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Abandoning mathematics. Reconstructing the process in the context of the social perception of mathematics

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Mathematics, as no other school subject, evokes conflicting emotions and contradictory attitudes – from "the gate to a career" and "the queen of science" to the widespread acceptance of mathematical ignorance in society. The process of studying mathematics requires systematic work and patience, as mathematical knowledge has a cumulative nature. In the case of mathematics education, some students abandon mathematics at quite early levels of education and begin to consider themselves "humanists", which results in serious consequences for future educational and career choices. In this paper, I propose a description of the process of escaping from mathematics in the context of students' perceptions of this subject, using the results of two studies – one qualitative and the other quantitative.

Keywords: sociology of education; mathematics; perception of mathematics; educational choices; intertemporal choices.

Mathematics, like no other school subject, has been a source of conflicting attitudes and emotions. It is set on a pedestal, regarded as "the gateway to a career" or "the queen of science", but it is also simply ignored. The process of learning mathematics is very specific – it requires perseverance and patience, furthermore, mathematical knowledge is cumulative in nature. The literature shows that mathematics is a natural skill for humans (Danesi 2002; Devlin, 2000; 2005; Lakoff and Núñez, 2000). However, some students turn away from the subject at a relatively early stage. They assume that they are not able to learn math and begin to describe themselves as "humanists", which has very serious consequences for their future educational and professional choices.

The area relating to mathematical knowledge and skills is highly appreciated and continuously developed in the labour market, (e.g. Bożykowski et al., 2014; EACEA 2011; Koedel and Tyrust 2012; Kotlarski 2006; Sedlak&Sedlak, 2011; 2012). However, admitting to mathematical ignorance is quite common. In this context, mathematics is often set in opposition to the humanities, and the neglect of mathematical education is rationalised by possessing other mental dispositions and legitimised by the fact of belonging to the "other world". This division has its origins in the history of science and the schism described in the famous *Two cultures* by Charles P. Snow (1999; Tyrała,

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2003). The discussion of this phenomenon has moved from the area of the philosophy of science to common knowledge, where the division between having either mathematical or humanistic competences is treated as something obvious (if one is poor in math, he/she is a natural "humanist"; Drążewska, 2006). Consequently, poor mathematical competences may be a reason for pride, a unique manifestation of the humanistic soul (Prigogine and Stengers, 1990; Whitehead, 1987; Tyrała, 2003).

The popular view concerning the existence of two separate worlds affects the social perception of mathematics and becomes an extremely important element influencing the motivation and behaviour of students and other important participants of the discourse. The belief in "alternative worlds" influences students' daily decisions in education, which indirectly affects their skills and, more importantly, their choice of a further educational pathway. How do they perceive mathematics? Do they benefit from learning this subject? How is it perceived in the school environment and what is its status? We should definitely try to understand the process of decreased motivation for learning, which can be described as "abandonment", "avoidance" or "running away from mathematics (these terms will be used interchangeably). It has serious consequences for further education and the careers of young people with poor mathematical competence.

In the school curriculum, mathematics – apart from Polish – is a basic subject, taught with great frequency until the end of general upper secondary school. At the same time, it is considered a difficult subject. For this reason, in 1983, a decision was made to abolish the compulsory matriculation examination in mathematics. Later, the exam was compulsory only for students in mathematics and physics profiled classes, others could choose it as an oral matriculation exam. The form and content of the exams was criticised mainly for the lack of uniform tasks and assessment criteria for all Polish general upper secondary school graduates (IBE, 2011). As part of the reform of education, the issue of restoring the matriculation examination in mathematics resurfaced several times, however, subsequent ministers of education failed to do so or delayed the decision for many years. The restoration of the compulsory matriculation exam in mathematics brought the public debate back to life. It is still uncertain whether the requirement of passing the matriculation exam in mathematics will provide sufficient motivation for students to increase their efforts to learn this subject, or, even more so, to increase the level of their mathematical skills (Jabłońska, 2011).

