

## WHAT MAKES LEARNING MATHEMATICS AN ENJOYABLE EXPERIENCE: LISTENING TO ESTONIAN PUPILS' VOICES

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### ABSTRACT

Research has shown that affective factors, including liking the subject, influence pupils' mathematical performance and future decision-making. The aim of this paper is to reveal the factors that influence one's liking of mathematics. The study, based on semi-structured interviews amongst pupils from 7th, 9th and 11th grades in Estonia, tried to find answers to the questions why pupils like or dislike mathematics as a subject and why pupils like or dislike the mathematics teacher. The study concluded that mathematics is liked because of specific activities that pupils are engaged with in the lesson (e.g. figuring things out); of specific content (e.g. word problems); of feeling competent in mathematics and understanding the subject, and because the teacher displayed the following characteristics: being polite, caring, funny, professional and reasonably strict, creating a good learning environment, explaining the subject well, relating mathematics to real life and being a sensible evaluator.

**Keywords:** Affective domain, Pupils' beliefs about mathematics, Likable mathematics, Teacher's influence, Likable mathematics teacher.

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## INTRODUCTION

Each year in Estonia fewer pupils choose to take the state exam in mathematics and to study mathematics at university. This decrease, at university-level, is also observed internationally (Holton, 2001). The diminishing number of university students who choose science and engineering is a problematic fact that has been acknowledged by the educational community as well as by the political leaders in Estonia. For decades it has been pointed out that students' beliefs and attitudes towards mathematics are among the influential factors in choosing further mathematics courses (Armstrong & Price, 1982; Reyes, 1980; Meece, Parsons, Kaczala, Goff, & Futterman, 1982) and dropping out of advanced mathematics courses (Ma & Willms, 1999). Furthermore, affective factors, such as attitudes and beliefs, are also claimed to be related to mathematics performance in general (Hannula & Malmivuori, 1996; Ma, 1997; Ma & Kishor, 1997; Schoenfeld, 1989; Wong, 1992); and, for example, in solving limit problems (Juter, 2005), in problem-solving (McLeod, 1993), and in geometry and data analysis (Walsh, 1991), in particular.

Therefore, one possibility to affect pupils' performance in mathematics and their further career decisions might be by emphasizing and promoting positive attitudes and beliefs, and facilitating enjoyment in mathematics. Perkkilä and Aarnos (2007) have also concluded that experiencing the feeling of joy in learning mathematics is important. Moreover, the new Estonian curriculum, which will be implemented in autumn 2011, will take into account the positive affective aspects in mathematics lessons. It is pointed out under the section of the learning goals for mathematics that teaching should aim at pupils' valuing mathematics and enjoying working with mathematics (Vabariigi Valitsus, 2010). This in turn motivates exploring the aspects of likable mathematics, and the possibilities to support the enjoyable learning of mathematics. Hence, researching aspects of teaching from the perspective of pupils is essential as well. As Konrad Krainer (2005) writes about studies of good mathematics teaching:

*Research is increasingly challenged to play an active role in mediating important educational issues in our society. The goal is to raise our society's expertise for good mathematics teaching. Thus researchers, teachers, students, policy makers, etc. are expected to be experts in arguing what constitutes good teaching. (p. 77)*

The study presented in this paper is a part of a larger doctoral project that investigated Estonian pupils' beliefs and attitudes towards mathematics, and its' teaching and learning. It included both quantitative and qualitative research methods for the purpose of methodological triangulation (Cohen & Manion, 1992) and for gaining a wider picture of the phenomenon under examination. This paper mainly includes the qualitative part of the study but also gives a short overview of the quantitative part in order to set out the background of the qualitative part of the inquiry. The aim for carrying out the qualitative study was to illuminate important characteristics that emerged from the analysis of the quantitative, questionnaire based, inquiry. Semi-structured interviews were composed using the ideas gained from the questionnaire study in order to get a deeper understanding of the reasons behind the answers. The interviews were carried out among pupils from grades 7, 9, and 11, and the analysis for this paper was approached from the perspective of the likable characteristics of mathematics. The motivation to have this aspect of the analysis emerged, first, from the open-ended answers of the questionnaires where respondents very often pointed out the importance of liking mathematics with substantial teacher influence for making mathematics more likeable to them (Kislenko, 2009b). Secondly, despite the fact that there is an extensive body of international research, Estonian pupils have not been investigated from this perspective. Therefore, the aim of the study is to investigate pupils' beliefs about enjoyable mathematics learning and likable mathematics teachers. In the paper a definition of belief is adapted from the work of Erkki Pehkonen (2003) who considers belief as individual subjective knowledge. In the context of this study, belief is the individual's subjective knowledge about mathematics and its learning, and I especially investigate the reasons why pupils might like or dislike mathematics or the mathematics teacher. Thus, the research questions were formulated as follows:

1. What are pupils' reasons for liking or disliking mathematics and its learning?
2. Does the mathematics teacher influence pupils' beliefs about mathematics?
3. What are pupils' reasons for liking or disliking the mathematics teacher?

When answering these questions in this paper the important factors that influence whether pupils like or dislike mathematics are presented, and suggestions for teaching practice are given.

## THE FOUNDATION OF THE STUDY

### Short summary of the quantitative study

The quantitative study focused on pupils' affective domain in mathematics education. It has been pointed out that there is a lack of well-developed theoretical frameworks in the study of affect (Goldin, 2004) and precise definitions of the main concepts in the area (Furinghetti & Pehkonen, 2002; Di Martino & Zan, 2003). This study has taken Douglas McLeod's (1989; 1992) work as a basis for the theoretical foundation of affect, which is generally regarded as something different from pure cognition; and he explains that beliefs, attitudes and emotions are specific subsets of the affective domain. Taken in that order, they represent an increasing degree of affective involvement and intensity of responses, and a decreasing level of cognitive involvement and stability of responses. Beliefs are mainly cognitive in nature and developed over a long period of time (Goldin, 2002; McLeod, 1992). This reflects back to the idea of beliefs being an individual's subjective knowledge (Lester, Garofalo, & Lambdin Kroll, 1989; Pehkonen, 2003), and being situated somewhere between humans' affective and cognitive domains, which Pehkonen (2003) calls the "twilight zone". As beliefs are always arranged in a system, then this individual mathematics-related belief system is called his/her view of mathematics (Pehkonen, 1995). Therefore, the aim of the quantitative study was to investigate pupils' view of mathematics, which encompasses pupils' beliefs about mathematics, about oneself as a learner and user of mathematics, and about mathematics teaching and learning.

