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Math teachers' visions of an ideal math class: What do they tell about bringing innovations into the classroom?

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Various social and political factors within the school environment influence how teachers ultimately design their teaching and also their motivation to bring innovation into the classroom. The paper presents results of math teacher interviews about their vision of ideal mathematics teaching. From these answers, conclusions can be drawn about teachers' potential for bringing innovation into the classroom and the factors that might hinder them. Three different types have been derived, with varying levels of motivation to participate in in-service teacher training and to further develop the teaching. Teachers that like to teach in the way "it has always been done" show the least potential, in contrast to the idealists among teachers, who align their teaching with their high standards to design lessons that they believe best for their students' learning. To narrow the theory-praxis gap, the focus should be on the third type of teacher – the struggling ones – who need support to stay true to their ideals and to avoid adapting to more traditional patterns.

Keywords: Teacher socialization, mathematics teachers' beliefs, theory-practice relationship.

Introduction

Working with in-service teachers in professional development courses is not always easy, and participants are often reluctant to acquire new knowledge and develop their teaching. "We do not have time for this" or "I am experienced enough after teaching for 20 years, I don't need this anymore" are just two statements given at the kick-off event for an in-school professional development course for high school mathematics teachers that aimed to elaborate the concept of "critical mathematics education" and possible implementations in the classroom.¹ These comments were made before the teachers even knew in more detail what the course was supposed to be about. From the very beginning, one could notice a general aversion to any participation in the professional development course. The intended courses at this school were canceled after the kick-off due to the lack of teacher motivation.

Continuing professional development throughout the career is seen as an essential part of the teaching profession. Teachers need to constantly develop their teaching practices to be effective in today's classrooms. In-service teacher training is a necessary prerequisite for innovations to be implemented in the educational system and the classrooms, as it is not enough to rely on next-generation teachers to bring about changes. It requires the participation of experienced teachers (Mayr & Neuweg, 2009). However, it seems that the awareness that teaching is a life-long learning process is not very pronounced for some teachers. Some of them might feel that they are "conclusively trained teachers" after completing their degrees and do not see a necessity to professionally develop further, which is why they articulate their resistance to development work (Körkkö et al., 2020). Such a mindset has long been fostered in Austria by the political and

¹ All quotes from my interviews are originally in German and have been translated into English by me.

structural requirements placed upon teachers since, until a few years ago, high school teachers had no obligation to undergo further training after completing their studies. Such regulations might therefore influence the image that teachers have of their profession, the demands placed upon them, and ultimately the extent to which innovations find their way into teaching practice. As teacher educators and researchers work to constantly improve teaching and learning and are eager to bring new scientific insights into practice, such attitudes are worrisome. This is especially the case as teachers are the ones who are supposed to engage students to evolve, learn new things, rethink old habits, and keep up with the times to meet future challenges.

The theory-practice gap in teacher education – complex reasons

The issue of the theory-practice gap is an ongoing one and has been discussed intensively in the research community. Reasons why it is especially challenging to bring about changes in the educational system are complex and multifaceted.

Teacher education programs might already cause some trouble in letting pre-service teachers link theory to practice and might not be structured in a way that counteracts eventually unfitting attitudes about the teaching profession. Most of the student teachers start teacher education programs a short time after they leave high school. This means they bring a vast amount of experience into the system they now want to work in and have strong preconceptions about what it means to be a teacher. Changing these preconceptions within teacher education seems to be very hard (Joram & Gabriele, 1998). Research shows that new teachers are often highly influenced by how they learned the subject matter themselves when they start teaching (Stofflett & Stoddart, 1994). This influence seems to go deep as even experienced teachers prefer to use teaching styles they were getting used to as students. Moreover, as they might think they already know what it means to be a teacher (as they have observed teachers more than half of their lives), many do not understand the need and the usefulness of the knowledge and competencies they acquire within teacher education. Their preconceptions influence the way they understand new knowledge (Korthagen, 2010).

