



HAL
open science

Mathematical agency and its connection to students' multilingual resources

Alexander Schüler-Meyer

► **To cite this version:**

Alexander Schüler-Meyer. Mathematical agency and its connection to students' multilingual resources. Proceedings of the IV ERME Topic Conference 'Classroom-based research on mathematics and language' (pp. 124-130), Mar 2018, Dresde, Germany. hal-01856536

HAL Id: hal-01856536

<https://hal.science/hal-01856536>

Submitted on 20 Aug 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Mathematical agency and its connection to students' multilingual resources

Alexander Schüler-Meyer

TU Dortmund University, Dortmund, Germany; alexander.schueler-meyer@math.tu-dortmund.de

By exercising agency, multilingual students are said to be able to direct the classroom discourse in ways that are conducive to their learning needs. It has been proposed that this is connected to the use of multilingual resources. In this study, a bilingual Turkish-German teaching intervention is investigated in regard to the question, whether exercising agency is connected to a specific use of Turkish or German or mixed. It employs positioning theory, assuming that exercising agency requires students to take positions from where they can articulate their problems/their learning needs. 176 instances of agency were identified in sessions two and four in 4 groups of the intervention (~720 minutes of video). Comparing the use of language in these instances with the distribution of languages in the intervention, there is no indication that exercising agency is specifically connected to the use of Turkish or mixed. Implications of this result are discussed.

Keywords: Student learning, mathematical agency, multilingual resources, positioning.

Introduction

The following conversation happens in a multilingual teaching intervention on fractions, where the students Rükiye, Atiye and Mediha try to determine $\frac{2}{9}$ of 36 with the help of a fraction bar.

73	Rükiye:	Off, ich versteh das nicht.	Off, I don't understand that.
74	Atiye:	Burda nasıl yazmış? Da kommt nicht 36 hin.	[Looks at her worksheet] How is it written here? 36 it doesn't belong there.
75	Rükiye:	Was dann?	What else, then? [cancels out 36 in this column]
76	Mediha:	Dann tue eins weg. Nein!	Then take away one. No!
77	Atiye:	Nein! Du nimmst zwei Felder weg.	No, you take away two parts [from 9 parts in the fraction bar].
78	Mediha:	Dann sind das. 36. Ozaman vier.	Then this is 36. Then four.

In this episode, there is no teacher to help in the learning situation, so that the students evaluate their work themselves and help each other. For that, the students change the direction of the discourse towards their learning needs. They change it towards a meta-level conversation about filling out a worksheet, and through this, explain the strategy of how to solve the task. It has been proposed that multilingual students can use their multilingual resources to overcome resistances by exercising agency (Langer-Osuna, Moschkovich, Norén, Powell & Vázquez, 2016). This episode is an example of such agency.

In this paper, the study reported is guided by the following research question: *Is there a connection between the use of multilingual resources and exercising agency?* Here, agency is understood as overcoming difficulties in understanding during collaborative work.

Multilingual students' agency in the mathematics classroom

Agency captures humans' capacity to act upon their world –“to reiterate and remake their world”– and not only to give significance to it (Holland, Lachicotte, Skinner & Cain, 1998, p. 42). It has

been acknowledged as important for language learning, as language and multilinguality are means for acting upon the social world and for making meaning in it (Vitanova, Miller, Gao & Deters, 2015). In school learning, the construct of agency emphasizes that students are not objects in an unchangeable teaching-learning situation which is imposed on them. Instead, students can (co-)direct classroom conversations and enable themselves to participate, which can foster learning (Boaler, 2003).

Mathematical agency is here conceptualized as a discursive phenomenon, located at the intersection of everyday and mathematical discourses. At this intersection, students can engage in “dances of agency” to overcome problems of understanding (Pickering, 1995): students interweave their own ideas (conceptual agency) with outcomes of “standard routines and procedures” (disciplinary agency), thereby bridging the everyday discourse with mathematical discourses to better understand something (Boaler, 2003). Hence, the “dance” enables students to actively work on their difficulties of understanding and not surrender to them. Hence, mathematical agency is here conceptualized as the capacity of students to direct classroom conversations towards their learning needs, e.g., overcoming difficulties of understanding.