The piloting of the quantitative study was done amongst 245 Norwegian pupils, and the main study included 580 Estonian pupils. The Likert scale questionnaire about pupils' beliefs and attitudes towards mathematics was given to the 7th, 9th and 11th grade pupils. Here I present briefly some essential conclusions of the Estonian study that related to the tendencies of the qualitative study (this relationship is presented in the concluding section). Extensive discussions of the quantitative part are reported in Kislenko (2009a; 2009b). In the main quantitative study, from the statements expressing pupils' beliefs about mathematics, learning mathematics and themselves, six factors were identified: interest in mathematics, self-confidence in mathematics, hard-working in mathematics, usefulness of mathematics, mathematics as an absolute discipline, and insecurity in mathematics

lessons. From there the results of three factors (interest, self-confidence and insecurity) are considered important for this paper. Out of all respondents 54% agreed that mathematics is exciting and interesting, and 37% answered that mathematics is boring. More than 20% of respondents did not provide consistent answers relating to this factor, and approximately 8% agreed with both of the statements at the same time. Mathematics was in general considered to be difficult (71% agreement), and only 28% claimed mathematics to be easy. Considering insecurity in mathematics lessons, it appeared that almost 40% of pupils were often or very often afraid of making mistakes when doing mathematics, and 22% were afraid to show their teacher that they do not understand mathematical problems (Kislenko, 2009b).

### **Literature review**

Elena Nardi and Susan Steward investigated quiet disaffection in the mathematics classroom, and they were able to detect several factors that make mathematics enjoyable or unpleasant for pupils (Nardi & Steward, 2002; 2003). Three components - the nature of the classroom activities, preferred ways of working, and the structures that organize learning – were pointed out as reinforcing the interest of mathematics. Firstly, pupils liked practical activities to which they could relate. The ‘fun’ activities could be games, puzzles, practical projects and investigations. Secondly, working together and having a reasonable working tempo in the lesson in order to gain a deeper understanding of the content were also preferred by the respondents. The third component concerned different ability groups in learning mathematics, which were not favoured by the respondents (Nardi & Steward, 2002). From the opposite view, when exploring disaffection in the mathematics classroom, five characteristics were detected: tedium, isolation, rote learning, elitism, and depersonalisation. Shortly, the negative view towards learning mathematics was related to, first, disliking irrelevant, trivial, and repetitive tasks, all of which make mathematics learning boring, and secondly having too little opportunity to work with peers. Moreover, experiencing mathematics as a set of rules and mindless task completion activity; perceiving mathematics as a demanding subject in which only exceptional people can succeed; and having a learning environment that does not take their individual needs into account were also disapproved. What pupils

actually want is 'relevance, excitement, variety and challenge', and 'deeper, more essential understanding' when learning mathematics (Nardi & Steward, 2003, p. 352, 355). The importance to students of practical and real-life related activities, as well as promoting understanding, was also evident from the study carried out by Khoh, Om P, and Yee (1999) amongst Singaporean junior college, polytechnics, and university students, whose attitudes towards mathematics were investigated. Their research suggested two ideas for encouraging students' enjoyment towards mathematics. First, students would like to have more real applications of mathematics that were related to either their future work or to other subject areas. Secondly, the assessment should focus on the understanding of concepts and thinking skills rather than an ability to score high marks through repeated practice and standard questions (Khoh et al., 1999).

There is some consistency in the conclusions of studies on pupils and student teachers, which focus on the positive and negative experiences in mathematics, based on the three following studies: the survey on 13 and 17 years old pupils by Berger (2000), the interviews with fifth grade pupils by Stodolsky, Salk, & Glaessner (1991), and student teachers' essays by Hoskonen (2007). The aspects of liking were related to ability, i.e. mathematics being easy, and being successful in mathematics (Hoskonen, 2007; Stodolsky et al., 1991). Stodolsky et al. (1991) included certain activities that were considered fun, and interesting content to this list. The respondents in Berger's (2000) study specified the content to geometry as something they had a good experience with. Both Berger (2000) and Hoskonen (2007) emphasized the development of logical thinking, and the latter mentioned also the beauty of the challenge and puzzling over the problems. As expected, some of the opinions about negative experiences in mathematics were the simple converse of the positive experiences. For example, Stodolsky et al. (1991) concluded that pupils disliked the times when they felt mathematics was too difficult and they did not succeed in mathematics. Occasionally, both content and activity in the lesson were considered boring (Stodolsky et al., 1991). The activities in the lessons are related to the teaching methods that in turn are related to the teacher. It was evident that most of the reasons for disliking mathematics in the studies by Berger (2000) and Hoskonen (2007) were explicitly related to the teacher and his/her behaviour and

way of teaching. For example, being set tests that were too difficult and being given too much homework were negative considerations (Berger, 2000). Also, it was disliked when the pace of teaching is too fast (Berger, 2000; Hoskonen, 2007) or too slow, or when the teacher only gives routine tasks in the lessons, behaves badly or discourteously, e.g. jeering at pupils' mistakes, and displays insufficient didactical and mathematical competencies (Hoskonen, 2007). Kirsti Hoskonen (2007) concluded this point by saying:

*Mathematics itself is not negative. Students join negative experiences into their teachers and their actions. [...] Even the pupils in the lower secondary school have missed a teacher who has authority and who can present mathematics in a coherent and meaningful way. (p. 254)*

She added that most of the pupils revealed negative experiences about only one specific teacher, and their attitude changed when they had another teacher.

Such findings, when considering pupils' attitudes toward mathematics, lead to questions such as 'how influential is the teacher?' and 'how much difference does the teacher make?' The findings of previous research suggest that the answers to these are that the teacher is very influential and makes a lot of difference. An explanation for these findings is that pupils' classroom experience is very important in the formation of their beliefs about and attitudes towards mathematics (Pehkonen, 1995; Schoenfeld, 1992; Thompson, 1992). Further, pupils' classroom experience is directly linked to the teacher. Nardi and Steward (2002) explicitly state that the teacher affects pupils' enjoyment in any subject, and particularly in mathematics.