Polish research on the perception of mathematics

Mathematics has become the topic of numerous papers in Poland. The results of each edition of PISA and the annual matriculation exams are widely commented on in the media, especially after the success of Polish fifteen-year-olds in the 2012 edition (Federowicz, 2013; Zawistowska, 2014). Issues relating to mathematics are the subject of many scientific papers. However, an analysis of the literature shows that most of the papers focus on the results of examinations and achievements in the context of the diagnosis of the state of mathematical education (Dąbrowski, 2011; IBE, 2013) or analyse performance at various stages of education, e.g. as part of the Program for International Student Assessment (PISA; Federowicz, 2013), Trends in International Mathematics and Science Study (TIMSS; Konarzewski and Bulkowski, 2016), the *Diagnosis of mathematical competence of primary school students* (*Diagnoza umiejętności matematycznych uczniów szkół podstawowych*, DUMA) or the study of mathematical competence of third- and fifth-graders (Kondratek, Grochowalska and Sułowska,

2015; Zambrowska, Karpiński and Kondratek, 2015). There are relatively few studies that go beyond the diagnosis of achievements, and even if they are conducted, they are strictly pedagogical in nature, focusing on mathematical talent (review in: Łubianka 2007; also see: Gruszczyk-Kolczyńska 1989; 1994; 2012 and – because of the contextual component – earlier editions of the *Polish nationwide survey of key competences of third-grade students* (*Ogólnopolskie badanie umiejętności trzecioklasistów* OBUT; Dąbrowski, 2011; 2013; Karpiński, Nowakowska, Orzechowska, Sosulska and Zambrowska, 2014).

Similarly, the attitude towards mathematics is rarely a subject of study, although it is sometimes taken up in connection with different projects. In terms of a more sociological approach, the data on the attitude towards mathematics collected in PISA 2000 and 2003 is definitely worth mentioning (Romaniuk, 2004). The following studies are also worth consideration: the Teacher Education and Development Study in Mathematics (TEDS-M), which examines the perception of mathematics among future teachers (Czajkowska, Jasińska and Sitek, 2010), the study on teaching mathematics in lower secondary schools, which includes a qualitative study of students and observation of mathematics lessons in terms of attitudes and motivation (Karpiński, Grudniewska and Zambrowska, 2013), as well as the latest study on teaching mathematics in primary schools, in which, apart from traditional surveys, observations, group interviews and individual interviews with mathematics teachers were also conducted (Karpiński and Zambrowska, 2015). A broader context was taken into account in the latest edition of the TIMSS study (Konarzewski and Bulkowski, 2016), which also examined the family situation and school characteristics.

The perception of mathematics, based on, among other things, attitude, the relationship between attitude and achievement, has been discussed in foreign literature since the 1960s (Aiken, 1970; Belbase, 2013; Feierabend, 1960; Ma and Kishor, 1997; Zan and Di Martino, 2007). The issue of mathematical stereotypes (e.g. Stanley Kogelman's and Joseph Davis's list of myths, cited in Shashidhara Belbase's work, 2013) is also relevant, particularly in the study of the reasons for abandoning mathematics. This topic is frequently developed with reference to gender stereotypes (e.g. Bedyńska and Rycielski, 2016; Eccles and Jacobs, 1986; Yee and Eccles, 1988). There are also separate (though not entirely) psychological analyses of the anxiety felt in connection with mathematics, defined as a form of a specific reactions to situations relating to the subject – which function independently of other "school fears", such as the fear of evaluation (e.g. Ashkraft and Krause, 2007; Cipora, 2015; Hembree, 1990).

These studies reveal factors that correlate with the level of mathematical skills; they also describe the effects of a certain type of perception of mathematics and related stereotypes. However, an attempt to describe the mechanism and the course of departure from mathematics requires greater emphasis on the relationship between the social perception of mathematics and the teaching of the subject, which is not included in studies of achievements, analyses of individual student problems and the classical application of socio-demographic variables.

The role of the two groups of actors who have the strongest influence on the attitude of young people towards mathematics – teachers and parents – is crucial. This is confirmed by research results (Aiken, 1970; Gunderson, Ramirez, Levine and Beilock, 2012; Jacobs, 1991; Keller, 2001; Kozłowski, 2013; Tiedmann, 2000). Teachers and parents have daily and direct contact with students. This is both an opportunity and a threat for the adoption of certain attitudes towards mathematics, because the members of these two groups may more or less consciously

impart their own stereotypes about the subject and their relationship to it (fascination, anxiety, interest, sense of importance and relevance in everyday life and in the future).

The theoretical approach

This analysis is based on the time--preference perspective[1] (e.g. Read, 2004; Stevens, 2010), where consequences are postponed. The subject of this article, however, is not the construction of a model of the time-preference perspective describing a student's decisions. The theoretical framework will serve to reconstruct the process of abandoning mathematics. This is a decision made more or less consciously, but it takes into account the tensions between present costs and future benefits and the impact of such factors as the perception of the subject, its status in the school and the student's closest environment on the described process.

