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Interactional obligations within collaborative learning situations bringing forth deeper collective argumentation

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Following an interactionist approach to learning, social interaction is to be understood as constitutive of learning processes. Based on this idea, learning of mathematics can be described as the increasingly autonomous participation in processes of collective argumentation (Krummheuer & Brandt, 2001). This study aims at describing, on an empirical level, how children receive optimised conditions for learning opportunities when, within the interaction with other learners, the children are interactively “obligated” to participate in bringing forth warrants or backings within collective argumentations. Specifically for this research, children between the ages of 6 and 12 were filmed when learning collaboratively in multi-age groups. The three interactional obligations which have been reconstructed so far – a strong contradiction, a mistake and certain types of questions – are described in this paper with the help of exemplary interactional sequences.

Keywords: Collective argumentation, collaborative learning, heterogeneous grouping, interactional analysis.

Learning in pair and group work

Within mathematics education research, mathematics is increasingly seen as being mediated and constructed by language. Social interaction is thus to be understood as constitutive of learning processes as social-constructivist theories of learning, including interactionist approaches to learning, view individual processes of learning as being constituted in the social processes of the negotiation of meaning (e.g. Vygotski, 1978; Voigt, 1994). This also results in a greater demand within mathematics education to incorporate group and pair work into mathematics classrooms, instead of using predominantly whole class discussions and individual work, as such collaborative activities are seen as holding a unique potential for providing opportunities for students’ learning (e.g. Brandt & Höck, 2012; Jung & Schütte, 2018). From an interactionist perspective, learning can be seen as the development, expansion or modulation of framings which becomes visible in an increasingly autonomous participation in collective argumentation within classroom interaction (Krummheuer & Brandt, 2001; Jung & Schütte, 2018). As this research follows this interactionist perspective, two main concepts of this perspective on learning - ‘framing’ and ‘collective argumentation’ - will be explained in the following chapter, as well as the relevance of ‘interactional obligations’ for bringing forth collective argumentation. Then the guiding research question for this study “Which interactional obligations for bringing forth warrants or even backings for conclusions can be found within collective argumentations in group and pair work?” is derived from the underlying theory and preliminary results are described.

Central concepts of the interactionist theory of learning

The interactionist theory of learning is based on the theory of Symbolic Interactionism which views meaning not as something inherent to an object but rather something that develops in the interaction

between people about the object and is therefore a social product (Blumer, 1975). Different participants of an interaction have their own interpretations of a situation on the basis of their individual experiences and knowledge – called definitions of the situation (Krummheuer, 1992). While the participants negotiate these different definitions of the situation within collective argumentations, ideally these definitions will become more aligned with each other and a working consensus (Goffmann, 1959) is brought forth enabling the participants to further work together. The working consensus has the potential to stimulate cognitive restructuring processes in the individual as it possibly goes beyond their previous experiences.

Framing

Especially, when the working consensus is brought forth repeatedly in the interaction, the participants' individual definitions of situations can become standardised and routinised and can therefore later be recalled in similar situations. Bauersfeld et al. (1988) call these individual definitions which outlast the situation *framings*. The process of developing, expanding or modulating individual mathematical framings is when learning takes place. Schütte and Krummheuer (2017) further differentiate between development of framings related to mathematical terms and procedures, which equals the acquisition of mathematical content, and the development of framings related to methods for reasoning and explaining, which they describe as the development of mathematical thinking. However, it often happens that the framings are not in alignment with each other (Krummheuer, 1992). In order to continue the process of negotiating meaning, the *differences in framing* between the participants need to be coordinated. While these differences in framing can make it more difficult for the participating individuals to adjust their definitions of the situations to fit each other, they also provide the “‘motor’ of learning” (Schütte, 2014) since, on the interactional level, they generate a necessity for negotiation. This is why, hereafter the focus will be on students participating in collective negotiations of meaning or argumentation, as this seems to hold the potential for learning to take place.

