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How do we teach mathematics to refugee students? A qualitative study of the teaching and learning of mathematics in International Preparatory Classes

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Although migration itself is not a new phenomenon, the rising numbers of refugees in Germany and Europe are influencing the population composition leading to greater diversity within our society. This particularly affects school systems, as a great number of refugees are of school age and have to be provided with adequate schooling. In this paper, we discuss how the German education system, in particular in the city of Hamburg, deals with the schooling and integration of refugee students in what are called International Preparatory Classes. We describe a research study, which is examining what aspects influence teaching practices in mathematics lessons in these classes for refugees. The study investigates how teachers in these classes design their lessons from a mathematical and a linguistic perspective, how they deal with the task of providing refugee students with adequate instruction and how students experience mathematics.

Keywords: Refugee students, teaching practices, mathematics classroom, diversity, mathematics education and language.

Introduction

[H]ow school systems respond to migration has an enormous impact on the economic and social well-being of all members of the communities they serve, whether they have an immigrant background or not. Some systems need to integrate large numbers of school-age migrants and asylum seekers quickly; some need to accommodate students whose mother tongue is different from the language spoken in the host community or whose families are socio-economically disadvantaged; some systems are confronted with all three challenges at once. (OECD, 2015a, p.1)

Indeed, it is a major challenge for the German school system to teach refugee students with limited knowledge of the German language and to provide them with adequate support. Refugee children and young adults are perceived as a vulnerable group with a diverse range of special needs. In Hamburg, refugees and other immigrant students attend International Preparatory Classes (IPCs). IPCs prepare them for admission into German mainstream classes. Currently, scarcely any research studies how mathematics teachers work with students in these particular IPCs. Moreover, little is known about how they design lessons while they are confronted with linguistic, cultural and performance-related heterogeneity (Benholz, Magnus, & Niederhaus, 2016). Supporting refugee students' development in general, and specifically in mathematics, is crucial for their participation in society and their ability to contribute to the society as a whole. Our study aims at contributing to close the existing gap in research but will also allow others (e.g., authorities) to use the knowledge gained for educational changes on several levels (Cornely Harboe, Mainzer-Murrenhoff, & Heine, 2016). In this paper, we present two case studies from two different mathematics classrooms. Sharing ideas and best practice examples in order to improve the schooling of refugees in the

European Union and worldwide is of great importance for the international community as recognized by the OECD report (OECD, 2015b). In the following, we introduce the current state of research on IPCs from a German perspective and present first results of our ongoing research.

National frameworks for IPCs

Although German federal states implement different school-organizational models of teaching children and adolescents from refugee families, three basic models can be recognized:

- Integrative model: In this model, the students of refugee families are taught in regular classes with additional language support in German.
- Parallel model: In this model, children and adolescents from refugee families are taught in separate classes that are set up for them. The greatest amount of teaching is dedicated to the acquisition of the German language.
- Semi-integrative models constitute a transition between these two models: Students who are taught in IPCs can already take part in regular classes, depending on the level of subject-specific competences in individual subjects (Massumi & Dewitz, 2015).

The three models outlined here are also prevalent internationally (OECD, 2015a). Countries deal very differently with the schooling of refugee students. Some countries such as Iceland and Norway follow the integrative model (Ragnarsdóttir, Berman, & Hansen, 2017), others such as Spain follow the parallel model (Gorgorió & Planas, 2001).

The framework for IPCs of the local education authorities in Hamburg provides insight into the current situation of schooling of refugees in Hamburg and Germany, since each year school-aged refugee children and adolescents move to Hamburg with little to no knowledge of the German language. According to the Geneva Convention, all children are guaranteed the right to education. The Geneva Refugee Conventions (Article 21), the UN Universal Declaration on Human Rights (Article 26) and the UN Convention on the Rights of the Child (Article 28) as well as the German Basic Law (Article 3) explicitly encourage compliance with this right (El-Mafaalani & Kemper, 2017). In IPCs at different types of schools (primary/middle/high school etc.), refugee students are prepared for entry into mainstream classes.¹ The objective of IPCs is to enable children and adolescents to learn the German language and thus to facilitate their integration into the German-speaking environment as smoothly as possible. Students that are able to write in the Latin script, start in IPCs that focus on learning the German language and basic knowledge of other subjects. Students who are illiterate² or literate in a different script – such as Arabic – gain German reading and writing skills in literacy classes. These classes focus on reading and writing in the Latin script and on basic German skills. IPCs aim at providing a quick transition to an age-appropriate class, suiting students' individual education level at general or vocational schools (mainstream classes). Refugee students can be admitted into IPCs at any time of the year and stay in them for a period of twelve months. The number of students in each class is around 15. The language learning process in all different forms of IPCs is divided into two phases in the first year of schooling. In the first phase

¹ Immigrant students from EU-countries or other countries are also schooled in IPCs. In our study, however, we focus on refugee students who recently and forcibly fled from their country of origin.