The starting point for researchers of this trend is the assumption that when making decisions with delayed consequences, people behave in a seemingly unreasonable manner. For example, they choose momentary pleasure (cheating on a diet) at the expense of long-term health benefits. A similar mechanism applies to the well-defined problems of addiction, saving money, protecting the environment, professional decisions and educational attainment (Urminsky and Zauberman, 2015). These problems are defined as "anomalies in intertemporal choice" described in many publications (e.g. Bańbuła, 2006; Leland, 2002; Loewenstein, 1992; Loewenstein and Prelec, 1992; Loewenstein and Thaler, 1989; Rachlin, 2011; Read, 2004; Zielonka, Sawicki and Weron, 2009)[2].

The concept of self-control is crucial – as it is exposed to temptation, but it also allows us to resist (Rachlin, 2011). Self-control problems are stronger in the case of younger people (Green and Myerson, 2004; Green, Fry and Myerson, 1994; Green, Myerson, Lichtman, Rosen and Fry, 1996; Loewenstein, 1987). Those who are susceptible to self-control problems try to cope by asking their community for help: support groups, sports coaches, dieticians, family members (Rachlin, 2011). The effectiveness of the help indirectly depends on the community's attitude to the problem. In the context of a student's problems with mathematics, the experiences of the person who is to provide help (e.g. a family member) in learning this particular subject may be of great importance. This approach sheds new light on the issue of abandoning mathematics – other than for reasons resulting from individual aptitudes – and has many practical consequences. Therefore, the following issues are at the centre of the discussion: the social perception of mathematics, the challenges and benefits for students in the short-term and longer perspectives, and the impact of the functioning of mathematics in the school on the potential involvement of students in systematically learning the subject.

Data and methodology

The analysis used the results of two studies. The first, part of the qualitative research that preceded the campaign "Mathematics – you can count on it" (*Matematyka – możesz na nią liczyć*), was a response to the need to diagnose the key elements of the social perception of mathematics and to identify the factors and beliefs influencing this perception. It included six focus group interviews (FGI) conducted in January 2009 in three schools in the Mazowieckie Voivodship (in Warsaw and a smaller town). The size of the town, the position of the school in the

[1] The literature also uses the terms "intertemporal choice" or "time perspective".

[2] Although traditionally, meta-analyses summarise the results of research on discounting from different countries, recent international studies suggest that cultural factors should be taken into account. (Wang, Rieger i Hens, 2016).

ranking and the type of upper secondary school (general, profiled and vocational upper secondary schools) were taken into account when selecting schools and classes. Two focus group interviews were conducted in each of the schools with students in the last year of school. Table 1 explains the coding of students' statements cited in the article. The original wording has been preserved.

Quantitative data are derived from the *Violence in school 2011* (*Przemoc w szkole 2011*) study conducted within the framework of the "School without violence" social programme among students, teachers and parents. The focus was on school violence presented in a broad context, with questions about the atmosphere in the school (Komendant-Brodowska, Baczko-Dombi and Giza-Poleszczuk, 2011). The questionnaire included a series of questions on the perception of mathematics and Polish. A complex random sampling scheme was used, based on a random sampling of schools, followed by a sampling of classes in primary schools (grades 4–6), lower secondary schools and upper secondary schools. Information was collected through individually completed auditory surveys. Only data from the student population (N = 3169) is presented in this article.

Due to the length restrictions of this article, I will focus on the results of the interviews; the quantitative results will serve to reflect the conclusions of the qualitative data.

Abandoning mathematics – reconstruction of the process

Early school experiences

53% of the students agreed with the statement that "in order to be good in math, you must have innate abilities, which not everyone possesses". What is important, this percentage increased in subsequent stages of education – from 43% in the case of primary school students, 54% in lower secondary schools to 59% in upper secondary schools. In comparison, for the case of Polish, it was only 34%, and the percentage of indications was almost constant at various stages of education. From a statistical point of view, there was no significant relationship between support for this view and the student's sex or school grades.

This result may be considered as a representation of the "two worlds" presented in the introduction and a reflection of the division into those who possess "special abilities" and those who are deprived of the possibility to be "good in math". In common language, used by the students participating in the interviews, it corresponds to the division between "mathematicians" and "humanists". It is worth emphasising that this is not a matter of classically understood humanistic interests – in the context of discussions about mathematics, "humanists" do not have to be particularly interested in literature or history. This is reflected in a statement by one of the interviewed students:

Table 1
Characteristics of the class which the respondents attended

Code	Characteristics
F1	Last year, humanistic profile, general upper secondary school, Warsaw suburbs.
F2	Last year, mathematical profile, general upper secondary school, Warsaw suburbs.
F3	Last year, humanistic profile, general upper secondary school, Warsaw.
F4	Last year, mathematical profile, general upper secondary school, Warsaw.
F5	Last year, profiled upper secondary school, Warsaw.
F6	Last year, vocational upper secondary school, Warsaw.

