Preliminary findings from a questionnaire on mathematics-related affect in primary school students

Hanna Viitala

University of Helsinki, Finland

Abstract: This paper presents preliminary findings from the use of a questionnaire designed to assess secondary school students' mathematics-related affect, with primary school students. More closely, the paper examines if a model for students' view of themselves as learners of mathematics form the same categories with primary school students as they did with secondary school students, and if the results follow the trends that are identified in previous research. The preliminary findings on a small sample of students show that the statements used to study students' view of themselves as learners of mathematics are, in most parts, consistent with previous research and, with caution, can be used also with primary school students.

Keywords: Mathematics-related affect, primary school, lower secondary school, students.

Contact: hanna.l.viitala@helsinki.fi.

1 Introduction

Internationally compared, Finnish students have very negative mathematics-related affect. For instance, Trends in International Mathematics and Science Study (TIMSS) showed that on grade 4, 31 % students do not like learning mathematics and only 28 % like it very much (Mullis et al., 2020). International average is 20 % and 45 % respectively. As in many other countries, the level of liking mathematics declines over the years among Finnish compulsory school students. On grade 8, 57 % of Finnish students report not liking to learn mathematics and only 9 % report liking it very much (Mullis et al., 2020). International average is 41 % and 20 % respectively. Similar results can be seen also in other studies (OECD, 2023; Ukkola et al., 2025; Metsämuuronen & Nousiainen, 2021; Metsämuuronen & Tuohilampi, 2014). Furthermore, like in many other countries, Finnish students' affect in mathematics start declining from a very early age (Niemivirta et al., 2024).

These results on students' mathematics-related affect are significant for students' future life. Already 3rd graders' view of mathematics as a school subject has shown to influence their choice of secondary education in grade 9 (Niemi et al., 2021). The influence is bigger if the student proceeds to academic secondary education compared to vocational education. This choice of secondary education is crucial when thinking of students' future careers and their potential paths towards mathematical sciences. The importance of students' positive attitude and self-image in mathematics is also recognised by the Finnish national core curriculum (Finnish National Board of Education, 2016). Positive is, that Finnish students value mathematics and think that it is useful despite not liking to learn it (Metsämuuronen & Nousiainen, 2021; Mullis et al., 2020).

To address students' low and declining affect in mathematics, a collaborative problem-solving intervention was first implemented in Finnish lower secondary schools (see Viitala, 2023, 2024a, 2024b). Problem solving was chosen for the intervention because it has shown to have a positive impact on students' affect in mathematics (see e.g. Liljedahl & Cai, 2021; Felmer et al., 2016) and because, together with collaboration skills, it has received large interest as a 21st century skill (OECD, 2017; Harvard Advanced Leadership Initiative, 2014). Collaborative problem solving has potential not only to engage students to learn mathematics, but it also makes students' mathematics learning visible to teachers and peers while developing also students' social skills (Liljedahl, 2014, 2021). Engaging students to learn mathematics, the use of problem solving, and developing students' social skills are all learning goals for the Finnish compulsory school students (Finnish National Board of Education, 2016).

After the collaborative problem-solving intervention was implemented in lower secondary school, the project extended into Finnish primary schools. This raised the need to measure students' mathematics-related affect also in primary schools. While the initial project aim was to study if the collaborative problem-solving intervention has a positive impact on students' mathematics-related affect as previous studies suggest (e.g. Tuohilampi et al., 2015; Liljedahl & Cai, 2021), the growing number of intervention groups opened a whole new set of possibilities for the research. If it would be possible to use the same measuring tool in different age groups, it would allow to compare the impact of the intervention in different age groups, and to follow the development of the same group from primary to secondary school.