Multilingual students’ resources in mathematics learning

Multilinguality can be a resource for mathematics learning. Most prominently, Planas (2014) illustrated three ways in which multilingual resources can be conducive to generating learning opportunities in mathematics. She identifies the negotiation of mathematical words among peers, the invention of words, and translations to overcome difficulties with words as instances of students being able to activate their multilingual resources. All of these three examples are also instances of students exercising agency. In these examples, the students overcome difficulties in understanding by acting in meaningful ways with mathematical language in the given situation.

With this perspective, agency sensitizes for how multilingual students might draw upon their home language “to support communication in the language of instruction” (Langer-Osuna et al., 2016, p. 164). Langer-Osuna et al. (2016, p. 166-171) identify three vignettes for multilinguals’ agency, which illustrate how students position themselves in order to avoid difficulties with language or articulate their difficulties. Similarly, Norén (2015) shows how students change the direction of a conversation towards the negotiation of unclear word meanings.

These studies show how the construct of agency helps to overcome the traditional “monolingual bias” where multilingual students are assumed to be recipients of the dominant language, and allow for conceptualizing language learning as an active process. Agency materializes in the students’ attempts to direct the ongoing conversation towards their learning needs, either mathematical or language-related. Exercising agency requires students to take positions in conversations from where they can articulate their problems and from where they can engage others in working on these problems.

Positioning theory and agency

As argued above, exercising agency in the mathematics classroom is connected to taking certain positions in the ongoing conversation. Positioning theory allows to grasp such positions (Wagner & Herbel-Eisenmann, 2009). Attempts to direct the ongoing conversation towards language- or mathematics-related learning needs materialize in how the multilingual students deliberately position themselves in the classroom. For example, students can deliberately position themselves as not understanding a certain word, or as in need of help, and this way might direct the conversation towards clarifying the language/mathematics at hand (cf. van Langenhove & Harré, 1999, p. 24). In deliberate self-positionings, students take initiative for their positioning, so that it is strongly connected to exercising agency. In contrast, in forced self-positionings, the initiative for a position lies with someone else, for example the teacher or other students. The teacher

strongly influences how students exercise agency to overcome difficulties, as he or she can, as a representative of the institution school, force students to position themselves (van Langenhove & Harré 1999, p. 26). As illustrated above, studies on agency strongly suggest that the teacher has to give room for agency (e.g., Norén, 2015).

Hypothesis

In this study, multilingual students participate in a bilingual Turkish-German teaching intervention. Thus, the activation of multilingual resources will be connected to the use of Turkish. It can be hypothesized that: When multilingual students try to overcome resistances in understanding language or mathematics in collaborative settings –when they exercise agency–, they will use their Turkish language, resulting in a higher use of Turkish or of Turkish-German mixed in situations of agency.

Background and methodological considerations

In this study, a bilingual Turkish-German teaching intervention for fostering 7th graders conceptual understanding of fractions is investigated. The intervention consisted of 5 lessons á 90 minutes. 41 multilingual Turkish-German speaking students participated in 11 groups with 3-5 students each. Typically, small groups of 2-3 students were video-taped in the 11 groups. In their regular classrooms, these students are predominantly educated monolingually in German.

The intervention was implemented by trained teacher students. The bilingual intervention followed the relating registers approach, which poses that languages and registers need to be continually interlinked (Prediger, Clarkson & Bose, 2016). Following this approach, Turkish and German were not treated as separate languages, but as a unified resource. The teaching intervention implemented several principles for activating multilingual resources, among them the implementation of tasks which connect to the students' everyday experiences and of activities of reflecting on differences in how languages conceptualize fractions.