> Humanists are not better in Polish. They simply don't know math.
>
> [F4]

The contrasting nature of labelling is very important. Being a "mathematician" involves possessing certain skills that are not "humanistic". It does not involve increased interest in the exact sciences, but the ability to cope with the challenges they pose. This label is the most important function in the division between the two worlds and almost always has a positive dimension.

Identification with one of the "worlds" is the result of a decision-making process. The assignment to the category of "humanists" or "mathematicians" is influenced by the experience of learning math, changing teachers, moving to higher levels of education.

> I felt I was a humanist from primary school, really. I don't know, maybe because the teacher wasn't able to arouse my interest, because I always think about math as something that I am not particularly fond of, that I don't want to do.
>
> [F3]

Students' statements show that the lack of mathematical skills is not an innate trait and a negative attitude towards the subject is not due to family traditions. This is evidenced by the way in which students in the last year of school, even those who experienced mathematical problems and had a negative attitude towards the obligatory examination in math, talked about their first experiences. The first contacts with mathematics were described as joyful, interesting, exciting. The students' behaviour when making these statements was relevant – body language and facial expressions changed, they began to gesticulate.

> I think my first contact with mathematics was when people asked me about my age and I had to show that I was three or four.
>
> [F2]

> I always fell asleep with my dad, but when I was really small, my parents taught me to count to a hundred. When I couldn't sleep, they would say: Come on, show us how you learnt to count to a hundred, and before I got there, I fell asleep.
>
> [F6]

It is worth mentioning three issues relating to students' first contact with mathematics: time (usually preceding school), family context and form of play. Positive memories were usually associated with the pre-school period – they did not disappear despite the passage of time and many years of further education, when mathematics actually became repugnant to some of the respondents. The stories frequently included parents, less often grandparents or siblings. These conclusions are in line with the concept of "children's counting" which appears in the literature (Gruszczyk-Kolczyńska, 1989; Gruszczyk-Kolczyńska and Zielińska, 2007), considered to be crucial for the development of further mathematical competences and the readiness to learn math in school.

> I remember what I felt in primary school when I learnt something new, that I can subtract, multiply. I was so excited that for two days, I multiplied everything.
>
> [F2]

Despite positive memories, with the passage of time some students began to abandon math. At some point in their school education, they came to the conclusion that they were not "mathematicians". They felt that they had ceased to cope with the subject, they could not keep up with the material, they were labelled as "humanists" or they began to consider themselves as such. Let us take a closer look at this phenomenon. When students tried to define the time when they encountered their first difficulties in learning math, they often pointed to primary school. This was frequently a moment of transition when the teaching style or the

level of difficulty changed (e.g. transition from 3rd to 4th grade, from primary to lower secondary school, change of school, change of teacher).

The students rarely talked about the difficulties encountered during the first three years of school. However, the results of research indicate that many difficulties in the subsequent stages of education are a consequence of serious problems during the initial years of mathematical education, relating to, among other things, the preparation of teachers (Karpiński and Zambrowska, 2015; see also Karpiński et al., 2014; Konarzewski, 2012; Wiatrak, 2011). Some of the students were successful in early school education thanks to a good teacher who was able to develop their mathematical skills, for example, by organising competitions, interest groups, motivating them with good grades. Sometimes, the solid foundation obtained in the first years of primary school were enough to become a "mathematician". However, those who were less fortunate and did not have good teachers showed signs of the first serious problems.

> R: I cried all night, because I got an F in math, and earlier I got only A's. I changed school, the level was the same, but the teacher was more demanding. So when I received an F, it was like a total disaster for me, a life disaster.
> I And what did you do?
> R: I did problems all the time, I did all the homework. If we didn't do something in class and moved on to the next chapter, I did all the problems that we skipped. I did all the problems from the course book, twice, and once again before a test, so that I wouldn't get an F. It's a pity it's not like that now.
>
> [F1]

Entering a "humanistic" path could also have been the result of a positive event – when, after failing in mathematics, the student received reinforcement from a teacher of another subject. If he was successful, he could receive a new label. Of course, we should be cautious with such simplified explanations and analyse them in a broader context.