Even if pre-service teachers' attitudes shift in the course of the teacher education program, it is not certain that innovations will find their way into the classroom. Different studies across different contexts describe that novice teachers experience a "practice or transition shock" after entering the teaching profession (e.g., Corcoran, 1981). As many do not feel well enough prepared and experience frustration within their beginning years, they are not using the theoretical knowledge and competencies acquired in teacher education. Many then fall back into what they experienced in their school carrier as students. Most new teachers tend to adjust their focus to rules and practices in school rather than on recent scientific insights. Especially young teachers experience the pressure to acquire the school's culture, following old patterns and standards that other teachers are using, which discourages modernization and innovation in teaching. Experienced teachers might pass on their attitude that theoretical knowledge and competencies acquired at university cannot be put into practice and is just something you needed to learn to get your degree. This "teacher socialization" often causes a shift away from initial ideals, as it might seem difficult for an individual to influence these existing patterns (Brouwer & Korthagen, 2005). Within this process, even highly motivated teachers with the will to change classroom practices towards more innovative and research-driven teaching practices might resign and comply with "how it has always been done". Resisting these

dynamics and insisting on one's ideals usually needs more individual effort. Moreover, it often goes hand in hand with resistance from different sides (colleagues, students, parents, principal) as schools often have hidden hierarchies keen on maintaining the self-created power structures. Consequently, efforts to change often encounter the "school system's immune system" and are either rejected or absorbed and defused (Heintel & Krainz 1998). This already illustrates the complex interrelationships and the wide variety of socio-political influencing factors that affect a teacher and thus also his or her teaching.

Nevertheless, some teachers are still eager to design classroom practice in the best possible way for students, even if this sometimes requires creative ways to not adhere to all the guidelines or get into conflict with more traditionally set colleagues. These are the ones most willing to develop further to meet new demands and are therefore also the ones with the most potential to bring changes into the classroom.

Nowadays, mathematics lessons can be carried out in a variety of ways: they can be very traditional and exercise-oriented or very application-oriented, the focus can be more on individual performance or group work and discussion, the lessons can always be similar or, depending on the topic, always different – in short, teachers have many possibilities to design their mathematics lessons. If you ask mathematics teachers about the "ideal" mathematics lesson in which they think children can best learn mathematics, it becomes apparent that opinions differ widely. Based on the teachers' answers, one can see whether this ideal teaching is implemented in reality or whether they only have an idea of it and do not carry it out for various reasons. The paper aims to present results of interviews carried out with middle and high school math teachers, who described their view of an ideal mathematics class. Looking more closely at their visions of mathematics teaching can also provide insights into their motivation to bring about changes to their teaching and the factors that might cause resistance.

Data collection and analysis

Twelve Austrian mathematics teachers who take part in the professional development course about implementing critical mathematics education approaches participated in the semi-structured interviews. Ten of them are teaching at a middle school, and two of them are teaching at a high school and a middle school (together, they form the entire mathematics teacher team of a middle school in Klagenfurt).² The teacher group ranged from participants with only one year of teaching experience to participants with over 30 years of experience. Five of the participants were male, leading to a nearly balanced gender distribution. The interviews were part of a larger study on how teachers deal with bringing critical mathematics education approaches into their classrooms. One of the questions focused on how the teacher would design mathematics classes to make them the best possible for their students to learn mathematics. Participants were asked to describe their vision of it (or what they would change compared to current practices to make it an ideal math class) without

² Pre-service teacher education differed between middle and high school teachers in Austria until some years ago. High school teachers needed to complete at least five years of studies at university level, while middle school teachers participated in a three-year program at the educational college. Therefore, theoretical background about teaching and learning mathematics might differ considerably between these two groups which might also influence their answers.

thinking about school guidelines or other regulations. Audio records of the whole interviews were transcribed and coded, letting themes emerge from the data. Within the process, codes across teachers' answers have been compared in order to find similarities and differences, which led to three different themes regarding the question of an ideal mathematics class.