² By illiterate, we mean that these students can neither read nor write.

(basic level), students acquire basic knowledge in German and receive guidance in dealing with, and acting within, the German-speaking world. This first phase should not be longer than 6 months. At the end of this phase, the parents receive information about the performance and learning development of their children in learning development talks organized by the teachers. These meetings advise parents on further schooling and acts as an exchange on how best to support the development of their children.

The second phase (advanced level) focuses on the preparation of the students for classroom communication and the use of subject-specific language in different subjects. After six months, students receive a transition certificate. At the end of the second phase, students transfer into mainstream classes and receive additional language tutoring for another year.

The basis for teaching in IPCs are the frameworks and curricula of German as a Second Language in IPCs at each school level, in which minimum requirements and assessment for performance are set. The level of difficulty of teaching is oriented towards the Common European Framework of Reference for Languages. Subject-specific instruction, such as mathematics, is based on the minimum requirements laid down in the curricula offered in each grade. The framework for IPCs in Hamburg focuses more on the macro level of the regulation of the schooling process than on the micro level of actually teaching the subject. It recommends, however, that teachers orient themselves towards the minimal requirements of the mathematics curricula for mainstream classes.

Current state of research on IPCs

In empirical educational research (in general), there are numerous and comprehensive analyses of the educational opportunities of various groups of refugees. In particular, the research field covers studies on participation in education, educational transitions, acquisition of competencies, and school success. In-depth analyses focus especially on social background, gender and ethnic background and/or migration background. Despite this highly differentiated field of research, the long history and increased presence of refugees, it is surprising that the educational opportunities and conditions of refugee students have not been steadily researched (El-Mafaalani & Kemper, 2017). Unsurprisingly, however, since Germany had a high influx of refugees in 2015, interest in education policy and research into the education of refugees has increased. This interest is also reflected in the literature and more recent research publications (Kleist, 2017).

Nevertheless, a paucity of research is still especially obvious when the focus turns to subject-specific instruction in IPCs, including mathematics education. Some studies use ‘wordless methods’ of teaching mathematics to circumvent possible language barriers. In his study, (Oswald, 2017) used ‘wordless methods’ with adolescent refugees and found that it had a positive impact on the motivation of the students and the teachers. Furthermore, Mink & Sauerwein (2017) conducted a teaching project in one IPC on figured numbers and proofs without words. They found that only after intensive study of the material the mathematics could be understood, and it remained questionable whether students who see a visualization for the first time can use this to carry out complex proofs, since they are still unfamiliar with elementary mathematical activities. Despite the intention of these ‘wordless methods’, it is not possible to avoid oral explanations, which were difficult for participating students to understand. Most of the respective research projects implemented so far focus on language and mathematics (Prediger & Schüler-Meyer, 2018), or

mathematics in the context of migration (Deseniss, 2015). In other words, this research does not consider mathematics lessons with refugee students and their teachers. Exceptions are the studies by Oswald (2017) and Mink and Sauerwein (2017), which focus on new teaching methods for IPCs. However, there currently exists no research on the actual classroom practices of teachers in IPCs. Although an increasing number of textbooks and teaching materials for refugee students are published by publishers all over Germany, there is clearly a gap in scientific research concerning the needs and challenges of teachers and students in IPCs.

Apart from the German state of research, there exists an extensive discussion on the teaching and learning of mathematics in multilingual classrooms that highlights social, cultural and linguistic aspects of mathematics teaching and learning (Gorgorió & Planas, 2001; Moschkovich, Wagner, Bose, Rodrigues Mendes, & Schütte, 2018). As most of these studies focus bilingual or multilingual classrooms and not classrooms with only refugee or immigrant students, we can only draw partially on these studies. For example, Barwell et al. (2016) stress that situations of language diversity have been extensively examined, such as bilingual and multilingual context. They underline that there is a need in researching trilingual contexts where learners are exposed to home languages, a national and an official language. However, they do not focus on students that are second languages learners (sometimes referred to as minority learners, immigrant students) with different native languages. Furthermore, refugee students might come from countries with multiple national languages, which equals bilingual students, but most of them have no knowledge of the academic language, in this case German, at all, when they enter IPCs. However, Barwell et al. focus partly on second language learners. Gorgorió & Planas (2001) conducted research on language and socio-cultural aspects of mathematics education in a classroom with a high percentage of immigrant students and they are particularly convinced of the importance of continuing to study the teaching and learning of mathematics in multiethnic and multilingual situations. Moreover, they emphasize the need for continuing studies not only in terms of equity and social justice, but also in terms of the richness of the research ground.