Collective argumentation

Krummheuer takes the idea of *collective argumentation* from a sociological learning theory by Miller (1986), who sees participating in collective argumentation as essential for fundamental learning – meaning learning something ‘new’ – for young learners. Contrary to Miller, for whom a collective argumentation is a communicative type of action which serves to solve a socio-cognitive conflict by bringing forth different arguments collectively and negotiating them, this study agrees with Krummheuer (1995) for whom there is no need for an explicit socio-cognitive conflict. He involves an ethnomethodological perspective which leads him to the conclusion that participants always indicate the rationality of their behaviour in the interaction (see also Jung & Schütte, 2018). Out of this concept Krummheuer and Brandt (2001) develop an interactional theory of learning where participating in collective argumentation within classroom interaction becomes both an opportunity for learning and the increase in autonomous participation an indicator that something has been learned. If collective argumentation is so central to the learning process, the question arises, when are collective argumentations brought forth? In whole class discussion, the teacher is predominantly the one fostering arguments to be brought forth, e.g. by asking for clarification or reasoning, or by giving counterexamples to claims (O'Connor, 2001; Schwarzkopf 2001). But often times only few students

have the opportunity to actively engage in these interactions. On the other hand, in group and pair work more students have the opportunity to engage more actively within the interaction and therefore possibly within an emerging collective argumentation. So the question arises: When do students bring forth collective argumentations?

Interactional Obligations

According to Voigt (1994), participants within an interaction do not act independently of other participants' utterances and actions. Rather, individual utterances and actions create *interactional obligations* connecting them with each other. Because of these obligations, individual participants develop expectations of how others will react to an utterance or action. However, these expectations typically remain implicit unless conflict arises between the participants. Therefore, whether or not a person interprets an utterance or action as creating an interactional obligations for him- or herself to respond to and in what way he or she should respond, is very much based on his or her framings. Thus one can only reconstruct an interactional obligation by the response of the other participants and by how the interaction unfolds. For Schwarzkopf (2001), interactional obligations are crucial for initiating argumentations. However, like Voigt he only analyses the obligations between teacher and students and not between students within collaborative learning situations. So the question arises whether there are interactional obligations for collective argumentations in students' interaction during group and pair work? This is the guiding research question for this paper.

Interactionist approach for analysing interactional obligations

Methodologically, this study is located within interactionist approaches of mathematics educational classroom research (e.g. Krummheuer & Brandt, 2001). Videos were taken in several multi-age classrooms with students learning together in different combinations of grade levels one through six (ages 6 to 12) depending on the school. Only schools which incorporated multi-age education in their school's pedagogic concept were chosen, however how multi-age learning is part of their everyday mathematics lessons is very diverse. In general, multi-age learning groups were chosen, as the overall goal of the study is to show how students with great diversity in their learning preconditions work together in collaborative settings. Furthermore, in multi-age learning groups it seems more likely that collective argumentations are brought forth because of the possibly more diverse framings the students may contribute than in single-age learning groups.

Only interactions of pupils from different grade levels working together in group or pair work on the same mathematical task are then transcribed and analysed using the interactional analysis first developed by Bauersfeld et al. (1988). The core of this analysis is a sequential analysis of the individual utterances combined with a turn-by-turn analysis in order to find possible interpretations of utterances taking into account the sequential organization of the conversation. The interactional analysis allows research to reconstruct the ways in which negotiations of mathematical meaning are interactively constituted by individuals. Furthermore, it can help to reconstruct patterns and structures of verbal actions of the teacher and the students (see also Schütte, Friesen & Jung, 2019) – as e.g. interactional obligations. Subsequently, the analysis of argumentation was used which is based on Toulmin (1969) and identifies which utterances or actions contribute to which of the four functional categories of an argumentation: data (undoubted statements), conclusion (inference together with the

data), warrant (contribution to the legitimation of the inference) or backing (undoubtable basic convictions which refer to the permissibility of the warrant).

According to Krummheuer and Brandt (2001), one of the aspects which increases the possibility of mathematical learning is seen when processes of argumentation with a complete ‘core’ of an argumentation - meaning data, conclusion and warrant - are produced and not only the data and/or the conclusion which is often the case. The research question therefore more specifically is “Which interactional obligations for bringing forth warrants or even backings for conclusions can be found within collective argumentations in group and pair work?” In the next chapter, interactional obligations which have been identified so far will be presented each by describing it and by giving an exemplary interactional sequence.⁴ For each presented transcript, the grade levels of the children participating in the interaction will be given.

Preliminary results

Interactional obligation nb. 1: a strong contradiction

A reoccurring interactional obligation seems to be a strong contradiction to a previous utterance or action especially when the working consensus emerges among the students that they have to agree on the solutions before continuing their work. An example can be seen in the following transcript between Isabella (grade 1), Hans (grade 2) and Elias (grade 3) working on a combination problem about creating Christmas ornaments using the colours blue, green and red and either stripes or dots in those same colours as the pattern. They are allowed to use only two colours for one ornament and have paper circles, dots and stripes in the different colours as a support.