Distribution of Turkish and German in the teaching intervention

To give background for this study, the use of Turkish in the teaching intervention in general is relevant. The students' use of Turkish and German and their participation were investigated in a previous study. The sample of that study consisted of N=35 students who participated in the third teaching intervention session. The 16 x 90 min. of video material from this third session was analyzed with the software TRANSANA in regard to each participants' turn-based contributions (S1-S5 and T). All utterances were measured for their length (in seconds), so that each participant's speaking time could be determined (as the sum of the lengths of the utterances). Furthermore, each utterance was analyzed in regard to the language used. The results of this analysis are outlined in Table 1. As can be seen, the students in the intervention could be encouraged to speak Turkish or mixed languages, when the teacher invests in the use of Turkish (with 28% of language production time in Turkish and 39% in mixed utterances) (Schüler-Meyer, Prediger, Kuzu, Wessel & Redder, 2017).

Table 1. Distribution of German and Turkish (averages) (Schüler-Meyer et al., 2017)

	Share of German utterances	Share of Turkish utterances	Share of mixed utterances	Total time of language production
Teacher language productions	32%	28%	39%	99% (1% unidentified)
Student language productions	66%	16%	15%	97% (3% unidentified)

Selection of data and method

The data in this study are taken from the second and fourth session of the teaching intervention. These data are chosen because, first, it accounts for learning processes in the beginning of the teaching intervention, where students might not be familiar with using Turkish (Session 2), and the end of the intervention, where students likely have become familiar with using Turkish (Session 4). Second, these data accounts for different activities, where Session 2 is more exploratory in nature and incorporates everyday contexts, while Session 4 is about the guided reinvention of the procedure for determining x/y of a , where a is bigger 1. Session 2 is dominated by small group work (2-3 students), while Session 4 consisted mainly of large group work (all students in the group). To account for different teaching stiles, groups from three of the four teacher students are chosen. In sum, four groups are investigated; they were chosen for their rich discussions and interactions. One of these groups was videotaped with two cameras, so that for Session 2, there is data of five small groups working on the tasks. In sum, around 720 minutes of video were transcribed and categorized.

The data are analyzed with quantitative content analysis (Mayring, 2010) with categories of deliberate self-positioning. Only utterances were coded which occur when students collaboratively work on their difficulties with the mathematics or mathematical language. Collaborative means that at least two students interact, without the teacher's guidance. The analysis was conducted in three steps:

1. Situations where students exercise agency are identified by linguistic markers that indicate self-positioning (I, me, myself, my), as these markers allow for a relatively good approximation of students positioning themselves as individuals ("lexical bundles", in Herbel-Eisenmann, Wagner & Cortes, 2008). Agency might also be exercised collectively, but are not investigated in this study.
2. From these identified situations, only those are investigated further in which the students try to collaboratively overcome difficulties of understanding. These are categorized in regard to the language that the agentic student uses to exercise agency (Turkish, German, or mixed) and in regard to the nature of agency. The latter categories were generated from the material.
3. Relations between language use and nature of agency are quantified with the Software MAXQda.

Results

In the here analyzed four groups and over the course of Session 2 and 4 of the bilingual teaching intervention (720 minutes) there are 174 self-positionings by which students attempt to direct the discourse towards their learning needs (Table 2, right column). Overall, this illustrates that students exercise agency relatively infrequent.

Table 2. Number of times agency is exercised in Sessions 2 and 4, differentiated to their category

	Self-positioning for upholding participation	Self-positioning to signal learning difficulties / successes	Self-positioning of frustration / resignation	Self-positioning to engage in negotiation of ideas	Sums
Session 2	3	42	10	12	67
Session 4	9	38	10	50	107
Sums	12	80	20	65	174

107 self-positionings occur in Session 4, and 67 in Session 2 (Right column in Table 2). As both sessions equal in the length of the analyzed videos, there is a slight imbalance in the number of instances where students exercise agency between Sessions 2 and 4. If analyzed per group, this imbalance can be found in three of the four analyzed groups (Table 3). It is unlikely that this imbalance is a result of the different variants of group work, where Session 2 was intended to be based on a lot of small group work, and Session 4 on large group work. Hypothetically, large-group work might have more opportunities for students to interact with each other, and thus, there could be more self-positionings. However, as groups H and I work consistently in small groups in both Session 2 and 4, there should have been an equal distribution of the number of self-positionings in these groups, but this is not the case (despite the smaller number of tasks, Table 3). Hence, the variant of group work likely does not explain the imbalance. Instead, this imbalance might be a result of the different tasks: The tasks in Session 2 are rooted in everyday contexts, while the task in Session 4 requires students to reorganize their previous knowledge about fractions, for which there are no everyday contexts. Hence, the tasks in Session 4 require students to reactivate previous contexts to engage in a dance of agency. This might lead to more difficulties to understand. As a result, the students might more often self-position themselves in order to direct the conversation towards their learning needs.

