaching is organised in the preschool class, which also needed to be taken into account in this study.

5.2 Data collection

The material analysed consists of tasks posed by these six-year-olds. These tasks were collected during the last of the two lessons, designed to follow a specific structure. In the first lesson, the focus was on problem solving. The teacher drew a looped curve starting in the middle of a piece of paper and spiralled outwards, asking the students how long the drawn curve would be if it were straightened. After that, the curve was measured with a string. The students were then given the task of trying to draw a curve of the same length as the one drawn by the teacher (see Palmér & van Bommel, 2023). In the second lesson, the focus was on problem posing. The teacher reminded the students of the task with the looped curve and asked them to pose a similar task to a friend. All students used white A4-sized paper to document their posed task, but no further instructions were given regarding the task itself. Most of the tasks posed by students included both a drawing and words. Due to the age of the students and their inability to write, the teachers when needed wrote the tasks posed by the students. In total, 62 tasks were posed by the students. However, only 55 of these were analysed in this study, as seven tasks did not focus on measurement.

5.3 Data analysis

The students' tasks were analysed using SFL and its four speech functions (*statement*, *question*, *offer*, and *command)* in order to examine what the students intended to accomplish with their posed tasks (Halliday & Matthiessen, 2013). More specifically, the tasks were analysed based on different acts of speaking (giving and demanding), and different exchanges (information and goods/services) in the four speech functions (Holmberg & Karlsson, 2006). Each of the four speech functions are a combination of one act of speaking and one exchange (see Table 1). This means that for the exchange 'information', giving information results in a *statement* while demanding information results in a *question*. Concerning the exchange 'goods or services', giving goods and services results in an *offer*, whereas demanding goods and services results in a *command*.

Table 1. Overview of the four primary speech functions as described by Holmberg & Karlsson (2006, p. 34, own translation).

		Act of speaking	
		Giving	Demanding
Exchange	Information	Statement	Question
	Goods/services	Offer	Command

On a critical note, in this study, the students are asked to pose a task, a question, which is defining the grammar used. One could therefore expect a high frequency of the speech function 'question' why the combination of the question and the other speech functions gives an insight into students' views on a mathematical task involving measurement.

The data analysis was carried out by coding the students posed tasks using four codes: statement, question, offer, and command (Holmberg & Karlsson, 2006). As some tasks contained more than one speech function, they were multi-coded. Since the tasks posed by students sometimes involved multiple modalities, such as drawings and words, the drawings were regarded as part of the language used to describe the task and were therefore included in the analysis. Each task was analysed by considering drawings and words as an integrated whole, rather than as separate components. While some tasks contained only one speech function, others included two or three. The students' tasks were initially coded by two researchers. The coding was then compared and discussed and subsequently reviewed by the entire research group to reach consensus.

6 Results

The analysis revealed in what way the four primary speech functions: *statement*, *question*, *offer*, and *command,* appeared in the 55 tasks posed by the students. The speech function statement was identified in 5 tasks, question in 22 tasks, offer in 14 tasks, and command in 37 tasks (Table 2). Further, in 34 tasks only one speech function was identified, in 19 tasks two speech functions were identified and in 2 tasks three speech functions were identified (Table 3). No tasks contained all four speech functions.

Table 2. Overview of the speech functions identified in the 55 tasks.

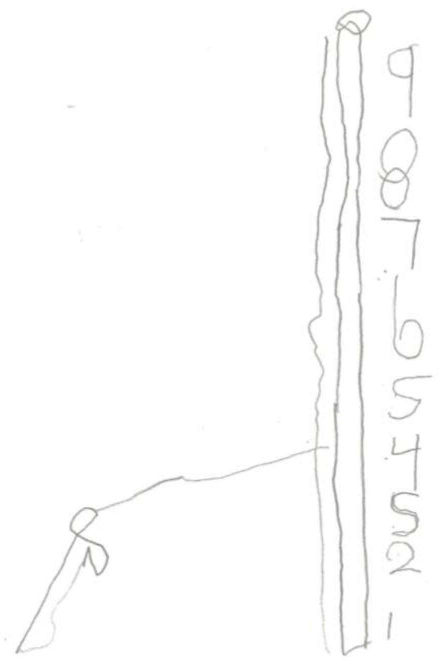
Speech Function	Task	Frequency
Statement	34, 40, 43, 50, 53	5
Question	17, 18, 21, 23, 24, 26, 28, 29, 32, 33, 34, 35, 36, 37, 38, 39, 47, 48, 49, 51, 52, 53	22
Offer	3, 6, 9, 11, 13, 14, 16, 17, 21, 26, 29, 31, 36, 53	14
Command	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 22, 25, 27, 28, 30, 31, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 54, 55	37

Table 3. Overview of the number of speech functions identified in the 55 tasks.