Findings: The ideal mathematics class – three different approaches

Results indicated that there are three different approaches to answering this question. From the answers given, it can be concluded that depending on which approach the teachers tend to correspond to, they also show different potential to bring innovations into the classroom. In general, it was striking that many of the teachers needed some time to think about the question. Some articulated that they have never thought about it before. Therefore, they had some difficulties answering the question, and it was challenging for them not to think about school regulations. That already indicates that many teachers do not think beyond their usual image of teaching and are quick to comply with the school's guidelines or "hidden" agenda of their school without reflecting on it. As one teacher with 20 years of teaching experience replied after thinking about it for some time:

Hm... Depends on the children. Maybe I would use more visual materials and maybe more time. I would really like to explain everything in more detail, but that is not possible in the lessons. Perhaps also more examples from real-life... I don't know. It would probably be good to have more math lessons per week... but that is not realistic anyway. We already have four math lessons a week, so from that point of view... I don't really know.

It becomes apparent that she has never really thought about it and also doesn't exactly know what to answer. In between, she keeps thinking and throws in new ideas, which, most of the time, she then discards because the regulations in the school system, in her opinion, don't allow it anyway. She does not elaborate on any of the ideas mentioned but simply lists different approaches. This suggests that she does not exactly know how she envisions an ideal mathematics class and that she might have never reflected about the socio-political agenda of her teaching as well. It appears that this teacher has adapted to the school's culture and teaches within this framework without feeling much need to change or evolve her mathematics lessons. Therefore, it might be assumed that she sees less need for regular in-service teacher training.

That might as well be the case if you as a teacher meet your own standards or ideals of teaching and school guidelines fit you well. A younger teacher (7 years teaching experience) responded very quickly and short: "I wouldn't change anything. It suits me just the way it is." He then explained that for his lessons, he often follows the two school books to structure his teaching, using the one with explanations for elaborating new content and the other one with examples for giving homework. That seems to work well for him and, in his opinion, also for his students. However, as school books often mainly focus on exercises and do not foster reflections about the use of mathematics, it might be assumed that students will mainly acquire operational and procedural skills in such a way of teaching mathematics.

These examples show that some teachers seem to always have had a clear image of what it means to teach mathematics and do not feel that changes or adaptations are needed. As a result, they likely are the ones with less motivation to participate in training courses, and when they do participate

(which is obligatory for middle school teachers but not for high school teachers who started teaching before the school year 2019/20), they might make little use of the new knowledge provided in these courses. Therefore, the potential of this group of teachers to bring innovations and new scientific insights into the classroom is rather low. As these teachers do not reflect much about their teaching practice and are quite happy with their traditional form of teaching mathematics it might also be assumed that they will not easily see a necessity for using more critical approaches in their mathematics lessons and might not really be aware of a connection between mathematics and socio-political issues themselves. They might not change their attitudes towards professional development and the teaching and learning of mathematics unless they experience an event that causes them to do so (Pehkonen, 1994).

Other teachers struggle more with meeting their own ideals of teaching mathematics, have a clear idea of how it should look but are unsure how to realize it. They articulated their struggles between meeting the school systems' demands and their standards of teaching as an excerpt of the interview of a young high school teacher (3 years of experience) shows:

In any case, [my ideal mathematics class would be] very application-oriented, where you can maybe also try things out... That you can touch certain things or you do projects or just always have such small fields of application [...] Working in a more open framework, where you can also work across subjects and not be stuck to mathematical content only. But you are a little bit caught in this concept of school, and you need to prepare students for the [standardized] matriculation exam. Nothing has happened in this [more open] direction in the last years. Everything is already so stuck. But for me [the ideal mathematics class is structured so] that the teacher should act more as a coach than a preacher, who stands in front and presents everything. That would be the ideal case... (is thinking) ... But there is again the question if and when you can implement that so easily... I am asking myself whether you can do so much as an individual.