As part of the initial intervention in lower secondary school, a questionnaire was developed to study students' mathematics-related affect. As part of that questionnaire, students' view of themselves as learners of mathematics was studied following the categories of statements that Rösken and colleagues (2011) found to be central to students in upper secondary school (ability, success, effort, enjoyment and difficulty of mathematics) (for the lower secondary school results, see Viitala, 2023, 2024a). The same statements were then used with primary school students to see if the questionnaire is suitable also for younger students. In this paper, the preliminary findings of the use of the questionnaire with primary school students are explored. The analysis will be done using descriptive statistics, classroom observations, and comparing the primary and secondary school results with literature to see if the results follow the known trends of the development of students' mathematics-related affect. The results are not intended to be generalisable and should be interpreted as an initial exploration whether the statements on students' view of themselves as learners of mathematics (Rösken et al., 2011) could be applicable also to younger students.

The research questions for the paper are:

1. Do primary school students' views of themselves as learners of mathematics form the same categories as those identified for secondary school students?
2. Do the results from primary school students align with the trends identified in previous research regarding students' mathematics-related affect?

2 Theoretical framework

Although affect in mathematics education is a well-established research field, it lacks consensus on the concepts and structures that are used in research (Haser et al., 2023). Hence, it is essential to start by defining central concepts for each study on mathematics-related affect. In this study, affect is understood as an umbrella term for the cognitive, motivational, and emotional aspects of affect (Hannula, 2012). These three aspects form an intertwined relationship of affective variables such as beliefs, attitudes, values and feelings. In Hannula's theory, cognitive aspects refer to information about self and the environment, motivation directs behaviour through goals and choices, and emotions reflect success or failure in goal-directed behaviour. Furthermore, affect is studied as an individual psychological trait, indicating to the more stable aspects of students' mathematics-related affect (Hannula, 2012). This perspective aligns with a questionnaire data, in which students have individually answered to statements referring to their more stable views of themselves as learners of mathematics.

Research on students' mathematics-related affect has often been focused on mathematics anxiety among adolescents. In recent years, research on mathematics anxiety has also expanded to cover younger students (see Hannula, 2018). Mathematics anxiety is something that can be identified through self-reports already in young students, even before primary school age (e.g. Petronzi et al., 2018). Unlike in many previous studies (see e.g. Gierl & Bisanz, 1995), in Finland, mathematics anxiety has reported to descend during primary school (between grades 2 and 5) (Sorvo, 2024). Mathematics anxiety starts to increase in transition from primary to lower secondary school (Sorvo, 2024) but later in lower secondary school, Finnish students' mathematics anxiety is reported to be the lowest in OECD countries (Ministry of Education and Culture, 2023). Based on these results, and since affective structures seem to be highly cultural (Tuohilampi et al., 2015), it seems reasonable to focus more on other affective structures than mathematics anxiety in the problem-solving intervention.

In this paper, students' mathematics-related affect is studied through students' views of themselves as learners of mathematics (Rösken et al., 2011). In their study of Finnish upper secondary school students, Rösken and colleagues (2011) found that students' view of themselves as learners of mathematics can be divided into seven categories: ability, effort, enjoyment of mathematics, difficulty of mathematics, success, teacher quality and family encouragement. In the problem-solving intervention, the aim was to understand how individual learners experience factors that are directly related to themselves, and how these views develop over the course of the intervention. Hence, following Rösken and colleagues (2011) reasoning on the categories, teacher quality and family encouragement were excluded from the study as factors that are relating primary on students' support instead of factors relating to personal affect.

From the five remaining categories, four refer to students' beliefs (ability, success, difficulty and effort) and one to their emotions (enjoyment) (Rösken et al., 2011). Beliefs refer to individual's cognitive statements attributing truth or applicability and emotions to feelings, moods and emotional reactions (Hannula, 2011). The third category of affect, motivation (Hannula, 2012), is studied through self-efficacy beliefs that are considered being highly effective predictor of students' motivation and learning (Zimmerman, 2000). Self-efficacy beliefs refer to an individual student's confidence in their own ability to learn mathematics (cf. Bandura, 1997).

In Rösken and colleagues' (2011) model, ability and success relate to students' self-efficacy beliefs. Ability refers to a student's confidence in their ability to learn mathematics now and success to their ability to learn mathematics in the future (Rösken et al., 2011). In their model, ability and success, together with the experienced difficulty of mathematics, form the core of students' views of themselves as learners of mathematics. Furthermore, a recent study has found that students' self-efficacy have the strongest connection to mathematics performance compared to other affective factors among Finnish students (Salonen et al., 2023, cf. Zimmerman, 2000). Similar results on the connection between self-efficacy and performance have also been found in younger students (Dowker et al., 2012).