180	Elias	and now we will do it the other way around [<i>puts a red circle on the table</i>]
181		< [<i>takes a blue dot and puts it on the red circle</i>]
182	Isabella	< I wouldn't do that
183	Hans	with two dots\ [<i>hands Elias another blue dot</i>]
184	Elias	no with one\ [<i>has his finger on the one blue dot</i>]
185	Hans	< nooo
186	Elias	< because because we only have so little of blue left and we still have some
187		<i>more left here right/ [points to the remaining blue dots and then points to the</i>
188		<i>other circles which are left] there we maybe still want to (also) #</i>
189	Hans	#oh come on\ look we still have so many of the other colours left\ . [<i>first</i>
190		<i>points to the green dots and then puts a second blue dot on the red circle]</i>

Table 3: Transcript Elias, Hans & Isabella

What can be seen is that even though Isabella contradicts Elias' suggestion (182), he does not respond to her. He does not seem to feel obligated to give a reason for his action by her “simple” contradiction. In the same way, when Elias in (184) contradicts Hans' suggestion to add two dots in (183), Hans only contradicts Elias stronger by emphasizing the “no” (185) but also at first without giving a reason. However, Elias starts giving a reason in (186-188) – here the warrant that they should only use one dot because otherwise they do not have enough dots left for the other circles – defending his own suggestion. This happens at the same time as Hans emphasizes his contradiction. One could argue that Elias feels obligated to explain his action either because two different children have contradicted

⁴ Transcripts are translated by the authors from German.

his solution (Isabella in 182 and Hans in 183) or because Hans contradicted Elias more strongly by emphasising the “no” in (185). Because Elias gives a warrant for his conclusion (186-188), his contradiction of Hans’ suggestion is now stronger than in (184), and this seems to in return put Hans under obligation to now give a warrant for his conclusion as well, which he does in (190, 191).

So this analysis suggests that simply contradicting a fellow student does not put them under obligation to further explain their action or conclusion. Yet, when the contradiction is strong it does, which seems to be either when a “no” is emphasised by saying it louder, longer or repeating it, or when a second contradiction of another child is added, or else when a warrant is added to a contradiction.

Interactional obligation nb. 2: a mistake

Another utterance or action which seems to be an interactional obligation to give a warrant or backing for an argument is when a person interprets this utterance or action as being a mistake. This holds true both for own mistakes and mistakes of others. However, as mentioned above, since it is all about one’s definition of the situation within the interaction, it is irrelevant whether it is an actual mistake or not. An example is when Kim (grade 1), Erich (grade 2) and Hannes (grade 3) are working on the same task as the three kids above:

58	Erich	< [takes two red dots and puts them on the blue circle in front of Kim]
59	Hannes	< and green strokes/ [touches the green stripes]
60	Erich	yes/ I have an idea\ so > here there there a green stroke has to go and there
61		also (unintelligible) stroke has to go\ so that
62	Hannes	> [holds a green stripe towards the blue circle with the red dots]
63	Kim	> we could also do (this)
64	Hannes	no/ there is another red dot missing put the stroke there . < no I will do the stroke/
65	Erich	< [takes another red dot and holds it next to the blue circle]
66	Kim	wait
67	Hannes	[puts a green stripe underneath the two red dots on a blue circle]
68	Kim	yes like that
69	Erich	smiley\ with nose\ [puts red dot on the blue circle]
70	Hannes	no/ we are only allowed to use two coolloouurs/ . shoot . green gone [takes
71		green stripes off the circle] . so

Table 2: Transcript Hannes, Erich and Kim

The three kids have been collaboratively working on this solution, all contributing at different times. Hannes is the one who suggests to add green stripes as well on the blue circle that already had red dots in (59) and in (67) places them there himself. As long as the children agree with each other’s suggestions, no one feels obligated to go into further details and give reasons for their actions or suggestions. However, in (70, 71) he clearly interprets his own (or their joint) solution of a blue circle with red dots and green stripes as being a wrong solution – and therefore as having done a mistake – which seems to make him feel obligated to give a warrant for his conclusion of taking off the green stripes again (70, 71). His warrant here is that only two colours are allowed to be used and so the third colour has to be taken off.