With these considerations in mind it is reasonable to assume that as the teacher makes a difference then it would be valuable to clarify the characteristics of teachers and teaching that might promote pupils' enjoyment in mathematics. Numerous studies have tried to suggest a number of aspects that teachers might consider for making the mathematics lesson more likable for pupils. These aspects can be found in the research studies about good mathematics teaching as well as in studies that investigate pupils', university students' and student teachers' beliefs about mathematics in general. Therefore, the aim at the outset of the study reported in this paper is to gain an overview of the components of teaching that pupils would like to experience in mathematics classrooms, to which other researchers have drawn attention.

I start with the research on pupils' beliefs. While investigating confidence in mathematics classrooms Leone Burton (2004) asked pupils to express their opinions about what teachers should and should not do to encourage an environment that supports the growth of confidence. Pupils assert that the teacher should explain well, should not rush the work, should be aware of what the pupils are talking about, and should be sensitive towards the pupils who struggle to understand. Moreover, pupils preferred a relaxed classroom environment where one is not afraid to make mistakes, and the discussion and teamwork are facilitated. They disapproved when somebody is ridiculed, and made to look foolish. Lessons are not enjoyed when pupils fail to understand, and when the activity is only repetitive and not applicable (Burton, 2004). These aspects are similar to those pointed out in the study by Nardi and Steward (2003) where English pupils stated the expectations about the teacher. The teacher is expected to be friendly and open to pupils' questions; to give positive feedback and praise; to explain clearly and in different ways; and to use concrete examples and tasks that are useful, enjoyable and to which they can relate. Similar to the respondents from Burton's study (2004) pupils disliked to work in the atmosphere of fear and humiliation, and to be put down (Nardi & Steward, 2003). Murphy, Delli, and Edwards (2004) looked for similarities among the views of 'the good teacher' held by second-grade pupils, pre-service teachers, and in-service teachers. Briefly, they concluded that a good teacher is caring, patient, not boring, polite and organized.

Singaporean college students emphasized the notion 'interesting' when giving suggestions for teaching (Khoh *et al.*, 1999). They recommended their lecturers to make the lectures more interesting; to challenge students with more interesting "situation" questions; to use visual aids or other interesting teaching approaches. Proceeding at slower pace, providing more examples, and including history of the development of the topic were also favoured (Khoh *et al.*, 1999).

The studies by Grevholm (2007) and Schuck (1996) exposed student teachers' descriptions of a good teacher and good teaching, and several categories of the answers overlapped. The first characteristics could be called personal qualities. Sandra Schuck (1996) pointed out being supportive, holding positive attitudes and having good communication skills, and Barbro Grevholm (2007) added



qualities such as being calm, fair, understanding, humorous, sharp, funny and engaged. The teacher's ability to support and motivate (Grevholm, 2007) as well as in using a variety of teaching methods and possessing good management skills (Schuck, 1996) were also mentioned. Two other classifications were involved, namely, the teacher's mathematical subject knowledge and the teacher's pedagogical content knowledge. The teacher is supposed to have knowledge in mathematics, should explain well, and be interested in mathematics. From the pedagogical perspective, the teacher is recommended to come down to the level of the pupils, to invent new ways of explaining if the first explanation was unsuccessful (Grevholm, 2007), to use practical methods of teaching, to illustrate the relevance of mathematics and to make sure that mathematics lessons are enjoyable (Schuck, 1996).

Concluding, based on the previous overview of different studies investigating different groups of people (pupils, students and student teachers) several similarities could be found. One of the important outcomes of this research overview was an understanding that often when a characteristic was considered likable its opposite side was considered dislikeable. For example, pupils liked practical activities that they could relate to and find relevant, but disliked irrelevant, decontextualised tasks that they found hard to relate to (Nardi & Steward, 2002; 2003). One of the important outcomes of this research overview was an understanding that often a characteristic that was considered likable its opposite side was considered dislikeable. For example, pupils liked practical activities to which they could relate to, and disliked irrelevant tasks (Nardi & Steward, 2002; 2003). Secondly, the likable and dislikeable characteristics of mathematics and mathematics teachers overlapped in many studies in different cohorts and countries. To summarise, the main points are: for interesting and enjoyable learning of mathematics teaching of mathematics should include teaching for understanding. This hinges on practical activities and relating mathematics to real life, and challenging and non-repetitive tasks. At same time the choice of tasks should be sensitive to pupils, meaning that pupils' individual needs would be taken into account. The purpose of this present report, based on an analysis of the study on Estonian pupils' beliefs, is to expose these factors in the Estonian context.

## METHODOLOGY

Twenty two individual interviews and one group interview (including two respondents due to some practical reasons) were conducted. Among these interviews 6 were with 7th grade pupils (13/14 years of age), 11 with 9th grade pupils (15/16 years of age), and 7 with 11th grade pupils (17/18 years of age). The interviews (see Appendix A) were semi-structured. All the interviews were audio-recorded and transcribed. The respondents of individual interviews were named from 'R1' to 'R22', and 'R23B' and 'R23G' denote the participants of the group interview.

Data were analysed using a process referred to as content analysis, which aims 'to obtain descriptive information about a topic' (Fraenkel & Wallen, 2006, p. 485). This was chosen because it fitted well with the purpose of the study. One approach to content analysis is to start with the previously determined categories (Fraenkel & Wallen, 2006). These previously defined categories were the six factors extracted in the quantitative part of the study that illustrated pupils' beliefs about mathematics, its teaching and learning (see discussion above). Thus, the intention of the analysis was to explore issues in relation to these categories in order to gain a deeper understanding of the reasons and explanations for these characteristics of pupils' beliefs.

First, all the interviews were transcribed and translated into English, and then analysed. When I was not sure about some ideas or notions I went back to the original language i.e. Estonian, and checked the translation. Secondly, taking into account the six pre-determined categories, within each different theme could be identified. Some independent themes that did not belong to any of the six categories were also noted, for example, 'the teacher'. There were statements that could also be identified in several categories or themes. For example, the claim 'Mathematics is something you need in life' was assigned to the category 'usefulness' as well as to the so-called independent theme 'the definition of mathematics'. This paper uses mainly two themes: the independent theme 'the teacher' and 'enjoyment' under the 'interest' category. There were five specific sections: 'liking mathematics', 'disliking mathematics', 'influence of the teacher', 'liking the teacher', and 'disliking the teacher' that relate to the aim and the research questions, upon which this paper focuses.