Education in lower secondary school and post-lower secondary school

A significant part of the interviewees declared that they already knew in lower secondary school whether they were good at mathematics and which world they belonged to. Sometimes the change of teaching conditions was enough to influence a change in the student's label – in this case, the role of the teacher was always emphasised:

> I had a fantastic teacher in the 3rd grade who let us catch up with the material. She repeated the 1st grade with us and I had a good grade in mathematics at that time, but I knew that I deserved it because she really taught us everything.
>
> [F1]

Upper secondary school is, according to final year students participating in the qualitative research, a time in which the existing divisions deepen, depending on the choice of school and class profile. Decisions made prior to the final stage of compulsory education are a kind of closure of the abandonment process and significantly impact future careers, narrowing or broadening the direction of further education. This is well illustrated by a statement of a student in a profiled upper secondary school:

> I liked math in lower secondary school, I never had any problems with it, but I think this school does not give enough attention to mathematics, there are too few hours and we have no homework. No requirements as to the books, only that we should buy them and bring them to school, so I think […] there should be greater emphasis on economic subjects […] trade, specialisation. I think that the level of our general upper secondary school is low.
>
> [F6]

Even if a general upper secondary school student opted for a specialised class in the exact sciences, he/she might have too little knowledge to pass the mathematics exam at an advanced level and receive enough points to be accepted to university to study the exact sciences.

The perception of mathematics – between challenges and benefits

Shaping the skill of accumulating knowledge

Mathematics is stereotypically perceived as a difficult subject. What exactly did the students say about the challenges they faced when learning this subject? First, they drew attention to the cumulative nature of mathematical knowledge.

> The worst thing is that subsequent topics are related to earlier ones, so if you don't learn something earlier, you won't cope later. […] It's a disaster. […] Because if you don't learn one thing, everything else falls apart.
>
> [F5]

Learning math requires a great deal of self-control, and even a small stumble and foundering with the material can result in a serious backlog.

> In my opinion [a person coping with mathematics – author's note] should be patient, because when there is a difficult problem, he/she tries, uses other patterns, but tries to finish. And some people do not have the patience [for this], for example me, and after the first failure, if the result does not match the answer, I get discouraged.
>
> [F3]

Students also talked about the need to support the process of learning mathematics. This can be done by a teacher or another person – a tutor, less frequently a parent. The role of the teacher is crucial, one can say that school mathematics "has the teacher's face". The student should be able to turn to the teacher for help, to catch up with the material and not run away from math.

> To some extent, you can learn on your own, but we need some kind of supervisor, who will demand something from us, because it's difficult on your own […].
>
> [F2]

> It has to be someone really persistent, someone who wants to achieve something on their own […], but someone needs to show us at least once what to do. If you have the basis, you can develop, move forward, but they need to tell us something if it's a new topic.
>
> [F2]

The awareness of difficulties and challenges also emerged in the quantitative results of the study. The percentage of respondents who think that mathematics requires systematic work was very high at all stages of education. In the case of other dimensions relating to mathematical challenges, there was a noticeable increase in the awareness of difficulties along with subsequent stages of education (Figure 1). This result can be interpreted in two ways – on the one hand, as a positive manifestation of growing student awareness, and on the other, as evidence that math is more demanding compared to other subjects. For many students, this could be a factor that moved them away from math towards subjects which can be learnt by rote. There is also a very significant drop in the percentage of students who believe they can learn mathematics themselves. This proves how important the role of the teacher is.

The usefulness of knowledge and satisfaction with learning

When referring to positive stimuli, it is worth mentioning the usefulness of mathematical knowledge and the satisfaction in having contact with math. In the public

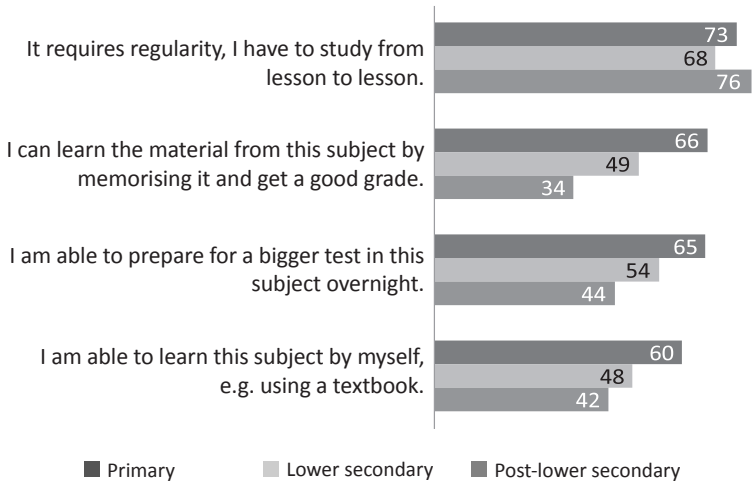

Figure 1. Challenges related to learning mathematics among students at different stages of education (in %).