Overall, these studies and the above-mentioned gaps in the research highlight the need for a deeper understanding of what is happening in the IPC mathematics classrooms, what affects the (teaching) practices of teachers and the challenges they face when it comes to teaching materials, previous knowledge of refugee students etc. This research project aims at narrowing this research gap.

Research questions and aims of the study

Overall, it can be stated that the framework for IPCs does not offer advice for teachers on how to teach mathematics to refugee students except to focus on the minimum requirements of the same or similar grade of general schools. Furthermore, the analysis of the current state of research on IPCs in the previous section shows that there is a research gap in the field of mathematics in the context of IPCs relating to best practices, teaching materials and theoretical approaches. Hence, our study highlights findings from research that explores mathematical teaching practices and aims at researching mathematical teaching approaches and mathematical practices within the IPC mathematics classrooms.

Our research project investigates the following research questions:

How do teachers deal with the task of designing and implementing mathematics lessons for refugee students? What kind of practices and which materials do they use, and how do social, cultural and linguistic aspects influence the learning and teaching of mathematics in IPCs?

Overall, the aim of this study is to generate knowledge about how teachers design lessons, which theories from other subjects their lessons are based on, and whether these fit the needs of the students they teach. More insight is necessary on the challenges mathematics teachers are encountering in IPCs, and how they deal with them within the mathematics lessons in order to develop supportive learning environments for refugee students.

Design of the study

The study is embedded in the project “Mathematics and refugees” at the University of Hamburg, a subproject of the state-funded research network “Everyday Mathematics as Part of Basic Adult Education”, the so-called “Hamburg Numeracy Project”. The research network focuses on (adult) numeracy practices and their use of everyday mathematics, focusing on particularly vulnerable groups, for example refugees and asylum seekers, over-indebted, and disabled persons. The presented study is qualitatively oriented and focuses on the IPC mathematics classroom and the practices of mathematics teacher and their students. The sample of the study consists of teachers and students from three comprehensive schools at lower and higher secondary level in Hamburg. For the data collection, we use different methods such as classroom observation, guideline-based interviews with the mathematics teachers and narrative interviews with 3-4 students from each class.

The study has been conducted in the last 6 months of 2018 and this paper emerges from a larger research project which we described above. At first, informal talks to gain a first impression of the research field have been carried out with teachers outside of the classroom. After that, participatory observations of four lessons each lasting 45 minutes have been conducted. From these observations and the literature we draw on, we generated questions for the guideline-based interviews. Each IPC-teacher has been interviewed for approximately one hour. The interviews focused on the question how teachers design mathematics lessons in IPCs, for example how they deal with the particular heterogeneity of the learning group, how they proceed methodically and didactically, which challenges occur and how they deal with them, and so forth. Moreover, we conducted narrative interviews with refugee students from each class. The interviews focused on the experiences of the students inside the mathematics classroom of their country of origin and in their new school in Germany. The data collection and analysis has been based the coding paradigm of Grounded Theory (Corbin & Strauss, 2015). All interviews conducted have been recorded and transcribed. Furthermore, the data collected has been or will be evaluated with MAXQDA.

Preliminary results

In the following, we focus on two IPCs at two different comprehensive schools in Hamburg, which were selected as paradigmatic cases reflecting general characteristics of the whole database. We summarize selected aspects of the observation of four lessons in the mathematics classroom and informal conversations with teachers and students. In this paper, we name these classes IPC A and IPC B to distinguish certain aspects of the observation. Both IPCs are linked to grade 7/8 teaching groups (inter-year groups) situated in parts of Hamburg with a low social index.

Both classes consisted of approximately 12-15 students at the age of 12-16 years. The majority of the students came from Syria, Afghanistan and Iraq. According to both mathematics teachers, the students were very heterogeneous in terms of their mathematical competences and educational biography. Some students from Afghanistan had never gone to school before having fled to Germany, others had finished primary or secondary school in Syria and directly joined the German system, and again others had not gone to school for many years. In addition, both classes had students from Eastern European countries, for example from Bulgaria, or students from countries such as Thailand, Turkey, Ghana and Togo.

