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Research article

Math anxiety in primary school teachers: Impact on teaching practice and classroom environment

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Abstract

Introduction. In recent years, math anxiety and its impact on mathematical development have been high on the research agenda due to its significant effect on students' math learning productivity. However, not only students are prone to math anxiety. Studies have shown that math anxiety can be found in teachers. Moreover, it prevails among pre-service and in-service primary (elementary) school teachers. It is a matter of serious concern since math anxiety in children appears as early as in primary school. The formation of children's math skills and attitudes towards math in the first years of formal education strongly depends on the primary school teacher. If the teacher experiences anxiety towards math, this can negatively affect students' math performance.

Materials and Methods. This article presents a brief review of foreign publications focusing on math anxiety among primary school teachers.

Results. The article discusses possible mechanisms of math anxiety development and its cause-and-effect relationship with math performance. The main focus is given to a teacher's role in students' propensity for math anxiety and lower learning outcomes. The article discusses how math anxiety among primary school teachers might contribute to their students' negative experiences of mathematics. The review provides examples of empirical research that discusses the prevalence and causes of math anxiety among in-service and pre-service teachers.

Conclusions. Overall, studies show that math anxiety among teachers is often the result of their own experience of negative interactions with teachers, the use of ineffective teaching approaches and low level of mathematical competence. Summarising the results of the studies, one can pay attention to the so-called cycle of unintentional transmission of math anxiety from teachers to students, which needs to be addressed at various levels.

Keywords: math anxiety, primary (elementary) school teachers, math performance, attitude towards mathematics, math anxiety transmission

Научная статья

Математическая тревожность у учителей начальных классов: влияние на практику преподавания и среду в классе

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Аннотация
Введение. Математическая тревожность и ее влияние на математическое развитие в последние годы вызывает большой интерес со стороны исследователей, поскольку может существенно влиять на продуктивность освоение математики учащимися. Однако не только учащиеся подвержены математической тревожности. Исследования показывают, что математическая тревожность обнаруживается у учителей и даже превалирует среди учителей (будущих учителей) начальных классов. Учитывая то, что математическая тревожность у детей появляется еще в начальной школе, это вызывает серьезную обеспокоенность. Во многом именно от учителя начальных классов зависит формирование математических навыков и отношение к предмету у ребенка в первые годы формального обучения. Если учитель испытывает тревожность по отношению к математике, то это может негативно сказаться на математической успеваемости его учеников.
Материалы и методы. В данной статье представлен краткий обзор публикаций, посвященных исследованиям математической тревожности среди учителей начальных классов.
Результаты. В статье обсуждаются возможные механизмы развития математической тревожности и ее связь с математической успеваемостью в контексте причинно-следственных отношений. Основное внимание уделяется роли учителя в формировании склонности учащихся к математической тревожности и более низким результатам обучения. Обсуждается, каким образом математическая тревожность среди учителей начальных классов может способствовать получению их учениками негативного опыта относительно изучения математики. Приводятся примеры эмпирических исследований, изучающих распространенность и причины математической тревожности именно среди данной категории как действующих, так и будущих учителей.
Заключение. Исследования демонстрируют, что математическая тревожность среди учителей зачастую является результатом их собственного негативного опыта взаимодействия с учителями, использование учителями неэффективных подходов к обучению, а также наличия у них довольно низкого уровня математической компетентности. Обобщая результаты исследований, можно обратить внимание на так называемую цикличность непреднамеренной передачи математической тревожности от учителя к ученикам, которая требует решения на различных уровнях.

Ключевые слова: математическая тревожность, учитель начальных классов, математическая успеваемость, отношение к математике, передача математической тревожности

The origins and features of math anxiety

Math anxiety, which is construed as a negative response to the apprehension about or involvement in mathematical activities, produces a certain influence on people, their reactions, behaviour and often productivity and math performance. Its symptoms may be physiological (rapid heartbeat, sweating, tremor), affective (fear, disappointment, helplessness, embarrassment) or cognitive (lack of concentration). A complex construct in itself, math anxiety may be due to a whole host of factors. Although theories seeking to explain its origins vary, there is as yet no clear understanding of how and why such anxiety may occur. We can still identify some of the most extensively discussed causes. Studies show, for instance, that genetic factors may contribute to math anxiety to some extent (Wang et al. 2014). However, even though they may add to one's propensity for math anxiety, its probability and degree are largely predicated on environmental factors coupled with personal experience.

Propensity for general anxiety should be mentioned among hereditary factors. Although math anxiety is different from other types (general or test anxiety), there is a positive correlation between them, with a moderate effect size (Hembree 1990). This is why, overall, genetic propensity for general anxiety may manifest itself in math-related situations as well. Negative experience of mathematics may leave its mark on the future development of anxiety (exacerbate it) in the face of mathematics.