Interactional obligation nb. 3: certain types of questions

The third interactional obligation is more difficult to clearly define as it seems to not be the question which obligates students to argue more deeply but what is expressed implicitly through the question.

One possible type of questions seems to be when the question is the suggestion of a conclusion but phrased as a question suggesting uncertainty. An example can be seen in the following transcript of Isabella (grade 1) and Henriette (grade 3) trying to find as many pentominoes⁵ as possible by using five small paper squares and a worksheet (WS) in chequer pattern.

222	Isabella	[<i>moves one square of the pentomino lying on the table</i>] . voila/
223	Henriette	we had thiiis/ (unintelligible) [<i>looks at the WS and turns it 90°</i>]
224	Isabella	mhm
225	Henriette	well here < [<i>turns the WS further around</i>]
226	Isabella	< or is it this/ . this this this this this [<i>points to the blue pentomino on the WS</i>]
227	Henriette	this [<i>points to the blue pentomino on the WS</i>] because > el [<i>moves her finger</i>
228		<i>along the pentomino from the top down two squares and then one to the right</i>]
229	Isabella	> no\ no no no#
230	Henriette	yes\ el el [<i>moves her finger like the letter 'L' twice along the pentomino on</i>
231		<i>the table made of little paper squares</i>] el el [<i>then moves her finger like the</i>
232		<i>letter 'L' twice on the blue pentomino on the WS</i>]

Table 3: Transcript Henriette and Isabella

In (226), Isabella asks “is it this?” and point to the worksheet which seems to be on the one hand suggesting the conclusion that the pentomino she created with squares is the same as one on the work sheet they have already created earlier, and at the same time expressing uncertainty through formulating it as a question. Henriette then starts giving an explanation with a warrant and even a backing of why the pentomino they created on the table is the same one as the light blue one on their worksheet. She could feel obligated to give this deeper argument because of Isabella’s question suggested uncertainty or because she interprets Isabella’s suggestion as a mistake, making (226) an interactional ‘obligation’ in the category of a mistake. In the utterances and actions (229-232), one can also see another example of the interactional obligation number one “a strong contradiction” by Isabella which then obligates Henriette to further deepen her argument.

Another type of question acting as interactional obligation can be seen in the following interaction between Lia (grade 2) and Lara (grade 1) while comparing pentominoes they have found with two 3rd graders. Here the question seems to explicitly request an explanation or justification of a contradiction. Lia makes a suggestion which Lara seems to interpret as a mistake but does not follow the interactional ‘obligation’ to give a warrant for her conclusion when contradicting Lia. By specifically asking Lara to justify her contradiction, it becomes visible that Lia seems to interpret the situation in a way that she thinks Lara should give a warrant for her conclusion. She therefore makes the interactional ‘obligation’ more explicit for Lara to respond, or only now Lara interprets the situation in a way where she feels obligated to give a warrant which she does in.

Conclusion

So far three interactional obligations have been identified after which students seem to feel obligated to give a warrant or backing for an argument: a strong contradiction, a mistake and certain types of questions. Therefore, within the interaction these obligations open up opportunities for students to participate more autonomously within the collective argumentation and bring forth a complete ‘core’

⁵ A shape consisting of five squares joined together at their sides.

of an argument. As a result, this gives all students participating in the interaction optimised condition for learning as they can possibly either expand their framings by comparing their own definitions of the situation with their interpretations of the arguments brought forth in the interaction and therefore develop new or expand existing framings, or modulate their framings by bringing forth arguments because of interactional obligations in the interaction and therefore change their own framings related to methods for reasoning and explaining (see also Friesen, 2019; Jung & Schütte, 2018).

In the future, these findings will be compared to other interactions in order to describe these obligations in more detail and possibly describe further obligations as well. As all the analysed interactions in this study are from heterogenous groupings in collaborative settings, analysing interactions in other types of group and pair work, could reveal different interactional obligations. However, the results of this study can still help mathematics educators understand more deeply which interactional patterns can be found within group and pair work and how learning takes place within collaborative situations. Furthermore, it can help teachers when listening to students giving arguments to understand the interactional patterns at work in the students' interaction, and possibly help the teacher foster collective argumentations within pair and group work by "sensitising" students to these interactional obligations or even "modelling" them in whole class discussions.

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