Table 3. Number of times agency exercised in Sessions 2 and 4 per group

	Group H*	Group I**	Group B	Group D		
Session 2	7 (Hale, Sevin)	3 (Sevda, Oguz)	21 (Emrah, Deniz)	25 (Ilknur, Akasya)	11 (Halim, Hakan)	67
Session 4	29 (Hale, Sevin)	16 (Sevda, Oguz)	17 (Emrah, Deniz, Yusuf, Ceylan)	45 (Ilknur, Akasya, Halim, Hakan)		107
Sums	36	19	38	81		174

* Tasks 5, 6, 7, 9 not analyzed; ** Tasks 6, 7, 9 not analyzed

Table 3 shows that some students seem to exercise agency more often than others. For example, the students Akasya and Ilknur (Group D) exercise agency roughly twice the time than the students in the other groups, and even Halim and Hakan in the same group. This imbalance is likely not a result of the teaching style of the teacher student, as Groups B and D were led by the same teacher student. Accordingly, exercising agency might be connected to the personalities and individual features of the students.

The overall sums for the different categories of self-positionings (Table 2) suggest that the imbalance in agency can be traced back to self-positionings by which students engage in the negotiation of ideas. This might be explained by the affordances of the task, which requires students to interweave ideas about fractions, as developed in the previous sessions, with standard mathematical routines of calculating $a \cdot x/y$ with $a > 1$, in other words, where students need to engage in a dance of agency.

Table 4. Students' use of languages while exercising agency

	Turkish	German	Mixed	Sums
Language of utterance in which agency is initiated (sums)	23	120	31	174
Percentages	13,22%	68,97%	17,82%	100%

It was hypothesized that students more often use their Turkish language to exercise agency than German. Table 4 illustrates that this is not the case. When compared with the general language use as illustrated in Table 1, it can be seen that the students use of Turkish, German and mixed language while exercising agency equals the distribution of language use in Session 3. Thus, the initial hypothesis can be falsified.

Discussion

In this study, there is no indication that multilingual students' exercising of agency is specifically connected to the use of Turkish or mixed German-Turkish language. This is an unexpected result, as it has been suggested that multilinguality is especially relevant in situation where students try to understand something (Norén, 2015; Langer-Osuna et al., 2016). There are several reasons why this might be the case.

In the present study with its specific conditions of a bilingual teaching intervention there is no indication that overcoming difficulties with understanding is especially connected to the activation of Turkish. Norén (2015) explicitly suggest that a potential for agency is connected to reform- and language-oriented classrooms where there is room for "creative changes within the mathematical discourse" (p. 181) and where power structures of dominant languages can be broken up as a result. As the here presented teaching intervention was relatively teacher centered and strict in the number of tasks that have to be worked on, there might not have been room for such creative changes. Thus, tightly clocked tasks which are typical for teaching interventions might compete with time for conversations about the meanings of language that stems from individually articulated needs for understanding certain language. As a result, the teacher might not give much room for exercising agency. This calls for studies that investigate the conditions which facilitate students to exercise agency.

The teaching intervention in this study is language oriented, but it does not break up the traditional role of the teacher as facilitator of learning. Accordingly, the students might rely on practices by which they ask for help or assistance that stem from the regular mathematics classroom, e.g., delegating difficulties of understanding to the teacher or of dropping out of the classroom conversation. This would explain why the distribution of languages while exercising agency is the same as the general distribution of languages, as agency is exercised like in the regular classroom, only now in multiple languages. There is a need for a comparative analysis of monolingual and multilingual learning processes to investigate language-related differences in students' agency.