Students' view on how much effort they put into learning mathematics also relates to self-relation in mathematics, referring to control beliefs over individual's learning (Rösken et al., 2011). The connection between effort and self-efficacy is found to be positively correlated, self-efficacy predicting how much effort students put into learning mathematics or performing a task (Zimmerman, 2000). Even though self-efficacy beliefs and effort are closely connected, enjoyment of mathematics (referring to emotions in Hannula, 2012) was closer to the core of students' views of themselves as learners of mathematics than effort (Rösken et al., 2011). Similar positive connection between control beliefs and enjoyment in mathematics has been identified also in primary school students (Putwain et al., 2018). Furthermore, enjoyment of mathematics has been positively connected with learning mathematics through problem solving (Liljedahl & Cai, 2021; Felmer et al., 2016; Liljedahl, 2021), making it an important aspect of study in the problem-solving intervention.

Previous results show that the categories found in Rösken and colleagues' research (2011) can also be formed reliably when studying lower secondary students' views on their mathematics learning (see Viitala, 2023). The results are in line with previous research that shows Finnish lower secondary students' negative mathematics-related affect (Mullis et al., 2020; Metsämuuronen & Nousiainen, 2021). Students experienced mathematics as difficult, and they did not enjoy learning it. However, they viewed their ability, effort, and success in mathematics as slightly positive, expressing also positive beliefs considering their learning of mathematics.

Since the mathematics-related affect decline over the span of compulsory school in Finland (Metsämuuronen & Tuohilampi, 2014), the expectancy for this study is that primary school students show more positive results compared to their peers in lower secondary school. Furthermore, since primary school students' mathematics-related affect seemed to follow the same trends as lower secondary students' affect in literature (Dowker et al., 2012; Putwain et al., 2018), the expectancy is that primary school students' view of themselves as learners of mathematics follow same structure than lower secondary school students. Primary school students' view of themselves as learners of mathematics has not been studied in primary school before, and thus, the study offers a new insight into understanding mathematics-related affect in primary school students.

3 Methods

3.1 Participants

The participants are 36 primary school students from grades 2 and 3 (8–10-year-olds), and 49 lower secondary school students from grades 8 and 9 (14–16-year-olds). The data are collected in the beginning of a collaborative problem-solving intervention in primary and lower secondary mathematics classes in Finland. However, for this paper, the problem-solving intervention served as a context for the data collection, and it is not the research objective. More information on the problem-solving intervention can be found in Viitala (2023, 2024a, 2024b).

3.2 Data collection

The data for this paper were collected through a questionnaire on students' view of themselves as learners of mathematics and observations in primary school classes. Both primary and lower secondary school students answered the questionnaire during their mathematics lessons in the beginning of the problem-solving intervention, primary school students in January (mid school year) and lower secondary school students in August (in the beginning of the school year). The timing for the data collection is relevant since the aim of the paper is to compare the primary and lower secondary school students' mathematics-related affect prior to the intervention to be able to compare the results with previous research.

In lower secondary school, the teachers conducted the data collection with instructions to ensure that the students can answer the questionnaire individually in their own pace. The students were instructed to leave the answer black if they did not understand the statement. In primary school, the researchers followed or conducted the data collection to observe students' needs with the statements and to monitor the data collection. Due to their young age, students in primary school also got more support to answer the questionnaire, compared to their peers in upper secondary school.

In primary school, the students were instructed on and introduced to answering the questionnaire using two statements that were not related to mathematics. All the statements were shown on document camera and read out loud by a researcher or a teacher, one by one. Students answered the questions all in the same pace. The students were allowed to ask questions about the statements if they did not understand them. Special attention was given to the negative or inverted questions where the teacher often used the opportunity to explain what the different answers meant. As an example, with the statement *Math has been my worst subject*, the answer *Fully agree* was explained that it means that math *has* been the worst subject, and the answer *Fully disagree* means that math *has not* been the worst subject. The students were also instructed to leave the answer blank if they did not understand the statement. Similar response setting has been used also in previous studies in which already 6-7-year-old students have been able to understand and follow the response procedure with minimal assistance (students in this study are 8-10-year-olds) (e.g. Petronzi et al., 2018).