In the following part, the results in all five sections are presented together with the examples from pupils' interviews. At the end of the part, a table summarising the sections is provided (see Table 1) using the pupils' wording to exemplify the principal issues that are exposed.

## RESULTS

*Characteristics of the liking of mathematics – 'What are the reasons for liking/disliking mathematics?'*

### What are the reasons for liking mathematics?

In general, there appeared to be four major arguments for liking mathematics pointed out directly: enjoying mathematical reasoning when doing mathematics, the teacher, the content, the aspect of ability, which included notions 'easy', 'can do', and 'understand'; and three distinct arguments: a favour of natural sciences in general, one's mood at the moment, and the usefulness of the subject. Mathematical reasoning, including solving process and figuring things out was mentioned several times as one of the interesting aspects in mathematics. R19 pointed out that 'It is interesting as well, the solving process. The solving process is more interesting than the answer itself', and R23B backed up by saying, '*[I like]* the most maybe when you take an exercise and use some other method for solving, and you get the right answer'. Figuring things out was mentioned twice, first, by R9 who said, 'It *[mathematics]* is not boring as you can figure things out and think logically. It is interesting', and secondly, R23G liked to apply something to somewhere and to get an answer. For example, R23G said:

*I like these sides of mathematics where a certain system or a thing is, and you just do it and it works out altogether. [...] It is nice to solve text exercises; I like these automatic procedures where you can feel yourself as a fish in the water. You determine the x-s and the rules and play around with them, and you get the answer, and then it feels good. (R23G)*

Solving processes that were related to specific activities (like inserting numbers in the formulas and getting the answers (R6); drawing something beautiful, for example, a cubic graph (R18)) or themes (such as word problems that 'are life-related and interesting' (R20)) were detected three times. A more philosophical

perspective was presented by R5 who liked 'the thinking that when I do mathematics my mind develops'. Moreover, R6 enjoyed seeing the connections between things, how everything evolves, and how the formulas have been made up.

The influence of two factors, the teacher and the specific content of mathematics, was obvious from the answers (the importance of the teacher is discussed thoroughly in the following sections). Four respondents explicitly mentioned that the liking of mathematics depends on the content of mathematics (R9, R15, R16, and R23G), and only one pupil explicitly said that the teacher does not influence his view towards mathematics, including the liking of it.

The aspect of ability proved to be a popular answer. There were three terms used: 'mathematics is easy', 'I can do mathematics', and 'I understand', and in some answers these three intertwined. For example, R16 pointed out, 'I think it depends on the easiness of the subject, how easy it is for you', and R6 also claimed that she likes it when she 'understands it is easy'. There were six pupils who noted that they like it when they 'can do' mathematics (R7, R10, R11, R14, R15, and R21). Five respondents mentioned the importance of understanding. Respondents R17, R23G and R23B directly claimed that when they understand they like mathematics. R19 added the liking of sharing the knowledge with others by answering the question 'do you enjoy working with mathematics?' with words 'Yes. If there is something that I understand easily, and there are others who cannot understand so easily, and when I explain this to them'. Respondent R13 took it all together (thinking, understanding, solving, and finding an answer) using a logical sequence by saying, '[I like mathematics] when I understand something. If there is a heavy theme and you think, and you understand, and then you solve exercises, and then you get the right answer.'

There were three particular reasons mentioned for liking mathematics. First, respondent R21 claimed to like mathematics as a part of natural sciences which she liked; secondly, one's mood at the specific moment might influence one's liking of mathematics (R16); and, thirdly, the necessity of mathematics, i.e. when one needs mathematics, then one likes it as well (R18).

### What are the reasons for disliking mathematics?

There was a strong correspondence between the arguments about what is liked and what is disliked in mathematics. Similarly with liking, four major groups of reasons appeared: disliking certain processes in mathematics, the teacher, the content, including specific themes, the aspect of inability, including notions ‘difficult’, ‘cannot do’, and ‘do not understand’; and a list of so called external factors, which were not directly related to what is happening in the mathematics lessons.

Memorizing formulas without having a proof (not having an understanding of where it is coming from) was disliked by the respondent R18. R23B supported this by saying, ‘[...] the worst is that we don’t get enough explanations why things work as they do, are what they are’. To the question ‘what is exciting?’ respondent R18 answered:

*If you learn the structure of the cell in biology you can relate it more [to the real life]. Then it is more interesting and you are curious to know. It never happened in mathematics, I am not interested at all how a line is presented in the graph. (R18)*

Therefore, it seems that a meaningful learning experience, including deeper understanding of where a certain mathematical theme or a concept is coming from, how it is fitting into the wider picture of mathematical knowledge, and how it is related to and used in a real-life situation, would be the characteristic of liking mathematics when learning it. Drill and practice as a process was mentioned twice as R7 pointed out that too much calculation is boring, and R23B added routine exercises. Respondent R13 found it displeasing when there is an answer given and one has to check it, especially when dealing with decimal fractions. She explained:

*If you know the answer and you have to explore the solution, and then the number [answer] is less than zero, like zero point something, and it does not come out. It is very unpleasant. (R13)*

Respondents R9 and R15 generally said that disliking the subject depends on the content. Unit transposition as well as getting an answer in the form of a fraction was disliked by R5, because she believed that if the answer is in fractional form then it is quite probably wrong, or in other words, that most answers in mathematics are supposed to be whole numbers. Respondent R20 related the concept ‘difficult’ to the

concepts 'boring' and 'useless', claiming that: 'Inequalities are difficult. These are boring and I don't like them.' And to the question 'why?' he answered:

*I don't know, these are only numbers there. This kind of thing gives nothing to anybody. You don't need this kind of thing when you are forty. (R20)*

The overall content in mathematics taught at school is claimed to be insufficient for comprehending its real importance in solving problems in life (R18 and R23B). Respondent R18 explained:

*[...] this mathematics [school mathematics] is too little to bring it to the real life. If you use a cubic equation for calculating a profit of the company then it is actually so unreal. Or when the girl has to swim across the river using a certain angle then it is definitely not a realistic exercise. In this sense, it is just impossible at the moment in mathematics to make it very believable to us. It would leave a very fake impression to us, which is even worse. (R18)*

To summarise, the reasons for disliking certain themes in mathematics were related to difficulty, uselessness in a longer perspective, being too superficial for real life applications, and getting an answer that is in contradiction to the idea of the right, meaning whole number, answer.

