THE USE OF FIRST LANGUAGE TURKISH AS A RESOURCE - A GERMAN CASE STUDY ON CHANCES AND LIMITS FOR BUILDING CONCEPTUAL UNDERSTANDING

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Making use of immigrant students’ first languages for giving students access to mathematics is a well established teaching strategy in many countries, but not yet in the specific German language context. This article presents explorative approaches and selected findings of interview studies with students of Turkish origin who deal with conceptually challenging mathematical texts. By a qualitative analysis, conditions of first language use in research settings and chances and limits of first language use are investigated for developing conceptual understanding in mathematics.

1. USING THE FIRST LANGUAGE FOR GIVING ACCESS TO MATHEMATICS

German is the exclusive language of instruction in German mathematics classrooms, although more than one fifth of students have another first language. Since language proficiency in the language of instruction has been shown to be crucial for success in mathematics (e.g. Heinze et al., 2009), most of the actual efforts to increase the success of multilingual students is concentrated on German language learning in all subjects (e.g. the national integration plan, Bundesregierung 2010, pp. 47-60).

Complementary to that, many international studies have highlighted the relevance of the first language for giving access to mathematics (Clarkson 1992, and many others). Various case studies have shown how the first language can provide wider options to participate in classroom interactions. This first language use is naturally interrupted by moments of code-switching, considered as a social practice of flexible use of languages (Moschkovich 2007, Setati & Duma 2009). Other studies emphasized the cognitive and meta-cognitive benefit of the first language while making sense of mathematical texts, for example for mathematically successful bilinguals (Clarkson 2007). Kern (1994) has specified the cognitive benefit in facilitating semantic processing, relieving the short term memory, and especially allowing concepts to become alive more easily since first languages offer richer connections to the students’ networks of associations; this last aspect seems particularly important for conceptual understanding (Ellerton & Clarkson 1996). Additionally, Clarkson (2007) emphasized the meta-cognitive use of language switching as bilinguals seem to self-correct themselves more frequently. These results are in line with general results on the relevance of individual languages for making sense of mathematical expressions and for developing conceptual understanding (Ellerton & Clarkson 1996). In spite of such empirical evidences from a variety of studies and the wide spread theoretical arguments for making use of the first language (see also Barwell 2009), this teaching strategy is rarely employed in Germany, neither in theoretical considerations in
mathematics education nor in classroom practices.

As teaching strategies cannot simply be transferred from one language context to another, we felt the need to explore the chances and limits of using first languages in the specific language context of German mathematics classrooms. This can be characterized by the presence of up to seven languages in many classrooms, whereas mathematics teachers are mostly monolingual Germans. Turkish is the language of the biggest language minority in Germany (immigrants of first, second or third generation). Hence, we focus our study on Turkish students in grade 4 and 6. The explorative case studies are guided by the following research questions:

1. How do students react to the offer of using the first language while making sense of mathematical texts? What reasons for their attitudes can be discerned?
2. In which ways do the students use their first language and for what purposes?
3. If any, what benefits flow to their conceptual understanding? What limits appear to be present within the German language context for this teaching strategy?

In Section 2, a preliminary study is sketched out that only deals with research question 1, but also focuses on the non-trivial development of adequate research settings. Section 3 then presents the central findings of the main study.

2. PRELIMINARY STUDY: DEVELOPING ADEQUATE RESEARCH SETTINGS

2.1. Interview designs with different bilingual settings

For investigating students’ processes of thinking, communicating and understanding in depth, we used the method of clinical interviews for the data collection of the preliminary study. The students who were 11-12 years in age, had a Turkish background, and could read and talk in Turkish (a condition of our studies that reduced the number of candidates drastically). All students have grown up in Germany and had good basic interpersonal communication skills (BICS) in Turkish and German and varying cognitive academic language proficiency in German (CALP, cf. Cummins 1979). In 21 interviews of 45-60 minutes length, students worked in groups of 2-3 with an open modelling problem formulated in a challenging text.