To study students' views of themselves as learners of mathematics, the students answered statements on their ability, effort, and success in mathematics, as well as enjoyment and difficulty of mathematics (Rösken et al., 2011). The statements were identical between the two data sets described above. Rösken and colleagues (2011) had 1–2 questions more in their categories, as well as two dimensions that were not included in the present study (teacher quality and family encouragement). Some of the statements were excluded due to the length of the questionnaire that also included questions about academic motivation and group work. These statements are not part of this paper. The data was collected through a Likert-scale from 1 = *Fully disagree* to 5 = *Fully agree*.

The data reported in Rösken and colleagues' article (2011) were collected from Finnish upper secondary schools. The original questionnaire was in Finnish and the same statements were used in the lower secondary school data collection. The primary school data were collected in Swedish language, which is the second official language in Finland. Three researchers were involved in the translation process between the Finnish and Swedish languages: one a native Finnish speaker and two native Swedish speakers. All three researchers are fluent in Finnish, Swedish and English languages. The translation between Finnish and Swedish had not been tested before this study where the questions were piloted in the Swedish speaking mathematics classes.

3.3 Data analysis

Since the sample size is small, the data for the first research question were analysed through descriptive statistics. Internal consistency of the sum variables was tested using Cronbach's alpha. Since the data were not normally distributed, significance of the descriptive statistics was tested using independent samples Mann-Whitney U test. For the second research question, primary and secondary school data was compared to assess if the results follow the same trends than what previous research suggest, and the core of students' view was evaluated using Kendall's tau b. Classroom observations were used to discuss the limitations of the study.

3.4 Limitations of the study

The study where the questionnaire was piloted in primary school, has many important limitations. First, the number of participants is very low, and the analysis is limited to descriptive statistics, correlations and Cronbach's alpha. Hence, the results are preliminary and not at all generalisable.

Second, the translation into Swedish has not been tested for measurement equivalence. The data collection served also as a pilot study for the translation. When translating the statements into Swedish, both Finnish (original questionnaire) and English statements (used in Rösken et al., 2011) were used and discussed by the researchers in the attempt to ensure that the statements measure the same things across all three languages. The statements were not discussed with Swedish speaking children prior to data collection. The data collection in primary classroom served as a pilot testing of the questionnaire. The researchers observed the use of the questionnaire in the primary classrooms. The observations showed that while young students did have difficulties understanding the answer options with negative of inverted statements, they did not have questions about the concepts used in statements measuring their mathematics-related affect.

Third, the teacher- or researcher-led administration of the questionnaire in primary classrooms where students were allowed to ask questions about the statements may cause response bias. This is the case especially in grade 2 classrooms where the students were observed to have more questions about the answer options than their peers in grade 3. In this study, the classroom situation was observed by one or two of the researchers and only one teacher participated in explaining the answer options while the researcher was present. According to the observations, the teacher and the researcher interpretated the answer options similarly. Furthermore, notable is that the setting for answering the questionnaires were different for primary and lower secondary students. While primary students had the opportunity to ask clarifying questions about the statements due to their young age, lower secondary students did not have this opportunity.

4 Results

Following the literature (Rösken et al., 2011), the data for this paper is divided into five categories: ability, effort, enjoyment of mathematics, difficulty of mathematics, and success. First, the internal consistency of the sum variables will be examined, followed by the results of the sum variables and individual statements. The results on lower secondary school students were first published in Viitala (2023). Second, the results from primary and lower secondary schools are compared with prior research.

4.1 Sum variables

Students' view of their ability in mathematics was studied through four statements: *I am no good at math*, *I am not the type to do well in math*, *Math has been my worst subject*, and *I have made it well in math*. The sum variable for primary school students' ability was somewhat reliable, α=.63 (the three negative statements inverted). Deleting items did not increase reliability. In the lower secondary school data, the reliability was higher, α=.83 (Viitala, 2023).