Correspondingly with the relationship between 'I am able to' and 'I like it', a relationship could be found between 'I am not able to' and 'I don't like it'. Seven respondents explicitly claimed that disinterest towards mathematics is related to the view of not being capable in mathematics. Respondent R9 noted, 'As it is not my stronger side then I obviously don't like it very much', and R10 offered support for this view:

*I know I liked it in elementary school because there you have a calculation – plus and minus – these were my favourites. But now the thing is so complicated that I don't understand anything. (R10)*

The difficulty aspect was mentioned twice (R20 and R23G), and difficulty together with lack of understanding twice (R10 (see above) and also R11). When asking about classmates attitudes R17 claimed that 'The ones who can do it they do [think] normally [about mathematics], and who have hard times they don't like it too much'. The importance of understanding for learning in general to be enjoyable was noted by R22 when saying, 'I understand nothing in biology, and I think it is boring. The same is with Russian but I know I have to learn Russian'.

Several external factors that are not directly related to the activities in the mathematics classroom were given as reasons for disliking mathematics. First, the curriculum that is overloaded and does not leave the time for more interesting teaching approaches (R23G). Secondly, mathematics was disliked as a part of natural sciences that were disliked in general (R1) (the same reason appeared in liking as well), and because of the fact that other subjects are more interesting (R18). Thirdly, respondent R12 claimed that too much of the 'personal night life' made mathematics boring for him, which can be interpreted as having other interests in life. Interestingly, one respondent (R1) pointed out that mathematics does not have to be interesting as it has another purpose, which is enlarging thinking. R1 explained:

*I think history is interesting but mathematics is not so interesting, it is for enlarging the thinking. Or the memory. Or something like this. (R1)*

*The influence of the teacher and characteristics of the likable teacher in mathematics – 'How influential is the teacher in forming pupils' opinion about mathematics? What are the characteristics that pupils like/do not like about mathematics teacher?'*

#### The influence of the teacher

Only one respondent (R9) explicitly said that the teacher and his/her opinion about and attitude towards mathematics do not influence his opinion about mathematics. He said, 'No, she [*the teacher*] doesn't influence. I just am in mathematics. I do what the teacher demands and try to get it. [*I*], just, am'. Respondent R12 hesitated and claimed that the liking of the subject depends on the person, on how strong personality one has, and on how much one lets oneself be influenced.

When asked about the teacher's influence, then all the explanations to the answers 'yes', 'certainly', or 'of course' could be broadly classified into two categories, these being the teacher's personality, and the teacher's way of acting and presenting the subject in the lesson, including the emphasizing of certain processes in mathematics, which in general could be described as teaching skills.

Four pupils pointed out that it is the mathematics teacher's personal characteristics that form their opinion about mathematics (R4, R8, R16, and R17). R4 explained that if the teacher would be 'foolish', he would not like it. Respondent R8 emphasized (teacher) being cheery when saying:

*If the teacher is cheerful, and I like this, then you want to go to the lesson, want to know new things. If the teacher is grumpy and having a bad mood then you start yourself to hate mathematics, don't want to go to the lesson, and mathematics relates to the mathematics teacher's bad mood, relates to bad things in general. (R8)*

Pupil R16 explained that some teachers can make the subject 'extremely unpleasant' with their way of being, and R17 supported:

*If you for example don't like the teacher you might start to find the subject unpleasant as well. [...] If you don't like the teacher's personality you don't want to go to the lesson. You start to think about mathematics, and this teacher is related to mathematics, and you might start feeling reluctant about mathematics as well. (R17)*

The last examples also confirm the thought about the teacher's influence on pupils' attendance in mathematics lessons. Thus, the teacher's personality and way of acting could be one of the reasons for dropping out in mathematics.

Other influential factors pointed out by the respondents were related to the teacher's teaching style. It was mentioned three times that the way the content is presented in the lesson has an impact on pupils (R3, R11, and R23G). R3 clarified:

*It depends on how she is presenting it all to you, doesn't it? If the teacher talks only about school mathematics, and doesn't try to relate it to the outside world then maybe mathematics feels very boring or something. But when you do real-life related exercises, word problems about life, then, yes, I think she influences a lot. (R3)*

The teacher influences pupils' opinions by emphasizing understanding (R1) and logic (R2). R6 claimed that if the teacher would have a negative opinion about mathematics himself or herself, and he or she would not care then it would not be possible to pass the mathematics over to the pupils in such a way that it excites them also. Communication with others (R10), creating a good atmosphere (R19), motivating (R21), having deep personal interest in the subject himself or herself (R23G and R23B), and inspiring (R23G and R23B) were also mentioned to be influential factors. Respondent R20 concluded by saying, 'I think at least half depends on the teacher because the teacher can make it interesting'.



### Likeable characteristics

The list of likable aspects about the mathematics teacher that pupils expressed was compiled from the answers where pupils mentioned the likable features of their own teacher, or where they said what they wished to see in the mathematics teacher. Two groups of answers could be detected, first, personal characteristics, including subgroups: polite, caring, funny, excited, professional and strict enough. And secondly, characteristics of the teaching, including subgroups: supporting, creating a good learning environment, explaining, relating to real-life, and being a reasonable evaluator.

#### *Personal characteristics*

Two respondents mentioned features related to gender and age. Pupil R12 preferred to have a female teacher and R15 favoured a young teacher who is supposedly friendlier than an older one. He explained:

*The teachers are much friendlier [compared to the teachers from his old school], there aren't too many old people. Well, only a few. The old ones are all so angry so you don't want to be with them.*

Being polite is one of the likable features of the teacher. Respondent R18 liked his teacher who was polite and apologized immediately when he noticed his impolite behaviour, and R17 claimed that it is good that the teacher does not get personal. Having a generally positive attitude towards pupils (R11) and not losing her nerves but staying calm in the lesson (R3) was favoured as well.

Being caring was pointed out several times (R9 and R22), and so was done for understanding (R1, R18 and R19). R9 said that their teacher takes care of them like her own children in a positive way. Respondent R19 emphasized the importance of the teacher being sensitive and understanding towards pupils when saying:

*It is good in some sense that the teacher understands that learning mathematics isn't everybody's priority. If all the teachers would think that their subject is the most important one, as it often happens, then it would not be humanly possible to go to this school. There are some more understanding teachers, like [his teacher's name], who have to ease off a bit to prevent people from dying. (R19)*

The teacher should be funny (R9) and also get excited about mathematics (R21, R23G and R23B). Therefore, showing positive emotions and the enjoyment that mathematics teaching brings along was noted as likeable features of a teacher.

