Using roles and positions to foster explorative talk in mathematics

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This article is part of the Theatre in Mathematics project (TIM), where we use drama and roles to change the way students learn mathematics. In this article, we report on the use of roles in group work in mathematics. The data comes from one group of six students that were given roles to use during joint task solving, and the analysis is based on transcriptions from the lesson. In this particular group, two of the students enacted the role of the curious very actively. We find that these two ask almost all the questions. Looking further into it, we find four types of questions that are most frequent: requesting answers and claims, requesting explanation, requesting evaluation and clarification, and requesting argumentation. The last three types are essential parts of explorative talk, and we conclude that our study has illustrated how an active role of curios can move the discussion forward in ways similar to explorative talk.

Keywords: Positioning, interactions, roles, explorative talk

Introduction

Our experience from the classroom indicates that many students participate to a small extent in discussions in mathematics. There are several reasons for this, ranging from some students taking a dominant position that makes other students passive to students lacking sufficient self-confidence in mathematics to dare to express themselves in the classroom. The background for this project was to explore whether we could change the classroom discourse by giving the students different roles and positions. To explore whether this could lead to a more exploratory talk in mathematics and if more students will be actively involved in the mathematical discussions. This included a shift in focus from searching for the correct answer in mathematics to discussion, argumentation, and in-depth explanations.

Both Mortimer and Scott (2003) and Mercer and Wegerif (2002) describe different types of classroom discourse. Mortimer and Scott (2003) suggest four communicative approaches, where one is preferable (the interactive-dialogic approach) as it gives room for several points of view and allows several persons to participate. In the same way do Mercer and Wegerif (2002) present three types of talk where one is preferred. In explorative talk, all partners actively participate, opinions are sought, and decisions are jointly made. This means that the interactive-dialogic approach and explorative talk both emphasize participation and openness to different ideas. Through positioning theory, we might explain and understand why not all classrooms look like this. We can even use positioning theory as a mean to change the classroom towards the ideals of Mortimer and Scott (2003) and Mercer and

Wegerif (2002). In this article, we report from a European project called Theatre in Mathematics (TIM), where we use positions, roles, and drama to create classroom discourses characterized by active participation, openness for ideas, and a clear focus on questions, challenges, explanations, and arguments. Our research question for this article is: How can assigned roles and positions, particularly the curious role, foster a more interactive and explorative talk in mathematics?

Theory

Mortimer and Scott (2003) suggest a model that describes teacher's communicative approach along two dimensions (table 1). The first is the authoritative-dialogic dimension, which refers to whether only one point of view (authoritative) or more than one point of view (dialogic) is paid attention to. The second dimension is the interactive-non-interactive dimension that separates between approaches that include or exclude people from participating.

Table 1: Communicative approach (Mortimer & Scott, 2003, p. 35)

	INTERACTIVE	NON-INTERACTIVE
DIALOGIC	A Interactiv/Dialogic	B Non-interactive/Dialogic
AUTHORITATIVE	C Interactive / Authoritative	D Non-interactive / Authoritative

The result is four different communicative approaches, where the interactive-dialogic approach, which opens for several points of view and includes participants, is preferred. Another one is the interactive-authoritative, where the teacher allows students to participate, but there is only one point of view. This has apparent similarities with the IRE pattern (Initiation-Response-Evaluation) (Cazden, 1988; Mehan,1979), as the students typically are allowed to answer questions and tasks but rarely allowed to introduce other points of view by initiating new ideas or evaluating.

While Mortimer and Scott (2003) present a model for a teacher's communicative approach, Mercer and Wegerif (2002) look at the dialogue per se and suggest three general types. The first is *the cumulative talk* in which each interaction builds on the prior one, in a positive and supportive way, but also uncritically. Repetitions, confirmations, and elaborations characterize cumulative talk, and only one idea is heard. The second is *the disputational talk* which is characterized by disagreement and individual decision making. Even though multiple ideas are heard, there is no genuine attempt to understand each other. Instead, it is characterized by assertions and challenges, and the participants are trying to win the discussion. The third is *the explorative talk*, where the participants engage critically but constructively, and multiple ideas are accepted and even wanted. It is also typical that suggestions are offered, justified, and challenged. It is characterized by making knowledge publicly accountable and making reasoning visible as part of the talk. While explorative talk is preferred by Mercer and Wegerif (2002), the characteristics of Mercer's categories are further explained and nuanced by Sjåstad (2018). A central argument that Sjåstad (2018) argues that all three types of talk have some positive sides. For example, the cumulative talk might be consensus-based or explanatory, and particularly the latter has potential for learning even though only one idea is discussed because

the idea through discussion is modified. Also, disputational talk may be argumentative or true disputational, and the first has potential for learning even though they do not try to agree because their ideas are substantiated (Mork, 2006, Sjåstad, 2018).