It gets clear that she is not genuinely practicing what she would see as an ideal mathematics class, pointing to constricting structures in the school. Her struggles show how much influence the (hidden) structures within the school system and, above all, the school culture itself and the associated expectations placed upon her ultimately have on her teaching practice. She is obviously experiencing a notion of a discrepancy between her ideals developed during teacher education and the pressure of more traditional patterns in school. As Dann et al. (1978) indicated, these "discrepancy experiences" lead to a decline in using more innovative teaching practices with whom teachers got in contact in pre-service teacher education programs. As a result, they rely more on traditional teacher-centered instruction. Others, like Brouwer and Korthagen (2005), indicated that this might also cause these teachers to start to doubt (again) whether it is possible to put the theoretical and research-based knowledge from education programs into practice. Even if you as a teacher are ultimately the one responsible for what happens in your classroom, the guidelines of the principal, the attitudes and practices of your colleagues, the expectations of parents and students (which are often generated by a certain school culture) might ultimately strongly influence how you design your classes.

Even though these struggling teachers experience obstacles, they do show the motivation to change classroom practice. How much of these ideas will find their way to their students might depend on how deep their beliefs are settled and how much support they will get to realize them. This is

especially important in the first years of teaching as the answer of a novice teacher, who only started to teach some months before the interview took place, shows:

I would say that it [the ideal math class] should be a bit experimental, with group work, problem-solving, discussing how you find a solution, and where everyone should be able to benefit from each other. [...] But I still have to get more into it, because you also need all the materials, you still have to get everything. But so far, my teaching hasn't been quite the way I imagine it, I was a bit more reserved in the first year, but it should go in that direction if everything is possible.

This young teacher has an idea of how she would like to design her math classes but hasn't really dared to carry that out in her first year, was still "reserved", and doesn't yet exactly know whether it's possible to realize it. This is probably because she first wants to get to know the habits of the school and her colleagues to see how far her ideals are from current practices, which is in line with research on teacher socialization (Brouwer & Korthagen, 2005). It gets clear that novice teachers orient their practices strongly on their colleagues and cannot easily realize their individual visions about teaching, which also underlines the power of the socio-political environment in maintaining the status quo. However, the motivation of this group of teachers to participate in professional development courses might be pretty high (especially at the beginning of their struggles), as these courses can be one way of supporting and strengthening their ideals. Moreover, they might get to know ways to realize them within their teaching and find others who have similar visions. Though, if there is no support from other teachers or from their institution to realize the ideals, these struggling teachers may adapt to prevailing rules and patterns and scale back their initial ideals after a few months or years. At the same time, their beliefs that theoretical knowledge and competencies acquired in teacher education can be useful in practice might fade, and their motivation to participate in professional development courses might decrease. This might be especially the case for teachers whose ideals were not yet firmly established but only began to change in the course of their teacher education.

Others with stronger convictions might find creative ways within the system to realize what they feel is the best possible way to teach mathematics or might otherwise even leave the profession when they are not able to do so.

I arrange my mathematics lessons within the school system in a way that I think the students can take away the most – otherwise, I simply couldn't work there. [...] For example, vocational orientation is, in my opinion, very important, and that also happens in my math classes, just like in other subjects. References to everyday life are always included [...]. Because just going in [the classroom] and simply calculating examples, then it's also boring at some point, and then you [as a teacher] are just happy when vacations begin again. And I don't want to be part of that [group of teachers], and I only want to do the job as long as I really like doing it!