Pupils valued highly the professionalism of the teacher and his/her expertise in mathematics. The teacher should be wise (R2) and have a deep personal interest in mathematics as a branch of knowledge (R23G and R23B). Respondent R21 would like to have a teacher who is a professional in her field and good in her subject. Being an authority and able to solve everything correctly in a second, and being accurate at the same time, was favoured by R23G and supported by R23B.

The teacher should be able to control the situation in the classroom by being strict enough (R5 and R19) and able to discipline the pupils (R11 and R14). Respondent R11 described a situation where having a discipline could be considered as the characteristic of teaching as well as of the teacher:

*The teacher has a strict discipline. When she talks nobody else is allowed to open his/her mouth; we listen to what she has to say. And then when one has something to say he/she raises his/her arm and speaks. [...] And when somebody starts to mess around then the teacher re-establishes the discipline. (R11)*

And later she added, 'We have the best teacher ever; the best at the whole school' (R11).

#### *Characteristics of teaching*

The general response from the pupil R17 was that she likes her teacher because she can teach very well, and added, 'I can cope with her very well, and I can understand her way of teaching'.

Several comments from pupils indicated that they liked when the teacher supported learning in general. The ways of working that were mentioned were, for example, the teacher wants her pupils to work properly (R9) and makes them learn (R19), the teacher has good teaching methods and she supports asking in the lesson (R2). Helping when needed (R3, R11 and R15) and having time for the pupils (R1 and R11) were also appreciated by the respondents.

The teacher was expected to create a comfortable learning environment for the pupils. It was pointed out that it is important for the teacher not to yell (R3 and

R19) and scold (R9), and many respondents said that they are never afraid to ask questions from their teacher (R1, R3, R4, R5, and R9). Humour has an essential role in the lesson. The teacher who makes jokes (R9), tells humorous stories about herself/himself and life (R11), and the teacher who laughs with the pupils makes the lesson less tense; and having no tensions is liked by the pupils (R1 and R17). R17 explained:

*We often laugh, and the teacher always laughs too. There are jokes [in the lesson]. Somebody says something strange and then the laughing period follows. Yeah, sure [I like it]. It is looser, not so tense, and not so stressing. In silence only it would eventually become negative.*

It was evident from the answers that the most important feature of a likable teacher was the ability to explain and to endorse understanding. Verbs such as ‘to explain’ and ‘to understand’ were mentioned by nine respondents. Pupils emphasised that the teacher is supposed to explain (R11), explain a lot and communicate with people (R14), explain well (R3 and R15), explain calmly until everybody understands (R1 and R5), and explain until it is clear (R4). Respondent R18 added that it is important that the teacher would make his/her subject understandable. Solving exercises together with the pupils in the lesson for better understanding was mentioned by R19. It was concluded by R21 who included the expertise in mathematics in her answer also saying that:

*[Our teacher] is a very good teacher. She is such a professional in the subject that she makes the theme much more interesting and easily understandable. [...] As she copes with it [mathematics] very well then she is able to deliver it very well also, and you can understand everything very easily and fast. (R21)*

Pupils appreciate it when the teacher relates mathematics to the real life situations. It is important that the mathematics teacher talks about useful things in general (R20 and R22) and explains the usefulness of mathematics in real life (R19). Respondent R20 emphasized that the exercises, which are solved in the lesson, should be related to real life situations.

The last characteristic identified was a reasonable assessment procedure, including not checking the homework. Respondents R1 and R11 liked that their teacher never puts a bad mark when it is not necessary. It was appreciated that the teacher accepts the fact that nobody does the homework (R18), forgives when the

homework is undone (R14), and does not check the given homework (R3 and R21).

R21 explained by saying:

*A good thing is that the teacher does not check the homework. I think it is very oppressive when they do that. The teacher says that there is an exam in the end of the year and you know yourself what kind of result you want to get there, and if you want to work hard or not, and this is where the motivation comes from. [...] If you do homework because the teacher checks it then there is a big probability that you just copy it down from somebody else and you don't learn yourself. Yeah, it is pointless. (R21)*

### Dislikeable characteristics

Corresponding to the characteristics of the reasons for liking the subject, where the reasons for liking and disliking mathematics highly overlapped, the reasons for disliking the teacher were to a great extent consistent with the opposite reasons for liking the teacher. The list of features that the respondents would not like their mathematics teacher to have could in general be classified in two categories: personal characteristics and the characteristics of the teaching. The first group includes terms like angry, nervous and getting personal. The statements in the second group are misusing the voice, explaining poorly, not noticing and being aware of pupils' comprehension, and dull teaching, using only drill and practice.

#### *Personal characteristics*

Respondent R14 explicitly said that the teacher should not be old or angry. Becoming easily nervous (R8 and R12) and getting personal (R8 and R10) were not favoured by the pupils either. Obviously, calling everybody with bad names without a reason and ridiculing pupils by calling them stupid were pointed out to be unacceptable behaviour noted by R8. Respondent R10 believed that his teacher had strong negative feelings towards him by saying, 'Sometimes it looks as she [*the teacher*] hates me or gibes me or something'.

#### *Characteristics of teaching*

The teacher is expected to control his/her voice in the lesson as yelling too much (R8) and suddenly changing from a quiet tone to a very loud tone (R7) are disliked by the pupils.