For studying first language use under laboratory conditions of a clinical interview, the operationalization of the language use in the interview design is crucial. The preliminary study investigated the functioning of different bilingual settings with varying options for language production and reception (see Fig. 1). We distinguish two options of using Turkish in language reception. For a facultative offer to use Turkish, we presented the text of the modelling problem in Turkish and German and let the students decide to use both or one of their languages only. In the second option, the students started with the German text and then were exposed to the Turkish text after some time, that is with delay. They were pushed to consider it by questions like “I also have another text that seems to be pretty similar. Unfortunately, I can’t read
Turkish. Can you also work on this problem here?” The three options for language production varied with the presence of a Turkish speaking person. Without this person, the use of the Turkish language was allowed during the working process, but the explanations to the interviewers had to be given in German (option encouraged among each other). In the second option, the presence of a Turkish speaking person enabled students to speak Turkish (facultative offer). In the third option the Turkish language use was pushed with delay by a “trick”: Once the students had developed and discussed their ideas for the problem, a second person entered the room and presented himself as an only Turkish-speaking “caretaker”. By sending the interviewer to the school’s headmaster, he stayed alone with the students and asked them to tell him what they are working on and what they have developed. Different bilingual settings were investigated by combining one option of language production and one option of language reception in each interview. All interviews were videotaped and selected parts were transcribed. The analysis of the transcripts was conducted in the interpretative research paradigm (cf. Voigt 1998).

2.2. Selected findings: Students’ reactions on offers of using Turkish

Concerning language reception, students’ reactions were quite uniform: When Turkish use was offered facultatively, nearly all students used the German text. Some children explained immediately that they are used to reading mathematics only in German. Others compared both texts and found the German one easier. The Turkish text was mostly used exclusively to find the meaning of some words. One girl started the work with the Turkish text but changed to German for collaborating with her partner. When language reception was pushed with delay, most students compared the texts and commented that “this is the same”. Only one student used the Turkish version to develop a new solution, based on a misunderstanding of the Turkish text.

If the opportunity for language production in Turkish was encouraged among each other or offered facultatively, the students did not make much use of their first language. In the interviews with two interviewing persons, almost all sequences in Turkish were initiated by the second (Turkish speaking) interviewer. The option of pushing language production with delay was more successful in the sense that it could
initiate students’ explanation of ideas in Turkish, although with hesitations and missing self-confidence. The Turkish explanations were, as expected, full of German technical terms and moments of code-switching but allowed the students to express themselves in richer registers.

Although the hesitating reactions to the facultative offers in language reception and production were not unexpected, the reconstruction of reasons was instructive for elaborating the research settings as well as for developing deeper insights into specificities of the German language context of mathematics education. Students’ utterances made clear that they would not change their habitualized context-specific language uses for “artificial” short-term research settings. As German is the exclusive language of instruction in mathematics classrooms, it is their usual language of communicating mathematics, even if their language of thinking might be Turkish (similar in Clarkson 2007, p. 194). Additionally, some of the students had limited self-confidence in their first language capacities in the mathematical context, although they communicated successfully. These three reasons (artificiality of the research setting, habitualized context-specific language use and missing self-confidence) led to the conclusion that an adequate research setting must invest more than simply allowing Turkish (see below). In the investigated cases of the preliminary study, more intense benefits of Turkish use were reconstructable in moments of language production than in those of language reception. Although this might be partly traced back to the specific modelling problem (in which finding possible solutions posed bigger challenges than understanding the text itself), this leads us to assume a tendency that should be investigated in the main study. Consequently, we intensified the moments of encouraged language production between the children and those of pushed language reception with delay.

3. THE MAIN STUDY: STUDENTS’ USE OF TURKISH

3.1. Design and methodology of the main study

Based on the results of the preliminary study, the options of the bilingual settings for language reception were reduced to pushed reception with delay (see Fig. 1), the options for language production stayed the same. For establishing a context in which Turkish as a working language can be really valued, the interviewer started by asking the children to teach her/him counting in Turkish. This changed the perceived distribution of linguistic competence. After a period of working in two languages, the caretaker came again to push with delay for Turkish explanations. Thirty-one interviews were conducted with children of grade 6 or grade 4, having language biographies comparable to those in the preliminary study. The students worked on two problems based on the relating register approach (cf. Prediger & Wessel, submitted) and Fig. 2.