For this teacher with about ten years of teaching experience, it seemed natural to always arrange mathematics lessons in a way that he felt would benefit students the most. He includes content that is not demanded by the mathematics curriculum if students are interested in it (e.g., cryptocurrency), setting a focus on building relationships to real-life situations. He clearly distinguishes himself from the group of teachers who, in his opinion, equate mathematics lessons with calculating examples without really thinking about what students are interested in. Moreover,

he articulated that he is keen on constantly developing his teaching further and that he would find it a good idea to observe math classes of his colleagues to learn from each other.

It is apparent that these teachers are more eager to participate in professional development courses and are the most likely to bring new ideas and innovations into the classroom. They seem to manage to find ways to deal with organizational struggles as well. As their teaching ideals are strong, they are willing to put more effort into designing lessons that meet those ideals. But even if they are willing to work more on an individual basis, most of them will need support in the school community after some time. If this type of teacher finds that, despite great effort, they cannot make their ideas a reality and nothing in their environment is improving, they may even leave the profession. Therefore, the ones with the greatest innovation potential are also the ones who resign first when they realize that nothing is changing and that they, as individuals, cannot do much about it.

Discussion

In education, there is still a large gap between theory and practice, and as the distribution of types of teachers in this small sample shows, a majority of teachers are within the first two types – so they are either not seeing any reason for changes or are struggling to implement them. Only two of the twelve teachers participating in the study could be categorized into the third, more idealistic type. Even though the three approaches were derived from a small sample of 12 teacher interviews, it can be assumed that most teachers can identify themselves with one of these categories. Besides, these cannot be considered static approaches; instead, teachers can find themselves in several of these within their professional life.

Moreover, it seems that there is a noticeable difference between middle and high school teachers when it comes to openness for development work. The initial excerpts in the introduction came from experiences with high school teachers with whom it was first planned to carry out the professional development course on critical mathematics education. However, as they showed no willingness to participate in any professional development course and even expressed a discouraging attitude towards anyone not directly anchored in the school system, a new school had to be found for the research project. From the beginning, middle school teachers were more open-minded towards the professional development course and were immediately interested in what it will be about in more detail. Even though the interviews show that also among middle school teachers, some do not offer much potential for change, these teachers still get involved in in-service training on new topics voluntarily. The fact that there are such noticeable differences in this respect between these types of teachers might be attributed to a wide variety of reasons: Teacher education has been structured differently and anchored at different institutions until two years ago in Austria. Regulations concerning professional duties differed as high school teachers had no obligation to undergo further training after graduation. This might have led to an image that this is not part of their job but more something like a hobby for the over-idealistic. In contrast, middle school teachers are accustomed to investing at least 15 hours per year for this purpose (which is still no guarantee for developmental work as you only need to be physically present to get your certificate). Moreover, the student clientele differs greatly in terms of social background, which makes collegial cooperation in middle schools all the more necessary to cope with possible challenges. The list can certainly be continued. Still, it does already show that socio-political guidelines and school

conventions greatly influence the success of professional development initiatives and how much innovative, science-based knowledge actually ends up in the classroom. However, as these described differences between high school and middle school teachers derived from the data and experiences with a rather small group of teachers of only two different schools, generalization of findings can only be done cautiously, and there might be different results in other areas and contexts.

To narrow the gap between theory and practice in the future, it seems particularly important to focus on the struggling teachers and strengthen those who have ideas but do not put them into practice for various reasons. Much potential for innovation will remain unused if these teachers are not supported in ways that allow them to realize what they learned is best for their students. Since the reasons for the theory-practice gap are manifold, there will not be one single way to solve the issue. Rather, interlocking initiatives at different levels could help move in the right direction and, above all, support those open to development and innovation. After all, it became clear that the extent to which innovations find their way into the classroom thus depends on a wide variety of interlinking governmental, political, cultural and social structures. The individual teachers' vision alone will (most of the time) not be enough for getting new research-based insights into practice. Decisions on how teacher education programs are structured, how cooperation between university and school institutions is promoted, how traditional the school structures are, and the legal framework conditions for teachers can strongly influence how much of the vision is carried out in reality.

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