However, how do we identify the different types of communicative approaches or talk? One way to do so is to study the discourse on a turn-by-turn basis. Scholars have developed a wide range of concepts describing different types of interactions, and some have also developed frameworks. One such is the inquiry co-operation model by Alrö and Skovsmose (2004), suggesting eight types of interactions that both teachers and students use: *getting in contact, locating, identifying, advocating, thinking aloud, reformulating, challenging, and evaluating*. Another framework that separates teachers' and students' interactions is suggested by Drageset (2014, 2015), which describes four main types of student comments: *(mere) answers to mathematical questions, explanations, initiatives, and evaluations.* Such frameworks, and their concepts, are helpful when trying to characterize different types of communication in the classroom, based on a turn-by-turn analysis.

While it is well established that a turn is dependent on the prior turn (Linell, 1998), communication is more than responding to prior turns. For example, some students never talk even when invited in by the teacher, while others tend to dominate any discussion. This might be explained by using positioning theory. According to Harré and Van Langenhove (1999), people have preferences that guide their position in social settings and discourse. Also, taking a position could affect other positions, so positioning may not be taken freely but instead a negotiation. Such positions, and positioning of others, could be intentional sometimes and unintentional at other times. For example, if one student position herself as a helper for those who do not understand during group work, this is also a way to position someone else as needing help. Also, if one or two positions themselves as a solver of a task, this might exclude or passivate others.

Roles are a concept related to positions. Roles are a central part of any drama, and even though roles are used in many ways (Drageset, Allern, & Røsseland, 2021), two key factors separate roles in drama from positions. One is that roles include fiction, while positions do not. The other is that you are always aware of playing a role, while you are not always conscious of your positioning and how this affects your surroundings. At the same time, there are apparent similarities as it is possible to choose both a role and a position deliberately, and it is possible to change to another role or position deliberately. In the TIM project, we use limited roles (which we call role categories) to make students aware of possible positions they can take in the classroom and give them experience in taking them and changing between them. One such role category is the curious, a role where you ask questions until you understand, sometimes rather insistent. It is well known that asking questions may be a scary thing to do as one might be seen as dumb, but when you are given the role of curious, you are asking because it is your task. Another role is the skeptic that tries to find other solutions or challenge ideas. We also use the role of authority, where this is a democratic authority that requests arguments and explanations and several points of view before deciding. Furthermore, we use a mediator that tries to find common ground for a joint decision. Then we try to establish these roles as positions in the classroom by giving students roles and encourage them to use the given position in the discussion around the math problems.

To study the dialogue, we have built an analytical framework based on the above theory. The starting point was a limited search for concepts that could describe student interactions in a group-work setting (without teacher participation). Then we grouped the concepts in different ways and arrived at seven quite distinct types of student interactions (see table 2). The framework was also adjusted during the analysis.

Table 2: Analytical framework describing seven main types of student interactions

Code	Description	Developed from
Answers & claims	These are answers to questions and might be correct, partial, or wrong. No explanation or argument is given. Often part of a flow of questions and answers, which is typical for cumulative talk.	(mere) answers to mathematical questions (Drageset et al., 2021) Cumulative talk (Mercer & Wegerif, 2002)
Argumentation	Argumentation is focused on why something is correct or beneficial, or logical.	Advocating (Alrø & Skovsmose, 2004)
Challenges	Challenges break with the flow, present a new idea, or opposes a presented idea. This is an essential part of explorative talk if it leads to arguments or explanations but might also create a disputational talk if challenges are met with challenges and no arguments or explanations.	Challenging (Alrø & Skovsmose, 2004) Explorative talk and Disputational talk (Mercer & Wegerif, 2002)
Evaluation & clarification	Evaluating is an assessment of any of the other codes, typically related to correctness or logic. It might also be about clarifying, typically seen in reformulating.	Evaluation (Alrø & Skovsmose, 2004) Explorative talk (Mercer & Wegerif, 2002) Reformulating (Alrø & Skovsmose, 2004)
Explanation	Explanations are focused on what is done, or has to be done, to reach an answer, typically chronologically.	Explanations (Drageset et al., 2021)
Questions	Questions about what, how, and why. It is typical for an explorative talk that students take initiatives and ask questions.	Initiatives (Drageset et al., 2021) Explorative talk (Mercer & Wegerif, 2002)
Suggestions	Suggestions are an initiative to a way of solving a task, often related to thinking aloud. These typically will be followed by arguments or explanations.	Thinking aloud (Alrø & Skovsmose, 2004) Initiatives (Drageset et al., 2021)

Method

This article builds on data gathered as part of the Theatre in Mathematics (TIM) project financed by Erasmus+ and partners from Italy, Norway, Greece, and Portugal. The aim is to develop a

mathematical teaching methodology that involves students actively in their mathematics lessons by using drama techniques. The methodology builds on two approaches. One approach uses process drama, where the participants take on specific characters or roles in a story. This is a form of drama where there are no fixed lines, but the participants instead interpret how the role or character would act in the different situations of the story. The other approach is called Mathemart, where theatre workshop techniques that include mathematical games and performative activities are used to explore a particular mathematical topic. These activities aim at creating a trusting atmosphere where mistakes are not stigmatized but instead considered elements of a creative process.