Teachers' mathematics and teaching experiences

The mathematics teachers of both IPCs had a very different educational biography but both were class teachers of the observed classes, meaning that they taught most of the subjects and lessons of their IPC. The teacher of IPC A completed her teacher education, worked and researched abroad, had a PhD and worked as a lecturer at university level in educational science, particular in multilingualism, migration and education. It was her first year teaching an IPC and the first time teaching mathematics to students. She emphasized that she did not study mathematics as a subject in her studies, but she had a very good knowledge of the didactics of German and German as a Second Language and carried out extensive research in the field of migration. The teacher of IPC B has completed his teacher education and taught mathematics in IPCs for seven years. He did not study mathematics as a subject at university but completed an additional course in mathematics some years ago. At that time, there was no specific teacher education program for IPC classes. Since the increase of new immigrant students in recent years, many teachers who have been employed for the newly created school classes have completed a German as a Second Language degree. Often these teachers have to teach mathematics lessons in their IPCs, also due to the existing lack of teachers of mathematics. This means that many teachers lack the didactic and mathematical knowledge of mathematics. In some cases, underqualified teachers were also recruited because the positions in the IPCs could not be filled otherwise. This highlights the fact that apparently many teachers have very different experience with IPCs and teaching mathematics as a subject.

Linguistic aspects

Teacher A paid significant attention to the native languages of the students, which is in line with the accepted research results. A table with important German sentences hang on one of the walls of the classroom, such as "What does that mean in German?", "Good Morning", "Can you help me?". Students added a translation of these sentences in their own mother tongue. Throughout the school year, the teacher studied all sentences of the languages of her students herself. At the beginning of each week, students were allowed to test her language skills. Apart from this, language comparisons between German and the native language of the students were an integral part of the lessons. In addition, two of the weekly lessons in mathematics focused on subject specific vocabulary. With teacher B the picture was contrary. Even if some posters with German grammar were hanging on the walls of the classroom and some dictionaries were available, a set of rules was attached to the teachers table forbidding or avoiding the usage of native languages of students. This seemed to be a general rule for the IPCs of this school. This handling of the native language of the students

contradicts findings from language teaching research and general pedagogy, and yet seems to be widespread.

Mathematical Aspects

In IPC A, students were taught in cross-class teaching two hours per week in homogenous groups regarding their performance in mathematics, and the other two-hour classes on subject-based mathematical language in their original classes. Some students sat in groups according to mother tongue, topics or performance. There were chalk-and-talk phases within the lesson and reflections on mathematical vocabulary. Work sheets with topics such as addition, subtraction, multiplication of fractions and subtraction of fractions with different denominators, text problems etc. mainly focused on basic mathematics. Students were working on different worksheets with diverse topics. After each lesson, the teacher collected the sheets, corrected them and handed them back during the next lesson. Furthermore, the teacher offered some enactive materials such as wooden fraction models. In IPC B, each student worked on his/her own work plan. The teacher talked to each student for 5-10 minutes and gave personal support, no chalk and talk phases occurred. Topics were similar to IPC A and focused on basic mathematics such as subtraction, addition, fractions and so on. In both classes, some students worked with the mathematics textbook that was being used in the mainstream classes they are supposed to transfer to after completing IPC.

Discussion and looking ahead

The two case studies presented here emphasize the great diversity of the design of the lessons in IPCs and the learning opportunities provided by the two teachers based on the heterogeneous group that they were teaching. Socio-cultural aspects played a crucial role, as students seem to have very different backgrounds according to their previous educational development and different linguistic background (and possibly experiences with flight, conflict and/or war). The role of the linguistic aspects in the observed lessons was handled very differently by the two teachers and led to different learning environments. Drawing on the research results of Prediger and Schüler-Meyer (2017) and other scholars, who emphasize that the appreciation of the students' native language has positive effects on students' motivation and confidence, we find it a concern that only one of the two teachers was drawing on these findings. This might indicate that there is a need of further education in terms of the inclusion of the native language of the students.

Furthermore, the initial results of the study point out that the two teachers design their mathematics lessons very differently. Nevertheless, both of them tried to adapt their classes to the need of the students, in a way that they think is best for them. Earlier on, we demonstrated that there is no official curriculum for mathematics in IPCs and few adequate teaching materials that have been developed in the last years. This is also reflected in the initial results, as both teachers' lessons are mostly based on self-developed materials. Overall the two case study presented in this paper provide first insights into how teachers deal with the task of carrying out mathematics lessons to refugee students. The research seems to suggest that the educational background of the teachers influences the way in which they carry out this task, especially concerning lingual aspects and the role of mathematical content and the kind of its inclusion, but also how external factors influence the learning and teaching of mathematics, such as socio-political and socio-cultural aspects.

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