Several respondents opposed messy and inappropriate explanations of the teacher. R21 exemplified by saying:

*She [the teacher] talks about one thing too long and pointlessly, and she swims away with the talk so the story doesn't make any sense, and she talks about one thing a hundred times. [...] it is just a thing that gets into my nerves sometimes. (R21)*

Respondent R1 pointed out that the teacher never explains, R5 added that the teacher explains assuming that pupils are clever and paying attention, which is not always the case. Making mistakes (R23G) and messing things up (R23G, R23B and R12) were not favoured by several pupils. R12 took it all together when noting:

*[The teacher] doesn't explain, doesn't bother to explain, and talks some kind of his own rubbish. He has some extreme troubles with his memory as well. (R12)*

It is essential for the pupils that the teacher acknowledges the importance of pupils' understanding. Respondent R1 disapproved when the teacher goes on with a theme too rapidly without confirming pupils' understanding. R5 criticized the fact that the teacher skips operations on the blackboard because things might not be understandable for everybody. It is disliked when the teacher does not find time for an individual approach that includes individual explanation, which should lead to the understanding. R21 explained:

*She [the teacher] says 'do it, do it', and when you want to ask something she walks to you, says this and this, and walks away again. [...] the teacher has not enough time for dealing with us individually, she should have more. (R21)*

Respondent R13 summed it all up by saying:

*She [the teacher] could sometimes ask more if you don't understand. Sometimes I would like, uh, I would like to ask something, and even raise the hand but she doesn't notice and continues talking. [...] She should sometimes ask how much we understand. Not that she only once explains assuming that everybody understands, and makes a test on it. (R13)*

Pupils dislike when the teaching includes only delivering material without a kind of problem-solving approach. Teaching from the textbook (R7), solving only

exercises all the time (R7), and calculating mechanically (R11) were not favoured by the respondents. R21 remarked that:

*Most of the teachers cannot imagine that the lesson could be interactive. They are often not concerned if pupils like it or not; they have an attitude that I just give my lesson, and then it is all right. There is a lot of only following the rules and delivering the material – it is negative. (R21)*

In summary, in order to get an overview about the main results the following table is presented.

*Table 1. The summary of the main results using pupils' expressions*

<b><i>Why do I like mathematics?</i></b>
<b><i>BECAUSE ...</i></b>
... I like mathematical reasoning and solving process/ ... to see the connections between mathematical ideas/ ... to see how formulas are derived
... I like the teacher
... I like life-related word problems ( <i>specific content</i> )
... I can do maths/ ... maths is easy/ ... I understand
<b><i>Why do I not like mathematics?</i></b>
<b><i>BECAUSE ...</i></b>
... I do not like to memorize formulas without having understanding of where they are coming from/ ... when I cannot relate what I learn to a real life situation/ ... to solve routine exercises
... I do not like the teacher
... I do not like to calculate with fractions ( <i>specific content</i> )
... I cannot do maths/ ... maths is difficult/ ... I do not understand
<b><i>In what way does the teacher influence my liking of mathematics?</i></b>
<b><i>I AM INFLUENCED BY ...</i></b>
... his/her personality
... his/her way of acting
... his/her way of presenting the subject, including the emphasizing of certain processes
<b><i>What would I like the mathematics teacher to be or do?</i></b>
<b><i>I WOULD LIKE THE TEACHER TO ...</i></b>
... be polite, calm, caring, supportive, funny, excited, professional, strict enough ( <i>personal characteristics</i> )
... create a good learning environment, explain, relate mathematics to real-life, be a reasonable evaluator ( <i>characteristics of teaching</i> )
<b><i>What would I not like the mathematics teacher to be or do?</i></b>
<b><i>I WOULD LIKE THE TEACHER NOT TO ...</i></b>
... be angry, nervous, get personal ( <i>personal characteristics</i> )
... scare pupils by shouting, explain poorly or not explain at all, teach boringly using only drill and practice, be ignorant about pupils' understanding ( <i>characteristics of teaching</i> )

## DISCUSSION

The research questions of the paper were seeking the reasons why pupils might like or dislike mathematics and its learning. The identified aspects were to a great extent similar to those identified in several international studies that have inquired into the beliefs of pupils, students, and student teachers. Some of the results might also indicate the reasons behind the beliefs that were identified in the quantitative part of the study.

This study is unique at the national level because in Estonia, as yet there have been no similar studies that aim to explore and expose pupils' reasons for liking or disliking mathematics using different methods of data collection and analysis. The analysis enabled the identification of the aspects that might be considered important, as the characteristics for both liking and disliking were to a great extent opposite sides of the same coin, i.e. pupils claimed to dislike the opposite that they liked. For example, pupils liked when they understood mathematics, and disliked when they did not understand mathematics. From another perspective, the results of this study could be of practical value when designing teacher education courses in Estonia. It has been pointed out that Estonian teachers' community, including mathematics teachers, is becoming older, and almost a quarter of the teachers are older than fifty-five years (Kass, 2010). Therefore, there is a large group of teachers at school who received their teacher education about twenty-five to thirty years ago. It is highly likely that in the years following there have been changes in the perspectives of what is considered to be good mathematics teaching and learning. Thus, when planning both pre-service and in-service mathematics teacher education courses, it might be valuable to take account of the qualities of the liking of the subject as this might improve teachers' practice.

The analysis identified only one reason for liking and disliking mathematics that was not directly related to the pupils' variable experience of mathematics in the classroom. This is the subject content, which is dependent on the national curriculum. Peter Kloosterman (2002) has pointed out that pupils' enjoyment of mathematics is different in different topics of mathematics (e.g. different degrees of interest towards geometry and algebra), and this also seems to be the case in my

study. The respondents favoured some specific activities, such as solving word problems and drawing cubic graphs. The latter is consistent with the studies by Berger (2000), where the beauty of geometry is emphasized. The unpleasant activities were related to rote learning, and connected to certain topics in mathematics, for example, calculating with decimal fractions, doing unit transpositions, and solving inequalities. Relating these results to the quantitative study could explain why more than twenty percent of respondents could not make up their mind whether mathematics is interesting or boring, and approximately eight percent claimed at the same time that mathematics could be both. It might also be that when talking about the liking of mathematics pupils could consider certain mathematical themes more interesting than others, and that makes expressing the general opinion about mathematics difficult. Thus, in future research the liking of different themes in mathematics and their relation to the overall liking of mathematics would be interesting to investigate. Also, if certain themes could be classified as boring amongst Estonian pupils, then further research about how to present these themes in a more attractive way might be considered.

Both Hoskonen (2007) and Stodolsky *et al.* (1991) found that pupils liked mathematics when they experienced success and when it was considered to be easy. Similarly, in the study amongst Norwegian pupils (Kislenko, 2009a) the relationship was shown between the factors of interest and self-confidence. Thus, the second most popular and rather expected reason for liking mathematics was pupil's feeling of being competent in mathematics. This was also strongly related to the understanding of mathematics so the actual mathematics lesson where the understanding is supposed to take place became more evident in the answers. The three aspects - easiness of the subject, the 'can do'-effect, and understanding the subject – were interrelated. From the opposite side – the difficulty of the subject, not being able to do and understand – were considered to be reasons for disliking mathematics (similar with Stodolsky *et al.* (1991) results). Taking into consideration that more than seventy percent of the respondents claimed mathematics to be difficult in the quantitative study, then the practitioners might notice that the liking of mathematics, influenced by perceived ability and understanding, is an important issue to address. Enjoyment usually reduces the reluctance to study mathematics,



which might make pupils more open to learn mathematics that might lead to the better understanding of the subject.