Analphabets in the world
According to a UN report, 1/4 of all adults in this world are analphabets, that means, they cannot read. Due to this, they cannot learn many professions.

Fig. 2 Interview text with parts of parts
3.2. The case of Dilara and Elina

Having taught the interviewer to count in Turkish, Dilara and Elina read the text in Fig. 2. When asked to reformulate it so that it is easier to understand, they omit the quantitative information and wrote: “Many humans are analphabets who cannot read and write so much. Thus, they cannot make many jobs. Many of these humans are women.”

In the next step, the text (in the verbal register) shall be related to the graphical register. The girls are asked to examine if the drawing of a fictitious girl (as printed in Fig. 3 but without caption) matches the text. For this task, they have to mentally construct the mathematical relations between parts and wholes that are expressed in the text. Having discovered in a Turkish dialogue that the grey part of the drawing represents the group of analphabets, they ask whether the groups of women and men are equally big. The first excerpt of the transcript starts when they hypothesize that there are more women. (In the translated transcript, the used language is signified by colours: the words spoken in Turkish are written in black, those spoken in German are written in grey, italics mentioning non-verbal actions are generally written in black. It should be noted that the translation of preposition into English is extremely difficult due to other semantic fields.)

1 I Mhh. They can write and read.
2 Elina And they not, well not write and read. *(points to the lower left field of the drawing)*
3 I Exact yes *(nods)*
4 Elina I understood .. now look .. the men, or? *(points to both upper fields)* ehmm eh .. eh can do much more *(points to the upper right field)*

Elina talks to the interviewer in German, but immediately switches to Turkish when she talks to Dilara. We interpret this abrupt switch of language as an indication for Turkish being the girls’ well established working language. However, as Elina does not express a reason for her switch, we only can guess at reasons (working without the interviewer; being in a more private atmosphere; mathematics is easier for them in Turkish; …).

5 Dilara *(nods)*
6 Elina And the fewerer [they use a non-existent comparative form of the comparative fewer, the authors] can’t *(points to the upper left field)* … among the women *(points to both lower fields)* … and the women
7 Dilara Ok, but take a look here
8 Elina Among the women- eh the one half can, the other half cannot *(speaks very quickly and points to the lower right field)*
9 Dilara Look at the woman … what she has said was right, look it is the same but the women mu- much more cannot

By inventing the Turkish double comparative form “fewerer”, Elina (L 6) seems to try to express a comparison on the rate of analphabets among the men to the rate among the women.

10 Elina Ok but look now she cannot *(points to the lower right field)* but-
11 Dilara Ok. Within the women the most *(points to the lower right field)* cannot. Within the
men the most can

By finding the word “the most”, Dilara is (in line 11) able to describe the parts of male / female analphabets among the men / women. This rate was not expressed before in German.

12 Elina Look, cannot, look. (points to the lower left field)
13 Dilara Ok. (nearly screaming) But look now this (points to the lower left field) if we would erase these lines, if they wouldn’t be there for example, then it would be the same .. from the one half to the other or? (points to the dividing line between the upper right and the lower right field)
14 Elina Hm here is a line
15 Dilara But of the women eh (points to the upper right field) at the women more eh (points to the lower right field) the majority of the women, which are more eh thingy eh cannot write and read but the most of the men (points to the upper right field) can read and write
16 Elina But the fewerer can’t read.
17 Dilara Yes ok. Of the women fewerer can read .. of the men a few
18 Elina Can not read eh yes the fewerer (points to the lower right field) can read.
19 Dilara Here the few (points to the lower right field) read, here (points to the upper right field) don’t read

In the former sequences, the girls used words like “fewerer” or “the most” to describe the rates in the groups of men and women. In this sequence, Dilara succeeds in expressing the comparison that might have already been apparent in line 9, namely the comparison of the rate of male analphabets among the men and the rate of female analphabets among the women.

20 Elina OK, now express.
21 Dilara Did you understand me?
22 Elina Eheh (negating) (laughs) ah. eh I understood .. but you tell, maybe she lines up ... this thing towards makes me down nervous (laughs) come on
23 Dilara Ehm
24 Elina (looks at the interviewing person, 3 sec.) What happens if she understands Turkish?