From a theoretical standpoint, the here presented construct of agency attempts a synthesis of proven constructs of agency, as for example put forth by Norén (2015), Boaler (2003) or Langer-Osuna et al. (2016). In these studies, on the one hand the conceptual function of agency is emphasized (Boaler, 2003 and others), while on the other hand its function for overcoming power structures resulting from dominant languages is emphasized (Norén, 2015; Langer-Osuna et al., 2016). Here, a combination of both is put forth, where agency is exercised for overcoming difficulties of understanding. These different notions call for a better operationalized model of agency that integrates these notions.

Acknowledgments

The project "MuM-Multi: Fostering Language in multilingual mathematics classrooms – effects and conditions of a content- and language integrated intervention" is funded by the German Ministry BMBF (grant 01JM1403A, grant holders S. Prediger, J. Rehbein & A. Redder). This paper has grown in the interdisciplinary cooperation with Susanne Prediger, Taha Kuzu, Jochen Rehbein, Jonas Wagner, and Meryem Çelikkol.

References

- Boaler, J. (2003). Studying and capturing the complexity of practice. The case of the “dance of agency”. In N. Pateman, B. J. Dougherty, & J. T. Zilliox (Eds.), *Proceedings of the 27th PME Conference and the 25th Conference of PME-NA* (Vol. 1, pp. 3-16), Honolulu, Hawaii: PME.
- Herbel-Eisenmann, B., Wagner, D., & Cortes, V. (2008). Encoding authority: Pervasive lexical bundles in mathematics classrooms. In O. Figueras, J. L. Cortina, S. Alatorre, T. Rojano, & A. Sepúlveda (Eds.), *Proceedings of the Joint Meeting of PME 32 and PME-NA XXX* (Vol. 3, pp. 153-160). Morelia, México: Universidad Michoacana de San Nicolás de Hidalgo.
- Holland, D., Lachicotte, W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.
- van Langenhove, L. & Harré (1999). Introducing positioning theory. In R. Harré & L. van Langenhove (Eds.), *Positioning theory. Moral contexts of intentional actions* (pp. 14-31). Oxford, UK: Blackwell.
- Langer-Osuna, J. M., Moschkovich, J., Norén, E., Powell, A. B., & Vázquez, S. (2016). Student agency and counter-narratives in diverse multilingual mathematics classrooms: Challenging deficit perspectives. In R. Barwell et al. (Eds.), *Mathematics education and language diversity. The 21st ICMI Study* (pp. 163-173). Cham, Switzerland: Springer.
- Mayring, P. (2010). *Qualitative Inhaltsanalyse. Grundlagen und Techniken*. Weinheim, Germany: Beltz.
- Norén, E. (2015). Agency and positioning in a multilingual mathematics classroom. *Educational Studies in Mathematics*, 89, 167-184.
- Pickering, A. (1995). *The mangle of practice: Time, agency, and science*. Chicago, IL: University of Chicago Press.
- Planas, N. (2014). One speaker, two languages: Learning opportunities in the mathematics classroom. *Educational Studies in Mathematics*, 87, 51-66.
- Prediger, S., Clarkson, P., & Bose, A. (2016). Purposefully relating multilingual registers: Building theory and teaching strategies for bilingual learners based on an integration of three traditions. In R. Barwell et al. (Eds.), *Mathematics education and language diversity. The 21st ICMI Study* (pp. 193-215). Cham, Switzerland: Springer.
- Schüler-Meyer, A., Prediger, S., Kuzu, T., Wessel, L., & Redder, A. (2017, online first). Is formal language proficiency in the home language required to profit from a bilingual teaching intervention in mathematics? A mixed methods study on fostering multilingual students' conceptual understanding. *International Journal for Science and Mathematics Education*.
- Vitanova, G., Miller, E. R., Gao, X., & Deters, P. (2015). Introduction to theorizing and analyzing agency in second language learning. In G. Vitanova et al. (Eds.), *Theorizing and analyzing agency in second language learning. Interdisciplinary approaches* (pp. 1-13). Bristol, UK: Multilingual Matters.
- Wagner, D., & Herbel-Eisenmann, B. (2009). Re-mythologizing mathematics through attention to classroom positioning. *Educational Studies in Mathematics*, 72, 1-15.