Students' view of their effort in mathematics was studied through four statements: *I am hard-working by nature*, *I have not worked hard enough*, *I have worked hard to learn math*, and *I always prepare myself carefully for exams*. The sum variable for primary school students' ability was highly reliable, α=.80. Deleting items did not increase reliability. In the lower secondary school data, the reliability was similar, α=.82 (Viitala, 2023).

Students' enjoyment of mathematics was studied through six statements: *It has been boring to study mathematics*, *Doing exercises has been pleasant*, *Mathematics is a mechanical and boring subject*, *I have enjoyed pondering mathematical exercises*, *Mathematics has been my favourite subject*, and *Mathematics has been the most unpleasant part of studying*. The sum variable for primary school students' enjoyment was reliable, α=.73 (the three negative statements inversed). Reliability was similar even without the statement Mathematics is a mechanical and boring subject. In the lower secondary school data, the reliability was higher, α=.93 (Viitala, 2023). Enjoyment reached similar reliability even without the statement Mathematics has been my favourite subject.

Students' view on the difficulty of mathematics was studied through two statements: *Mathematics is difficult*, and *Learning mathematics requires a lot of effort*. The sum variable for primary school students' difficulty was not reliable, α=.21. In the lower secondary school data, the reliability was high, α=.80 (Viitala, 2023).

Students' view on success in mathematics was studied through four statements: *I can get good grades in math*, *I am sure that I can learn math*, *I know I can do well in math*, and *I think I could handle more difficult math*. The sum variable for primary school students' success was somewhat reliable, α=.68. However, the reliability is similar even without the statement I think I could handle more difficult math and somewhat higher without the statement I am sure that I can learn math, α=.75. In the lower secondary school data, the reliability was only a bit higher, α=.77 (Viitala, 2023).

Since the levels of reliability are all on a satisfactory lever and similar even after deleting some items, the results from this small-scale study can be reported using the categories: ability, effort, enjoyment and success. However, since difficulty of mathematics was not reliable as a sum variable in the primary school data, the statements in this category will be summarised only individually.

4.2 Results of the sum variables and the individual statements

Across all categories, primary school students' view of themselves as learners of mathematics is more positive than lower secondary school students' view. The results of the sum variables are presented in Table 1. The results of individual statements are presented in Table 2.

Table 1. Descriptive statistics of the sum variables

	Mean		Median		St. Deviation	
	Primary	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**
Ability	4.10	3.40***	4.25	3.5	0.728	0.861
Effort	3.91	3.29***	4.00	3.5	0.971	0.853
Enjoyment	4.04	2.66***	4.33	2.9	0.744	0.966
Difficulty		3.29		3.0		1.056
Success	4.02	3.36***	4.25	3.5	0.838	0.746

*** Difference is highly significant, *p*<.001 (2-sided).

Table 2. Descriptive statistics of the individual statements

	Mean		Median		St. Deviation	
	Primary	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**
Ability						
I am no good at math	1.91	2.90***	2	3	1.121	1.026
I am not the type to do well in math	1.88	3.00***	2	3	0.977	1.052
Math has been my worst subject	2.06	2.04	2	2	0.873	1.148
I have made it well in math	4.31	3.58***	5	4	1.283	1.007
Effort						
I am hard-working by nature	3.67	3.51	4	4	1.148	1.043
I have not worked hard enough	2.31	2.57**	2	2	1.064	0.979
I have worked hard to learn math	3.48	3.21**	3	3	1.199	1.020
I always prepare myself carefully for exams	3.22	2.96**	4	3	1.261	1.129
Enjoyment						
It has been boring to study mathematics	2.87	3.48***	3	3	1,368	1.031
Doing exercises has been pleasant	3.18	2.80**	3	3	1.337	1.118
Mathematics is a mechanical and boring subject	2.55	3.16***	2	3	1.305	1.143
I have enjoyed pondering mathematical exercises	3.11	2.63***	3	3	1.252	1.074
Mathematics has been my	2.81	1.96***	3	2	1.444	1.079