The data reported in this paper comes from a lesson in a tenth-grade class with 25 students and their teacher. The students have used role categories since they were in grade 8. In this lesson, they were given a set with nine problem-solving tasks to complete in groups (five to six students) in 60 minutes. The tasks covered statistics, relations between metrics, physics and variables, geometry, equations, and functions. An example is how to make and analyze diagrams that show how many apprentices there are in different educational programs. Another is to find the relations between density and volume in a practical situation. The students had worked on the tasks on their own before the group session. Each group of students was given three different role categories to be used during the work with the tasks: authority, curious, mediatorial. One can see the curios as a role that cultivates what Mercer and Wegerif (2002) call explorative talk, while the mediator cultivates the cumulative talk. Arguably, an authoritarian role could be seen as cultivating disputational talk, but we seek to create a more democratic authority that listens to all before deciding, hence supporting both cumulative and explorative talk. The working process of each group was video-recorded, and a desk microphone captured their speech. For this paper, one group of six girls was chosen as a case study because two students were playing curios in a very active way.

The group discussions were transcribed, and the analysis was done using NVivo, where we first coded all student turns into the seven categories from table 2. Then we identified one group where two of the students were actively playing the role of curios and looked further into this. In the second step we coded the two girls' questions based on what they asked for (of the six other categories), to characterize how they used their role to include others in different ways. The analysis of turns was supported by observation of non-verbal communications seen in the video.

Findings

The group consisted of six girls, one being an authority, three being curios, and two mediators. First, we categorized all turns related to table 2 (See table 3).

Table 3: Amount of each type of turn for each girl, named by their role category

Categories	Sum	Girl 1 (curious)	Girl 2 (curious)	Girl 3 (curious)	Girl 4 (mediator)	Girl 5 (mediator)	Girl 6 (authoritarian)
Argumentation	3	1	0	0	0	2	0
Evaluation/clarification	76	28	9	3	10	19	7
Explanation	48	12	5	0	3	21	7
Suggestion	35	9	8	0	4	13	1
Question	88	55	18	3	1	4	7

Answer/claim	52	13	11	4	5	12	7
Challenge/initiative	32	15	2	0	0	6	9

The first analyzes showed that two of the three students who had a role as curious asked 90% of all the questions in the group. The girls in the role of curious were aware of their roles as questioners. One of them even asks at the beginning of the lesson: Should I ask questions, even though I know the answer? We decided to analyze in more detail the type of questions they asked. In the analysis below, we looked for the qualities of the questions in terms of the type of response they asked for. This means that we coded the questions of these two active curios based on what they asked for (using the categories of table 2). Figure 1 highlights the type of questions the two girls asked. The category challenge and initiative are not included because we only found one example of that kind.

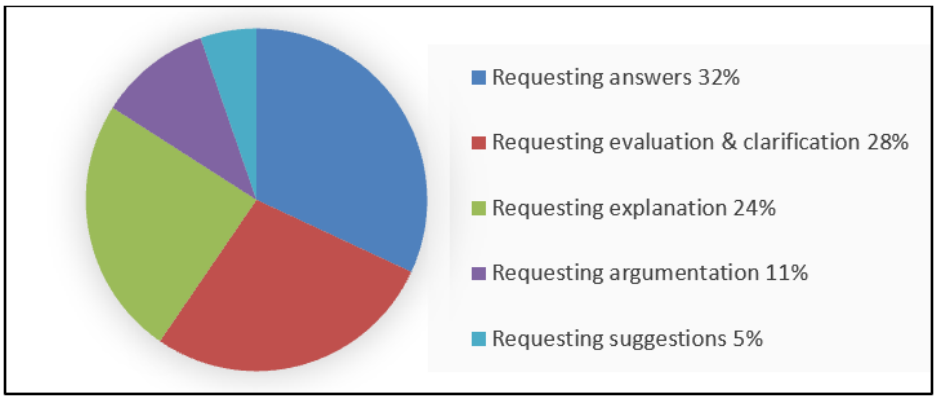

Figure 1: Type of questions in the percentage of all questions

There were four types of questions most frequently asked by these two curious girls. The first, *requesting answers and claims*, could be questions such as "how long was that (line between A and B)?", "are they all of equal length?" and "what is the formula?" Such questions are essential to create progress and get something on the table to discuss or work on. At the same time, they just request what Drageset et al. (2021) call (mere) answers without any explanation. When such questions and (mere) answers go on with confirmations and no elaboration, it is a typical cumulative pattern described by Mercer and Wegerif (2002).