Own analysis based on the study *Violence in school* 2011 (*N* = 3169). Students were asked if they agree with statements regarding mathematics. More statements were analysed, but for the purpose of this article, statements were selected on the essence of the problem under discussion.

discourse, the first factor is considered the main motivator for learning. With regard to usefulness, students talked about elementary issues, such as dealing with shopping or banking. In the quantitative survey, students were asked about current benefits (usefulness of knowledge in school and in everyday life) and deferred benefits (chance of further studies, finding a job). It turned out that changes in the perception of different types of benefits are reflected in the quantitative data. At the level of primary school, the percentage of students who saw future benefits was close to 90% (89 and 87%, respectively), while in the case of current benefits, it was slightly lower (81 and 78%). At the level of lower secondary school, these figures dropped only slightly with regard to the need to enter university and the usefulness of mathematics in other subjects. A very significant decline in the proportion of students who believed in the usefulness of mathematics in everyday life (from 81 to 64%) is also worth noting. As regards the usefulness of mathematics in other subjects, this occurs in upper secondary school, but it is not significant (Figure 2). In other words, the stratification of long-term and short-term benefits is noticeable. On the other hand, this division is characterised by a decrease in the perception of the practical, everyday use of mathematics in comparison to its usefulness in school. This would explain the different dynamics of the answers in relation to finding a good job and the chance of being admitted to university.

Another, often underestimated dimension of mathematical satisfaction is feeling challenged, as described by students, similar to the experience of competition or sport. This factor often motivates them to "stay close to math".

> The challenge, the duel, the content of the task, that you have to find something, be clever, use your skills.
>
> [F3]

Finding the right result is a source of great joy. It is a "moment of truth", although in the case of mathematics, satisfaction can

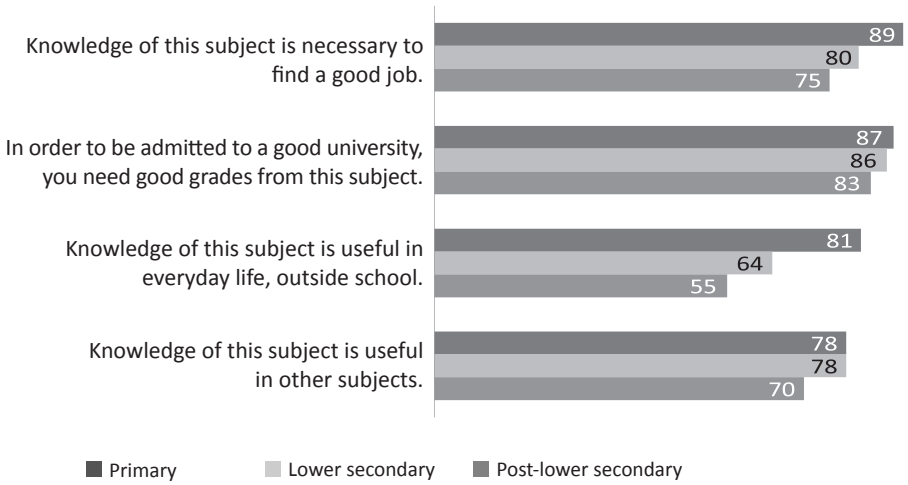

Figure 2. The usefulness of mathematics in the short-term and longer perspectives among students at different levels of education (in %).

Own analysis based on the study *Violence in school 2011* (*N* = 3169). Students were asked if they agree with the statements regarding mathematics, formulated as presented in the graph.

also be achieved in the search for the solution to the problem.

> I did my homework and some of the results were wrong, so I thought that's it... I pulled my hood over my head, lay down on the floor; I was angry, but when it worked I was really happy, I danced.
>
> [F1]

> I was fascinated, because I could not handle it, all those patterns, implications, negatives, other things, but it got me so involved that I was just sitting and solving those long problems, a mess of symbols really, and finally I got the answer "Yes", "No", or just ... I came to a logical solution.
>
> [F3]

Another advantage of learning math is that the tasks have only one solution. Unlike the case of Polish, where the result depends on the interpretation – especially in the matriculation exam, when success depends on the skilful formulation of statements consistent with the exam key. It can be said that math is a kind game based on fair play – demanding, but predictable. Mathematical success cannot be undermined.