Math anxiety is associated with poor math performance. We have to note, however, that they are not the same since poor progress does not necessarily entail anxiety and vice versa. Research suggests a negative correlation between them, but most often with a moderate effect size (Hembree 1990). Such observations can be made in secondary school students and adults. Meanwhile, math anxiety can be also discovered in younger schoolchildren, albeit without any strong correlation with their achievement. The issue of whether math anxiety may be due to math underperformance is definitely yet to be resolved.

The Reduced Competency Account gives two fundamental explanations to the development of math anxiety (Ramirez et al. 2018). First, lower numerical or spatial skills may impinge on student performance, which, in its turn, leads to math anxiety. Second, difficulty in understanding mathematical concepts may be conducive to avoidance of mathematics — a behaviour typical of anxiety, which eventually only worsens the situation, creating a 'vicious circle' (Dowker et al. 2016).

As mentioned above, math anxiety is characteristic of schoolchildren of younger age. In this group, however, it does not correlate with mathematics achievement. This leads some researchers to think that lower math achievement results from a high level of math anxiety. The Disruption Account links worse performance with disrupted working (short-term) memory resources (Ramirez et al. 2018). Ruminations about the fears and consequences of a failed task, for example, prevent students from focusing on the performance of the task itself. Limited working memory leads to errors that can happen regardless of the student's baseline mathematical knowledge. Here we should stress that math anxiety is a cause rather than a consequence of underperformance. That is why some researchers look into the role of social or environmental factors as triggers of math anxiety.

Social and environmental factors may play a decisive role in the development of math anxiety at any stage. Negative experience of mathematics, gender stereotypes, cultural differences, a parent's or educator's influence and teaching methods are to name but a few. This paper reviews the critical role of teachers in shaping children's attitudes to study in general and a specific discipline in particular. Teachers can influence their students through the choice of the teaching methods and strategies and, last but not least, an attitude and behaviour of their own. Just like anyone else, teachers may be also negative about mathematics or even experience elevated math anxiety. This can quite naturally find its way into their choice of the teaching strategy and behaviour.

Math anxiety among primary school teachers

Researchers examining the reasons driving children's proneness to math anxiety put forward a hypothesis that adverse teacher-associated

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experience may contribute to the development of math anxiety in students (Raymond 1997) and impinge on their mathematics performance (Beilock et al. 2010). The bulk of studies revolving around this issue focus on attitudes to mathematics among primary school teachers. Studies most often involve prospective primary school teachers. English-language sources use the term 'pre-service primary (elementary) teachers', meaning teachers enrolled in training to become primary (elementary) school teachers. The smallest proportion of studies deal with 'in-service primary (elementary) teachers', who have already undergone the required training and teach in primary school.

There are multiple reasons why particular stress is laid on primary school teachers. First of all, some studies claim that math anxiety stems from the first years of formal mathematics schooling (Ramirez et al. 2013). Therefore, primary school teachers play an essential role in shaping the attitude that students adopt to mathematics as a subject. Second, primary school teachers have vast knowledge of children's psychology, pedagogy and methodology for teaching primary school subjects, but no training background in mathematics in particular. As a result, they may feel less confident about teaching mathematics, overstress the difficulty of the subject or opt for more formal teaching methods. Besides, since primary school educators are in charge of teaching a whole range of disciplines, they may tend to avoid mathematics or rush it through, giving priority to other subjects that may be of more interest to them. This may be certainly fraught with adverse implications. Therefore, research could bring into sharp relief the challenges faced by primary school teachers and prove instrumental in mapping out targeted measures to support them.

Overall, research into math anxiety among elementary school teachers goes back to as early as 1951, when a study dedicated to attitudes toward arithmetic among primary school teachers came out (Dutton 1951). It involved university students planning to teach in primary school. They reported experiencing some difficulties with arithmetic and having a generally low interest in its study. Besides, some of the respondents admitted they had a fear of making a mistake and were prone to frustration and avoidance in the face of mathematics. Regrettably, further research corroborated that trend among elementary school teachers (Hembree 1990).

As follows from a meta-analysis by Hembree (Hembree 1990), primary school teachers, on average, have a higher level of math anxiety compared to students focusing on other disciplines (e.g. social sciences, humanities, business, health sciences, mathematics and natural sciences). An empirical study conducted by Kelly and Tomhave (Kelly, Tomhave 1985) scrutinised several groups of students predisposed to math anxiety. The authors found out that the group undergoing training in primary education showed the highest level of math anxiety compared to other groups (the score was only higher among the students enrolled in a workshop for math anxiety).

Kelly and Tomhave also pointed out that math anxiety was higher in women. It is noteworthy that most studies confirm this trend (Hembree 1990). Math anxiety is thus more prevalent among female educators. Meanwhile, women make up an overwhelming majority of primary school teachers (Brady, Bowd 2005). The gender effect could thus account for elevated math anxiety in elementary school teachers. However, considering that students who have decided to become elementary school teachers basically show no particular interest in mathematics, but are supposed to teach it, other reasons exacerbating the prevalence of this problem in this group of students come to the fore. They may have to do with students' baseline mathematical competence, self-assurance, confidence in their knowledge and level of training in teaching mathematics.