The second, *requesting explanation*, could be questions such as "hmm, how do we find the average then?" and "how do we construct that (an angle of 120 degrees)?" These questions focus on revealing what was or could be done to reach an answer, often step by step. Such questions and explanations are typically about elaboration, and if these explanations are mostly accepted without further questions, they might be explanatory as part of a cumulative talk. On the other hand, when questions are further worked on or challenged, they might form a basis for Mercer and Wegerif's (2002) explorative talk.

The third, *requesting evaluation and clarification*, could be questions such as "What if there were no number in the middle, what if so? (talking about the median)". While these questions request an evaluation, they also typically request clarification of detail, or what Alrø and Skovsmose (2004) call reformulation, which is vital to move the process or understanding forward. Such questions form an essential part of an explorative talk (Mercer & Wegerif, 2002) since clarifications and evaluations form the basis for further developing each other's ideas.

The fourth, *requesting argumentation*, could be questions such as "Why did you do that?" and "Why is it so that we can add and divide?" These questions could be separated from explanations as they request a logical explanation or advocating (Alrø & Skovsmose, 2004) for a reason and not just a chronological explanation of the steps that lead to the answer. Such questions are an essential part of an exploratory talk, but when they are rhetorical with no genuine interest in the answers, they belong more to Mercer and Wegerif's (2002) disputational talk.

Overall, girls 1 and 2 moves the mathematical talk forward with their different types of questions. When one question is asked, suggestions and explanations are often followed up by additional questions, requiring elaboration and involvement from several students. Since both multiple students and multiple points of view were accepted, the conversation in the group is characterized by having an interactive-dialogic approach (Mortimer & Scott, 2003). One example of how girls 1 and 2 move the talk forward is this, where they support and elaborate on each other's questions:

Girl1:	Which education programs have more apprentices than the average for all education programs? What must be done then?
Girl2:	Then we must find the average
Girl1:	Of all of them?
Girl2:	Yes. How do you do that then? I have forgotten
Girl1:	Hmm, how do you find the average here then?
Girl6:	You add everyone, and then you divide by the number.
Girl1:	Lovely, and then once we have done that, then we find out which ones are over?
Girl2:	Yes, which one is more than average?
Girl1:	Why is it so that we can add and divide? Why is it like that?

The students' discussion can be seen as negotiations about understanding where meaning is constructed together. It is not necessarily the correct answer that gets the most attention, but rather the process that leads to the answer. The students build on each other's input, which is a characteristic of cumulative talk. At the same time, the conversation shows elements from an exploratory talk where statements are being challenged and required for further explanations. The situation above can also be characterized as a dialogical interaction (Mortimer & Scott, 2003). The students are open to each other's ideas, and they build on the suggestions that emerge. They do not respond by pointing out errors but ask for further argumentation and explanation when they do not understand.

Although not all the girls were equally active orally, for example, the third girl who had the role of curious, the video shows that even the students who did not contribute with many statements were involved. They responded with *yes*, *no*, and other statements of support such as *hmm*, and visual expressions such as nodding their heads. Our opinion is that questions, explanations, and clarifications given by some of the students in the group contributed so that all students became actively involved in the mathematical discussions, some with an active role as listening more than talking.

Discussion and conclusion

This article reports from a study of how assigned roles and positions, particularly the curious role, can foster a more interactive and explorative talk in mathematics. Our findings show that the discussion in the group we studied is characterized by both cumulative talk and explorative talk (as

defined by Mercer & Wegerif, 2002). Cumulative talk is most clearly seen when the curios request answers and claims and when they request explanations without using the explanation further. At the same time, almost two thirds of the questions request explanations, evaluations, and arguments. Such questions help to shift the focus from the search for mere answers to inviting peer students to focus on reason. These are signs of explorative talks, and these questions are so frequent that this group discussion is more explorative than cumulative. Further, the questions from girl 1 and 2 invites the other students to share their ideas, which means that the discussion is also characterized by dialogic and interactive communication, as defined by Mortimer and Scott (2003).

These findings illustrate how roles in mathematics, where we especially highlight the role as curious, can influence the mathematical talk towards a more interactive and explorative talk. This is done by requesting explanations, evaluations, and arguments, and in this way inviting other students into the discourse while simultaneously shifting the focus from finding mere answers towards reasoning.

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