The role of the status of mathematics

The factor that distinguishes mathematics from other cumulative subjects (physics or chemistry) is its status. In addition to Polish, this is the only subject that students learn in all years of their school education and they need to pass the compulsory matriculation exam. Mathematics is also the basis for recruiting students, practically in all fields of science studies, as well as in many natural and social fields of study. Abandoning this subject at an early stage of education closes many educational paths. Mathematical proficiency will affect success in other science subjects – both at school and university. Students know this. In the quantitative study, 30% of students said that mathematics was the most important subject, and 71% declared that it was one of the three most important subjects, which corresponds to the opinions about Polish (28% and 66%, respectively).

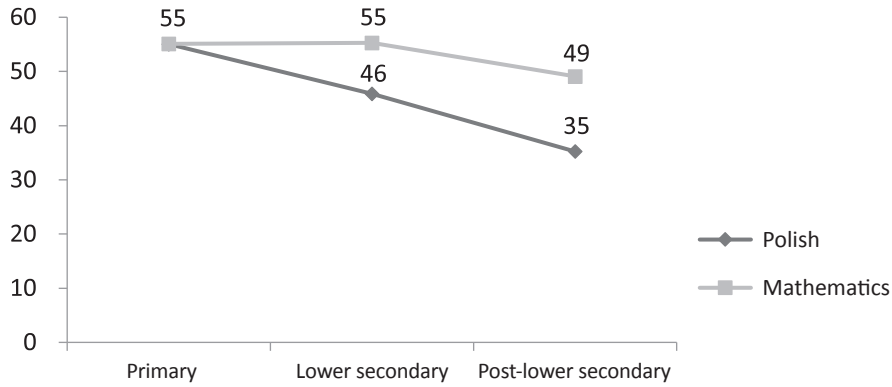

Figure 3. "Many teachers of other subjects at my school pay attention to grades in math" – a comparison of opinions on mathematics and Polish among students at different levels of education.

Own analysis based on the study *Violence in school 2011* (*N* = 3169).

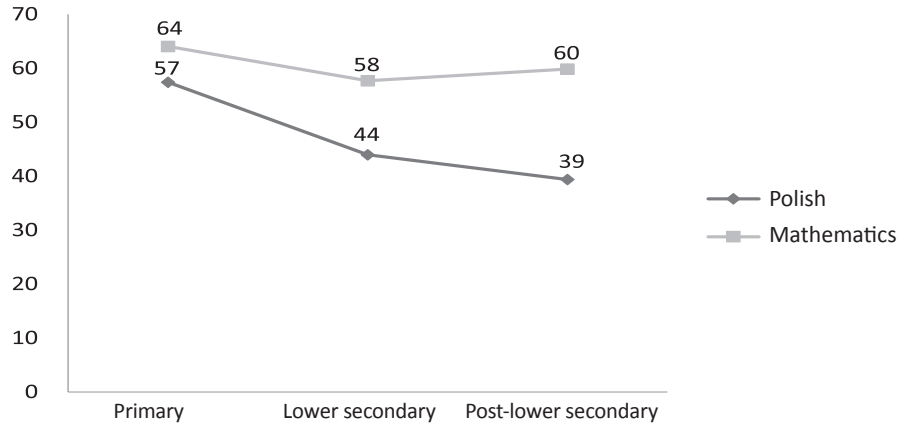

Figure 4. "Being good in this subject is a distinguishing factor among other students" – a comparison of opinions on mathematics and Polish among students at different levels of education.

Own analysis based on the study *Violence in school 2011* (*N* = 3169).

Interviews conducted with upper secondary school graduates show that mathematical skills are an important criterion for determining identity, which also affects the status of the subject. In this sense, the feeling of possessing (or not) mathematical skills will be a factor that strongly differentiates both worlds of "mathematicians" and "humanists". This was analysed in the quantitative study by asking whether teachers pay attention to grades in mathematics (Figure 3), and whether being good in this subject is a distinguishing factor among students (Figure 4).

The status of mathematics in the family environment is also important. Interviews show that parents have a special attitude towards the subject. Much depends on

whether mastering mathematics is considered a difficult, unattainable goal – in this case, their own experience is crucial. Students often said that math grades were treated differently than grades from other subjects. Due to the perception of mathematics as a difficult subject, parents tend to have lower expectations of their children in this area.