# Speech Functions	Task	Frequency
1	1, 2, 4, 5, 7, 8, 10, 12, 15, 18, 19, 20, 22, 23, 24, 25, 27, 30, 32, 33, 35, 37, 38, 39, 40, 41, 42, 44, 45, 46, 51, 52, 54, 55	34
2	3, 6, 9, 11, 13, 14, 16, 17, 26, 28, 29, 31, 34, 35, 43, 47, 48, 49, 50	19
3	21, 53	2
4	-	-

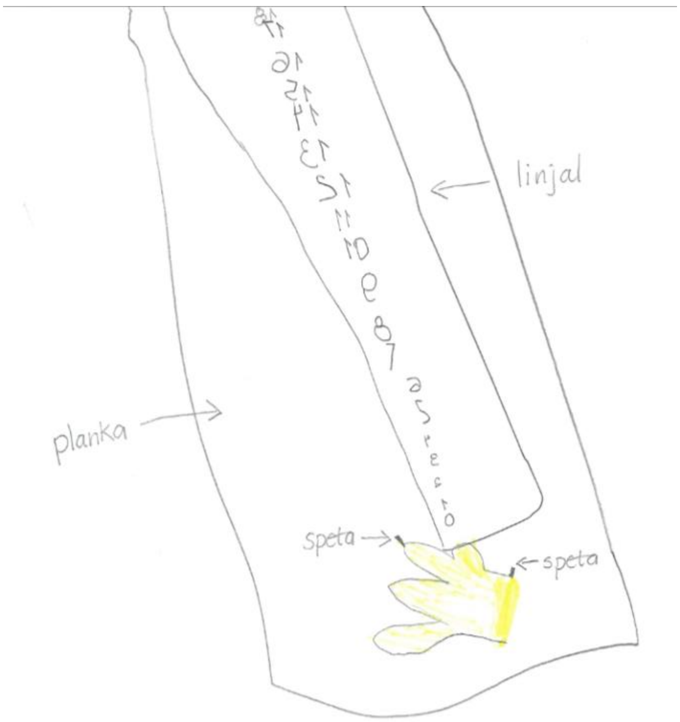
The speech function command is identified in 37 tasks posed by students (Table 2). In 22 of these tasks, command is the only speech function identified. For instance, Measure the snake with a string. In 14 tasks, command is combined with another speech function: statement, question, or offer. For instance, Measure the snowflake. How long is it? (command and question). When a statement is combined with an offer, the offer appears either in the wording or in the drawing. For instance, Measure the girl with Kapla or a ruler (command and offer). In one task, command (Measure the flagpole with the thread) is combined with two other speech functions, both question (how long is it?) and offer. The measuring tool drawn is categorised as an offer, a tool offered to use to solve the task (Figure 1).

Figure 1. Measure the school flagpole with the thread, how long is it?



The speech function *question* is identified in 22 tasks posed by students (Table 2). In 11 of these tasks, question is the only speech function identified. For instance, *How long is the snake?* In nine tasks, question is combined with another speech function: statement, offer or command. For instance, *How long is this? I made a different shape than Kim* (question and statement). In the tasks where question is combined with an offer, the offer is identified in the drawing (Figure 1). In two tasks, question is combined with two other speech functions, statement and command as described earlier concerning the flagpole task in Figure 1, or offer and statement (Figure 2). How long is the plank (question) is combined here with a statement (he got a splinter when he was measuring). The ruler drawn is categorised as an offer, a tool offered to use to solve the task.

Figure 2. How long is the plank? He got a splinter when he was measuring.



The speech function *offer* is identified in 14 tasks posed by students (Table 2). Offer never appears alone, it is always combined with other speech functions. Further, offer was both identified in the drawings (13 tasks) and identified as part of the wording (one task). In all 14 tasks, offer is combined with either statement (nine tasks) or question (six tasks). In one of these tasks, both statement and question is identified (Figure 1).

The speech function *statement* is identified in five tasks posed by students (Table 2). In one task, statement is identified as the only speech function. *You need to put a string around, to see how long it is*. In two tasks, statement is combined with command. For instance, *Go through the maze and find the treasure. You have 5 minutes*. (statement and command) In the remaining two tasks, statement is combined with question. For instance, *How long is this? I made a different shape than Kim*. (question and statement).