There are two indications that Elina does not yet understand the comparison that Dilara has elaborated: Elina has only expressed relations of the separated genders (e.g., line 16 and 18), and she refuses (line 22) to reformulate the relations Dilara has verbalised before. Dilara however feels ready to express her complex insight in German:

25 Dilara I think- well we mean (points to Elina) so ehm that- at the women- (points to the lower right field) that at the man (points to the upper right field) the most can read and at the- (points to the lower right field) no
26 Elina women not
27 Dilara That both are the same, but among the women the most cannot read and write and among the men- they can

Altogether, the episode shows two girls struggling with (the expression of) mathematical relations. For the description of these relations they do not activate mathematical terms of rates and ratios although these topics have already been taught in the classroom. Instead, Dilara creates the double comparative form “fewerer” in order to express the complex comparison of rates. Together, they elaborate a working consensus (Voigt 1989, p. 652), which seems to be pretty vague (in line 21-24). The creation
“fewerer” is only an intermediate state and is later substituted by “the most” which is a more usual way to describe rates. This expression is finally translated to German (line 27). This analysis does of course not imply that the girls would not have been able to elaborate the mathematical relations by speaking German.

The scene of Dilara and Elina is a paradigmatic example of how students appear to use their first language to elaborate mathematical relations and their descriptions in this study. It gives interesting insights how both cognitive and linguistic development are deeply interconnected in these kinds of processes of conceptual understanding.

Observations from other interviews

Beyond the illustrated cognitive benefit found in various interviews, we also found evidences of how the first language strengthened some students’ participation in the group interaction. These students’ participation in the group had previously been markedly less when only German was spoken. One simple reason for their engagement in the Turkish-speaking parts might be connected to the exclusion of the controlling interviewer (see also line 24 in the transcript above). In another interview the participants elaborated a communication rule: Whenever the interviewer said something like “You can reconsider that together”, the children switched to Turkish.

Despite the interactive and cognitive benefits of using the first language for the construction and formulation of mathematical relations, some distinct limits could also be observed. First the registers of technical terms are not developed that much in Turkish. Thus moments of code-switching could be observed in several scenes (e.g. Elina borrowed the word ‘line’ from German in line 14). Similar strategies could be observed several times. The use of those strategies depends on the acquisition of usable technical terms in German. Otherwise, some children made use of words like “things” (e.g. to express the concept of numbers).

4. CONCLUDING REMARKS

If the use of another language in mathematics education is the topic of research, then we have to be clear that the focus is on the goal of a better understanding of mathematics, and not on the promotion of languages, as has been claimed for instance by Setati and Duma (2009) and Moschkovich (2007). However, the situation in South Africa and America is significantly different to the German language context with many different, non-shared languages in a classroom and monolingual teachers. Flexible, transparent language use as claimed by Setati and Duma (2009) will thus not be an adequate aim for Germany. These context conditions and the students’ hesitations for first language use that we observed in the preliminary study might even be interpreted as an indication that the use of the first language does not make sense in German mathematics classrooms. In contrast to this interpretation, our further research will be guided by the following considerations:

1. It is expected that students will not immediately change habitualized patterns of
language they have established over years in the monolingual culture of mathematics classrooms. Consequently, laboratory research on language use must develop the language settings very carefully. We are encouraged by the experience that small changes for expressing appreciation (counting in Turkish) can have enormous effects. This potentially will lead to applicable strategies in classrooms.

2. In many sequences we could reconstruct moments of interactional, cognitive and/or meta-cognitive benefits of first language use for conceptual understanding. The most important aspect is that the first language in some moments gives access to conceptual understanding as the linguistic and conceptual development is deeply interwoven. The observed limit that some students cannot express their mathematical thoughts in their first language can be overcome by instituting bilingual classrooms, starting from the first day of school.

3. As the options of bilingual language reception did not show many effects in both studies, we will focus our future research on the language production. We are hoping that a culture of using the first language in mathematics education will support the understanding of mathematics even if the teacher does not share this language.

BIBLIOGRAPHY