favourite subject						
Mathematics has been the most unpleasant part of studying	2.27	2.78***	2	3	1.257	1.295
Difficulty						
Mathematics is difficult	2.77	3.12**	3	3	1.226	1.130
Learning mathematics requires a lot of effort	3.44	3.42	3	3.5	1.196	1.164
Success						
I can get good grades in math	4.14	3.80	4	4	1.018	0.935
I am sure that I can learn math	4.42	3.76***	5	4	0.996	0.969
I know I can do well in math	4.23	3.28***	4	3	1.031	1.057
I think I could handle more difficult math	3.37	2.56***	4	3	1.087	0.956

** Difference is significant, $p<.01$ (2-sided); *** Difference is highly significant, $p<.001$ (2-sided).

Both group of students are positive about their abilities in mathematics (primary $M=4.10$, $SD=0.728$; lower secondary $M=3.40$, $SD=0.861$). Primary school students' view is significantly more positive than their peers' in lower secondary school ($z=-3.872$, $p<.001$). Individual statements show that both groups believe that they have made it well in mathematics (primary $M=4.31$, $SD=1.283$; lower secondary $M=3.58$, $SD=1.007$; $z=-3.980$, $p<.001$) and that they are good at mathematics (primary $M=1.91$, $SD=1.121$; lower secondary $M=2.90$, $SD=1.026$; $z=-4.074$, $p<.001$), primary school students being significantly more positive than lower secondary school students. Interestingly, both groups disagree with the statement "Mathematics has been my worst subject" without significant differences between them (primary $M=2.06$, $SD=0.873$; lower secondary $M=2.04$, $SD=1.148$).

Both groups of students think that they put effort into learning mathematics (primary $M=3.91$, $SD=0.971$; lower secondary $M=3.29$, $SD=0.853$). Primary school students' view is significantly more positive than lower secondary school students' view ($z=-3.310$, $p<.001$). Individual statements show that there are only small, though significant differences between the student groups. Both groups believe they have worked hard to learn mathematics (primary $M=3.48$, $SD=1.199$; lower secondary $M=3.21$, $SD=1.020$; $z=-2.733$, $p<.01$) and that they prepare carefully for exams (primary $M=3.22$, $SD=1.261$; lower secondary $M=2.96$, $SD=1.129$; $z=-2.635$, $p<.01$).

Primary school students enjoy learning mathematics, unlike their peers in lower secondary school (*M*=4.04, *SD*=0.744 and *M*=2.66, *SD*=0.966, respectively). The difference is highly significant (*z*=-5.702, *p*<.001). Individual statements show that, unlike their peers in lower secondary school, primary school students enjoy pondering mathematical exercises (primary *M*=3.11, *SD*=1.252; lower secondary *M*=2.63, *SD*=1.074; *z*=-4.258, *p*<.001), and do not think it is boring to study mathematics (primary *M*=2.87, *SD*=1.368; lower secondary *M*=3.48, *SD*=1.031; *z*=-4.955, *p*<.001). On average, mathematics is not their favourite subject in either of the groups even though primary school students view is significantly more positive (primary *M*=2.81, *SD*=1.444; lower secondary M23.78, *SD*=1.295; *z*=-6.435, *p*<.001).

Students' view on the difficulty of mathematics was studied with two statements that were not connected in the primary school data. Primary school students think mathematics is significantly less difficult than lower secondary school students (primary *M*=2.77, *SD*=1.226; lower secondary *M*=3.12, *SD*=1.130; *z*=-3.158, *p*<.01). Both groups have similar view that learning mathematics requires effort (primary *M*=3.44, *SD*=1.196; lower secondary *M*=3.42, *SD*=1.164).