Third, certain processes that take place when learning mathematics were liked. The recognition of mathematical reasoning and problem solving were favoured, so solving process together with the acknowledgement of the development of logical thinking were considered to be pleasant. It is consistent with the results from Hoskonen's study (2007) where the respondents also appreciated the beauty of challenge and puzzling over problems. Pupils considered mathematics dislikeable when they had to memorize formulas so called blindly, calculate too much and solve routine exercises all the time. Likewise, pupils in Nardi and Steward's study (2003) disapproved when mathematics was presented as a set of rules. Therefore, an inference that might usefully inform practice is that pupils *per se* do not oppose the solving process of the exercises - the solving process itself is actually favoured, but it is only favoured in the environment of understanding where the answers come from.

The fourth and the most cited reason for liking or disliking mathematics was pointed out to be the teacher of mathematics. The teacher's personal characteristics, his/her way of being and way of acting in the lessons form pupils' opinion about mathematics and their enthusiasm to participate in the lessons. The teacher whom pupils like should be polite, calm, caring, understanding, funny, and get excited about mathematics (all these characteristics have been pointed out in other studies also, e.g. Grevholm, 2007; Murphy *et al.*, 2004; Perry, 2007). He/she should also be an expert in mathematics, have deep interest in it, and be able to manage the pupils and have control over the situation in the classroom. This is similar with the results from Wilson, Cooney, and Stinson's (2005) and Perry's (2007) studies in which the researchers concluded that a good teacher should have a good knowledge in mathematics; and to that Wilson *et al.* (2005) added, effective management skills. The teacher should not be angry, nervous, become personal, and ridicule the pupils (similar results have been reported in Hoskonen's (2007), Burton's (2004), and Nardi and Steward's (2003) studies). The fear of being ridiculed might be one of the explanations why four pupils out of ten in the quantitative study claimed that they are afraid of making mistakes when doing mathematics, and every fifth admitted to being afraid to show the teacher their misunderstanding of the theme. Therefore, for

reducing these fears, teachers might start by acknowledging them as problems in the lesson (it often happens that the teacher acts unconsciously and does not recognize his/her own negative behaviour towards the pupils) and tries to develop a higher sensitivity towards pupils' emotions and fears in his/her behaviour.

What comes to behaviour in the lesson, the likable teacher does not yell, and is able to laugh in the lesson and with the pupils. Pupils appreciate if the mathematical tasks are related to real life situations and examples are taken from problems that emerge in everyday activities. Emphasizing the relevance of mathematics by considering more real life applications and practical activities was also favoured by the respondents in Nardi and Steward's (2002; 2003), Khoh *et al.*'s (1999), Burton's (2004), and Schuck's (1996) studies. In the lesson a variety of teaching methods and activities emphasizing the solving processes and different solving procedures should take place, as only drill and practice and mechanical calculation did not satisfy the pupils. Interestingly, the issue of homework was only explicitly mentioned in the study by Berger (2000) where the respondents did not favour when there was too much homework given. In my study, the homework itself was not the problem for the pupils. It was about the assessment of the homework, in which several pupils mentioned that they appreciate when the teacher does not check the homework or does not act negatively when it is undone.

The most important feature for the likable teacher is the ability to explain and to support understanding. Comprehension was also mentioned as the most important feature for liking mathematics. Almost all the studies presented in the literature review mention in one or another way explaining and promoting understanding as an important feature of good and likable teaching. From one perspective, drawing on the results from the questionnaire study, more than every fifth respondent claimed to be afraid to show that they do not understand mathematical problems. From another perspective, the interview study showed that understanding is one indicator of the liking of the subject. Therefore, for facilitating the enjoyment in mathematics, the teacher should be aware that every fifth pupil in the classroom might hide their inadequate understanding or complete misunderstanding of the subject, and consequently might more easily start to dislike mathematics. Thus, the teacher

should support the pupils to express explicitly their lack of understanding of the subject, which could be possible through being supportive and encouraging.

It is logical to assume that what is liked about mathematics and its' teaching and learning should be promoted, and what is disliked should be eschewed. Elena Nardi and Susan Steward (2003) concluded in their study that English pupils want to experience relevance, excitement, variety, challenge, and deeper understanding. And it appears that all these characteristics are found amongst Estonian pupils' preferences as well. To be likable, mathematics teaching should encourage pupils to feel joy of figuring things out in a meaningful and understandable way, and this is possible to achieve with the help of a sensitive teacher who uses a variety of teaching methods and teaches for understanding.

This investigation provides evidence that pupils wish to learn mathematics through understanding the subject; they like reasoning and to do things in mathematics, and carry out activities. They have clear opinions about the teacher they prefer. The teacher has to find the tasks and activities that are on the level where the pupil is challenged to achieve some new knowledge and understand what is happening and still can succeed with the task. Teachers need to be recognised as having considerable authority and responsibility to work in such fine tuned ways and adjust the level of work to each pupil. In Estonia this is called "õpilasekeskne õpetamine" and it can be considered as learner centred teaching. It is an important task for teacher education programmes in each country to offer student teachers opportunities to learn how to work in this way.

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## APPENDIXES

### APPENDIX A: The semi-structured interview questions

1. What do you think mathematics is?
2. What do you think about how mathematics should be learnt/taught?
3. What do you like the most/the least about mathematics?
4. Would you like to learn more/less mathematics at school?

5. Do you need mathematics? Why/why not?
6. Can you recall the most favourable/unpleasant situation happened to you in relation to mathematics?
7. Are you afraid in mathematics lessons? Why?
8. What do you usually do in mathematics lessons? How is the learning process led? Who is usually speaking in the lesson?
9. How is homework organized?
10. What do you think your classmates' opinion is about mathematics and its learning? Does it influence your opinion about mathematics?
11. What do you think your parents' opinion is about mathematics and its learning? Does it influence your opinion about mathematics?

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