To sum up, the findings show that young students have different views on mathematical tasks. Since the students were given the task of posing their own problems, the speech function question was expected to be the most common. However, by analysing the four primary speech functions as described by Holmberg and Karlsson (2006) (Table 1), the findings show that command is the most frequently used speech function. This indicates a view on mathematical tasks where the question itself is not in focus, but rather instructions for action and directed activity. The speech function offer is most often identified in the students' drawings, providing tools to the task solver, and always combined with other speech functions. This shows how young students add more speech functions when using various modalities in their communication. The speech function statement is the least common speech function in the tasks posed by the students.

7 Discussion

In this paper, we explored students' views on mathematical tasks related to measurement. The analysis of the posed tasks reveals insights into how six-year-olds conceptualise teaching, mathematical measurement, and how they linguistically construct a mathematical task. The frequent use of the speech function *command*— either alone or combined with others— suggests that students often viewed mathematical tasks as instructions for action, emphasising doing. This aligns with English (2003), who suggests that young students often receive information passively. Even though receiving information passively, a posed task can, however, activate collaborative endeavours at a later stage (Ebbelind et al., 2024).

Surprisingly, while the speech function *question* was expected to dominate due to the task setup (posing a task to a friend), it occurred in fewer than half of the analysed tasks. This suggests that the act of problem posing, which involves student work, does not primarily align with inquiry or open-ended exploration, but rather with directing others. Di Martino (2019) shows that students' views on mathematical problems evolve over time, and our results suggest that such views may begin to form already in preschool class. The tendency to use *command* rather than *question* may indicate an early instrumental view of mathematics, where tasks are seen as something to be executed rather than explored.

One query is whether the experience of problem solving of these students, as presented in lesson one, is perceived as *command* and whether this experience influences the tasks they pose. This may reflect the students' earlier school experiences, where *command* might dominate the classroom interactions. From a Systemic Functional Linguistic perspective (Halliday & Matthiessen, 2013), the prevalence of *commands* may indicate that students position mathematics teaching, or any learning, as an authoritative task-giving activity, even at this young age. This is further supported by Lerman (2009), who argues that pedagogical discourse shapes students' identity and participation. The dominance of *command* may reflect the classroom discourse students are familiar with, in early mathematics education, where instructions from the teacher are central. One query is whether the experience of problem solving in lesson one is perceived as *command* and whether this experience influences the tasks they pose.

Moreover, the multimodal nature of the posed tasks, where drawings contributed to meaning making and often carried the speech function *offer*, highlights the role of visual elements in early mathematics education. This supports the idea that young students need to use multiple semiotic resources to express mathematical ideas, aligning with Halliday's view of language as functional (Halliday & Matthiessen, 2013). The inclusion of measurement tools in drawings can be interpreted as an implicit *offer* of resources to the task solver, reflecting an awareness of the tools necessary for problem solving and measurement reasoning. This aligns with Wathne & Carlsen (2024), who propose that students use a range of communicative modes to negotiate mathematical meaning.

The relative scarcity of the speech function *statement* and its frequent combination with other speech functions suggest that students rarely use language in an explanatory or descriptive way when posing tasks. This may reflect how teaching is organised in preschool class, where verbal reflection is less emphasised than action.

Some limitations should be mentioned related to the current study: a small sample size, a cultural specificity (with a focus on the Swedish context), and the interpretive challenges of multimodal data.

Finally, our results support previous findings that problem posing can reveal insights into students' mathematical thinking (Cai & Hwang, 2019), uncovering students' views on mathematical tasks. Palmér & van Bommel (2020) argue that when students pose their own tasks, they develop a deeper understanding of mathematical content. While supporting this claim, the findings also reveal that students' own tasks are often framed as action-oriented instructions rather than explorative questions.

8 Conclusion

This study provides insights into six-year-old students' views on mathematical tasks on measurement. Even though the students were specifically asked to pose their own problems (questions), they mainly use the speech function *command*—rather than *question*— indicating a view on mathematical tasks as instructions for action rather than exploring a question. This viewpoint may be influenced by the students' previous schooling experiences or the specific context in this study. Furthermore, the frequent presence of the speech function *offer* in students' drawings highlights the importance of using various modalities in early mathematics. The use of various modalities enables a multimodal use of language in communication and interaction, in line with the SFL perspective (Halliday & Matthiessen, 2013).

Overall, the study contributes to a broader understanding of young students' views on mathematical tasks. These findings have implications for early mathematics education, particularly in how educators might foster a more inquiry-based and dialogic approach when working on problem solving and problem posing. Encouraging young students to focus on *questions* when posing their own mathematics tasks, instead of giving a *command*, may support the development of a more inquiry-based early mathematics education, instead of an education where focus is on following instructions for action. If students primarily experience mathematics as a series of *commands*, they may internalise this structure when asked to create their own tasks. Future research could explore how varying teacher discourse—such as modelling open-ended questioning—might influence students' use of the speech function *question*.

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