Primary school students think they can success in mathematics, more so than students in lower secondary school (*M*=4.02, *SD*=0.838 and *M*=3.36, *SD*=.746, respectively). The difference is highly significant (*z*=-4.355, *p*<.001). Individual statements show that the greatest significant differences are between how well students can do in mathematics (primary *M*=4.23, *SD*=1.031; lower secondary *M*=3.28, *SD*=1.057; *z*=-4.390, *p*<.001) and how difficult mathematics they believe they can handle (primary *M*=3.37, *SD*=1.087; lower secondary *M*=2.56, *SD*=0.956; *z*=-3.492, *p*<.001), both favouring primary school students. There are no significant differences in how good grades they believe they can get (primary *M*=4.14, *SD*=1.018; lower secondary *M*=3.80, *SD*=0.935).

4.3 Comparing the results with prior research

When comparing the primary and secondary school students' results, they seem to follow the trends identified in prior research. Across all categories, primary school students' view of themselves as learners of mathematics is more positive than lower secondary school students' view. Considering their self-efficacy beliefs (ability and success), the results are in line with previous studies that show that students' self-efficacy beliefs descend throughout compulsory school (Metsämuuronen & Tuohilampi, 2014).

Like in Rösken and colleagues' (2011) study, upper secondary school students' view on their ability and success form the core of their view of themselves as learners of mathematics (highest correlation between the categories, r_τ=.50, p<.001). Interestingly, this is not the case with primary school students, whose core turned out to be between success and effort (r_τ=.51, p<.001). This indicates that primary school students' self-efficacy belief in their mathematics ability in the future (success) is more connected to the effort they put in learning mathematics than in their current ability in mathematics, like their peers in secondary school belief. The primary school result indicates a different core connection than Putwain and colleagues (2018) suggest. However, since the questionnaires in these two studies examine mathematics-related affect so differently, the primary school result can be interpreted as additional to prior research, rather than contradictory.

The difference between primary and secondary school students is largest with enjoyment. The result is similar than previous research that show the descending trend or the difference in students' emotions in mathematics (Metsämuuronen & Tuohilampi, 2014; Mullis et al., 2020).

5 Summary and conclusion

The aim of this paper was to present preliminary findings from a study that used a questionnaire on students' mathematics-related affect with primary school students. The findings suggest that the questionnaire seem to be applicable to primary school students in most parts. Four of the five sum variables formed categories reliably in primary and lower secondary data: ability, effort, enjoyment and success (research question 1). However, students' view on difficulty of mathematics was covered only by two of the original three statements, which means that the variables can be studied only by using individual statements.

When looking at the results of the five categories and individual statements, the results are clear: primary school students' view of themselves as learners of mathematics is more positive in all categories than lower secondary school students' view (research question 2). This is consistent with the research on the development of student's self-efficacy beliefs (Metsämuuronen & Tuohilampi, 2014) and emotions (Mullis et al., 2020). The difference is largest with enjoyment: primary school students enjoy learning mathematics significantly more than their peers in lower secondary school.

Notable in the results are that the core of primary school students' view of themselves as learners of mathematics (Rösken et al., 2011) appears to be more closely linked to their effort in learning mathematics than to their perceived ability. This indicates a different conceptualization of the mathematics-related affect compared to secondary school students, where ability and success are more central (Rösken et al., 2011; Salonen et al., 2023).

Furthermore, the individual statements relating to the difficulty of mathematics (Rösken et al., 2011) show that, unlike their peers in lower secondary school, primary school students do not link effort to the perceived difficulty of mathematics. Through knowing that effort is connected to success in primary school and to perceived difficulty in lower secondary school, teachers can better understand the role of effort in students' conceptions of learning mathematics. Using this knowledge, teachers can deliberately frame effort as a productive route to learning mathematics for instance through fostering persistence or a growth mindset in mathematics classrooms (for findings from mindset interventions, see e.g. Bui et al., 2023).

While the results presented in this paper are preliminary and not intended to be generalizable, they provide valuable insights into the mathematics-related affect of young students. However, these preliminary findings are to be read with caution. The small sample size, lack of measurement equivalence, possible response bias and the different response setting are all limitations to this study.

Future research should continue to explore the dynamics between the different aspects of students' mathematics-related affect, particularly when interventions like collaborative problem-solving are expanded to younger populations. Increasing the sample size in subsequent studies would enhance the reliability of findings and provide a more comprehensive understanding of how mathematics-related affect develops across different age groups.

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