Teacher as a source of math anxiety, or 'vicious circle' effect

There is a variety of explanations for how negative experience of mathematics can be transferred from teachers to students. When interpreting their findings Kelly and Tomhave (Kelly, Tomhave 1985) made a case that female students may acquire math anxiety from their female teachers. This assumption is built on the premise that students are more susceptible to the influence of the teachers of the same sex, often copying their behaviour pattern. Beilock

and co-authors investigated the probability of this scenario (Beilock et al. 2010). Their study revealed no link between the degree of teachers' math anxiety and student performance in mathematics in the early stages of schooling. By the end of the academic year, however, girls taught by teachers with elevated math anxiety tended to demonstrate worse academic performance. It is noteworthy that achievement was lower only in those girls who had a preconceived notion that boys are better at mathematics. The issue of the gender effect, which contributes to stereotypes about mathematics, is high on the agenda.

Gender stereotypes are not the only pathway for student–teacher transfer of math anxiety. Overly anxious teachers, for example, may pass their negative attitude toward mathematics to their students, adhering to the least efficient approaches to teaching. This means educators may rely too heavily on learning by rote, confine themselves to conventional learning methods, rush through the teaching, leave out important details, underexplain some of the mathematical concepts, neglect relations between mathematics and other disciplines or the real world, lack a personalised approach, etc. Teachers' negative attitude to mathematics may also go with a lack of confidence in their mathematical competence. This may certainly reflect on teachers' behaviour during math classes. For example, teachers can get irritated at the students requiring extra explanation, focus solely on mistakes, leave their students' efforts without praise, etc. Such practices may be a major obstacle for many students as they study mathematics.

This brings up the question of where math anxiety in teachers comes from. In one of the studies (McAnallen 2010), in-service primary school teachers were asked to outline the reasons that, in their opinion, might have contributed to their anxiety. The respondents mentioned their previous negative experience with teachers in primary and secondary school, which made them feel ridiculed or humiliated, and a focus on the speed of task performance and learning rules and facts by rote without understanding them among the factors that actually enhanced their math anxiety. Those who reported developing this type of anxiety in high school also recalled having been taught algebra and geometry in a way that was overly abstract. Along with the student–teacher interaction and teaching practice, the respondents quoted a lack of conceptual mathematical knowledge as another cause of math anxiety (McAnallen 2010). These findings illustrate that math anxiety is closely associated with educators, their attitudes, communication style and level of teaching. To an extent, they also back up the idea that teachers may unintentionally transmit their math anxiety to students, eventually pushing some of them towards becoming anxious teachers themselves.

A number of researchers tend to consider a lack of teaching skills or background as the core contributor to teacher anxiety. Gresham, for instance, comes to a conclusion that math anxiety in prospective elementary school teachers may slightly diminish (but not peter out, however) after they start working and building up their teaching experience (Gresham 2018). As discussed above, current research involving in-service primary school teachers is yet too limited to allow solid conclusions. Besides, researchers have recently started to draw a line between math anxiety and math teaching anxiety. The former implies anxiety about mathematical classes which may be found in any group of population while the latter is only characteristic of teachers, directed at the teaching process and not necessarily linked to mathematics itself. Although math teaching anxiety applies to difficulties with math teaching, not all researchers differentiate between these two concepts (Olson, Stoehr 2019).

Conclusion

A rule of thumb is that the same teacher may influence their students in completely different manners. If some children have problems with numerical or spatial skills and lack confidence, for example, they may largely fall under the malign influence of their anxious teachers, which may give rise to their math anxiety (Maloney, Beilock 2012). At the same time, all problems in mathematical education cannot be boiled down to math anxiety alone, for it can be but one of the reasons for the imperfection of math teaching methods (Wood 1988). Nevertheless, we have to acknowledge that math anxiety can be found in teachers as well, and in primary school

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teachers in particular. In the meantime, mathematics is a compulsory subject which educators have to teach in primary school. This explains the critical importance of instilling them with a positive attitude toward mathematics, thereby building a more beneficial environment for studying the subject. Particular attention should be given to teacher training programmes, which need to be aimed at deepening teachers' knowledge and bettering their math skills — something that may ultimately have a bearing on their anxiety levels. Overcoming math anxiety definitely requires initiative from teachers themselves, who need to aspire to personal development and training.

Conflict of Interest

The authors declare that there is no conflict of interest, either existing or potential.

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Авторы заявляют об отсутствии потенциального или явного конфликта интересов.

Author Contributions

A. V. Shakmaeva — review of publications, translation, preparation of the text.

A. A. Adaskina — research supervision, critical analysis and revision of the text, manuscript editing.

Вклад авторов

А. В. Шакмаева — обзор литературы, перевод, подготовка текста статьи.

А. А. Адаскина — научное руководство, критическая оценка и доработка статьи, редакционная правка текста публикации.

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