> [Mum] says that mathematics is the queen of all sciences. But when I tell her that I got a B in Polish, she asks "Why not an A?", and when I say that I got a B from math, she says "Well done!".
>
> [F1]

This clue is extremely valuable and worth investigating further. The way children perceive mathematics is indirectly influenced by the way parents perceive the subject. This is revealed in the expectations they have of their children, encouraging them to work, shaping attitudes toward the subject (Kozłowski, 2013).

Trampoline or self-fulfilling prophecy?

Abandoning mathematics can be a rational strategy. Identifying oneself as a "humanist" to a certain extent releases us from the need to face challenges and overcome difficulties. If a student stumbles and fails to catch up, then such an identity allows him/her to choose a less bumpy path, enabling him/her to advance in school and career – slightly differently than would a "mathematician". On the other hand, the high status of mathematics and the potential to differentiate between the "two worlds", may trigger the mechanism of a self-fulfilling prophecy. If a student believes he/she is weak and the external environment shares this view, it can affect his/her success or failure in other subjects.

> This is a problem, because for example, when we had physics or chemistry in 1st and 2nd grade, the teachers said: "OK, a humanist". It becomes an excuse.
>
> [F1]

This statement casts the "humanist" in the light of a person not interested in the exact sciences. If the teacher of the subject also believes this stereotype, he/she may come to the conclusion that it is not worth spending time and energy on the student. The impact of this stereotype could include entire humanistic classes, which in turn affects the quality of teaching.

The other side of this spectrum is the label "mathematician" – a mathematical and logical thinker – that can serve as a trampoline for the student. A person considered to be good in math may be treated favourably in other subjects, e.g. "humanistic" subjects, and the more he/she invests in the development of mathematical skills, the better results he/she achieves in related subjects.

A positive perception of mathematical skills in the environment may be a reason for developing a feeling of superiority. This is related to the different way of acquiring knowledge. "Humanists" are attributed with reproductive, memory-based acquisition of the material and a specific "lack of mental intelligence". It should be emphasised that this mechanism is detrimental primarily to the humanities, as it brings this field of study down to being "non-mathematics".

> [I snap my fingers] and it's done and they say: "Oh no, how should I do this, I'll put in this result, no, this is wrong" – and so on. Well [during the matura exam] I did all our closed tasks in three or four minutes, and I looked around, although I should not have – that's true – but I looked around, because there were only humanists around me, and one of them was sitting and staring at the front page and looking at me "how was it possible that I was so far ahead, how did I do that", and he had to put in the results and check if that was how it should be done. So I look at him and think, he's basing it on his memory, that's it.
>
> [F2]

Summary

The aim of this article was to reconstruct the mechanisms that make students abandon mathematics, taking into account the specificity of the learning process, as well as the perception and high status of the subject. It was shown that even after a relatively insignificant stumble, a student may choose a safer educational path and abandon mathematics by limiting his/her contact with the subject. In the long run, this may result in the closure of educational and professional paths which require the development of mathematical skills.

According to the assumed theoretical approach, the structure of the motivation of learning mathematics is very important in terms of current usefulness, satisfaction with daily contact and the prospect of benefiting in the foreseeable future. However, data shows the tension between school mathematics and the practical, everyday use of math, which students quickly lose sight of. Involvement in learning math is influenced by the challenges associated with the subject: systematic learning, the cumulative nature of the subject and the great deal of self-control that is required. An important risk factor for abandoning mathematics is the specific status of the subject, which can act as a catalyst in the process of determining our membership in one of two worlds. The attitudes of adults, who are present in the student's surroundings, also influence individual motivations and decisions. Frequently, teachers spend too little time trying to interest students in the exact sciences, and parents look at their children's results through the prism of their own experience with mathematics.

By looking at the problem from this perspective, we can see certain possibilities of "saving" students from abandoning the subject. This can be achieved by motivating students to acquire mathematical skills and relating them to everyday life, showing the current benefits of math. Teachers should plan lessons in such a way as to interest students, especially older ones, so that they can observe the direct relationship between the school curriculum and everyday life. On the other hand, when thinking about mathematics in the context of self-control challenges, we see how important it is for parents to shape these skills in pre-school children: building high self-esteem, promoting cognitive curiosity, developing the willingness to take up challenges, as well as patience and perseverance in pursuit of a purpose. Schools then should also be developing these skills. The need to educate children by showing them that failures are a constant factor of being active and by creating opportunities for them to feel joy and satisfaction in achieving success take on an entirely new dimension. These skills are an extremely valuable asset that will be beneficial not only in math classes, but also in other areas of life.

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