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Mathematics Identity of Prospective Mathematics Teachers: Content Analysis of Open-Ended Survey Questions

Annisa Dwi Kurniawati
Doctoral Study Program of Mathematics Education, Universitas Negeri Surabaya, Surabaya, Indonesia ORCID: 0000-0003-0795-3747

Dwi Juniati*
Department of Mathematics, Universitas Negeri Surabaya, Surabaya, Indonesia ORCID: 0000-0002-5352-3708

Abadi Abadi
Department of Mathematics, Universitas Negeri Surabaya, Surabaya, Indonesia ORCID: 0000-0002-8475-922X

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Many problems faced by mathematics learners both at the school and college levels have occurred so far. Mathematics education students involved in mathematics daily also face various problems, be it problems related to cognitive and affective abilities. Problems such as the emergence of mathematical anxiety, negative self-perception of mathematics, lack of mathematical competence, and many other problems have become the recent focus in mathematics education research. So, how do mathematics education students, especially prospective mathematics teachers, view themselves as related to mathematics? What is their mathematical identity? This study aims to determine the mathematics identity possessed by prospective mathematics teachers. To find out the mathematics identity of prospective mathematics teachers, a descriptive design utilizing a survey with five open-ended questions was asked. Demographic data were analyzed using descriptive frequencies, while the five open-ended questions were analyzed using summative content analysis to analyze free-text responses from 225 prospective mathematics teachers. Free-text responses contain answers to five questions in each component of the mathematical identity obtained from disseminating questions through google forms. We obtained the results that prospective mathematics teachers generally have a positive mathematical identity, but some components need improvement. However, it was also found that the results were quite surprising concerning the mathematical identity of the prospective mathematics teacher. A complete explanation will be discussed in this article.

* Correspondency: dwijuniati@unesa.ac.id

Introduction

Recently, sociocultural and historical perspectives have been used in mathematics education research to understand better how students experience school mathematics and start to realize they are capable math learners. One of the core ideas in mathematics education during the past 20 years has been "identity". Examining features of power, access, equity, career choice, interactions participating in mathematical activities, sociopolitical issues, and a person's relationships with mathematics have all been made using identities connected to mathematics (Darragh, 2016). Identities related to mathematics are commonly known as mathematics identity. Mathematics identity can be seen as a head, heart, and head approach, where mathematics and mathematics learning involves a cognitive component and specific knowledge (head), some particular skills and activities (hand), and affective engagement (heart) (Grootenboer, 2020). Furthermore, mathematics identity refers to one's perceptions of their relationship to mathematics (Cribbs et al., 2021).

Based on how students perceive and handle their daily interactions with mathematics, students' views of themselves concerning mathematics are the basis for the definition of mathematical identity employed in this study. This explanation of the concept of mathematics identity focuses on how students view themselves about mathematics and how their interactions with the subject have shaped these ideas. A term called mathematics identity offers a lens through which to view students' decisions about mathematics. Depending on how strongly a person is connected to mathematics, two types of mathematical identities have been recognized in the literature: robust and fragile (McGee, 2015). Fragile identities are associated with unpleasant mathematical experiences and are mostly extrinsically motivated. Robust identities are associated with pleasant mathematical experiences (McGee, 2015). Learners with robust identities tend to be assertive, persistent and have a positive outlook on mathematics. People with fragile identities are less confident, less tenacious, and negatively view mathematics.

The mathematics identity of a prospective mathematics teacher is important and needs to be known. Apart from developing conceptual and procedural fluency, a well-developed mathematical identity is essential for ensuring mathematical success (NCTM, 2014). In particular, mathematics identity research can explore the broader context of mathematics education and what it means to be a mathematics learner (Lester, 2007). Mathematical identity can also be used to understand students' experiences and persistence in mathematics (Cribbs, 2012). Using a mathematical identity framework, understanding how students' self-perceptions affect long-term goals can be better developed.

Mathematical identity in a person's eyes can be negative or positive, so the impact will also vary. Radovic et al. (2017) said that mathematical identity could be seen from several aspects, namely activity, emotion, motivation, involvement, and mathematical character in his mind (Gweshe & Brodie, 2019; Luczak, 2021; Syyeda, 2021). An explanation framework for mathematics identity was developed in a previous study (Crossley et al., 2018; Darragh, 2016; Grootenboer & Marshman, 2015). Mathematical identity comprises four components: interest, recognition, competence, and performance (Cribbs et al., 2015). According to Solomon (2009), mathematics identities include beliefs about one's self as a mathematics student, ideas about the nature of mathematics, involvement in mathematics, and sense of oneself as a potential participant in mathematics. The components of mathematical identity offered by Martin (2000) included knowledge of the value of mathematics for an individual, motivation to learn mathematics, opportunities for learning mathematics, strategies for learning or participating in the context of formal and informal mathematics, challenges faced in learning mathematics, and capacity or ability possessed to participate in mathematics learning. There are similarities

between the components used by Martin (2000) and Solomon (2009), namely beliefs about the nature of mathematics (Solomon, 2009) and the importance of mathematics (Martin, 2000). Thus, in this study, the components of mathematical identity refer to the four components used by Cribbs et al. (2015), which were developed by adding one component about beliefs about mathematics (Martin, 2000; Solomon, 2009). Thus, the five components used in this study are interest, recognition, competence, performance, and beliefs about the nature of mathematics (Kurniawati et al., 2022a). A more detailed explanation of the five components used in this study can be seen in previously published research articles (Kurniawati et al., 2022a) .

So far, mathematical identity research has been carried out for students at various levels. As much as 50% of research on mathematical identity focuses on students at various levels from elementary or primary school, 28% of studies focus on teachers, and only 17% focus on pre-service teachers (Darragh, 2016). One of the research projects on mathematical identity was conducted by Gweshe & Brodie (2019) examined the mathematical identities of high school students. They discovered that students could possess mostly strong, moderate, or fragile mathematical identities concerning these three indications: the learners' identities were influenced by their past and present mathematical experiences, what their family and peers said about them, and mathematics, including peer labeling. According to Gardee (2019), there is a correlation between teachers' actual and narrated practices, students' readiness to participate in and fully join their classroom community, and their satisfaction with learning mathematics. Teachers' practices influence the types of identities students construct in their classrooms. Cribbs et al. (2016) said a relationship exists between mathematical identity and a person's persistence in engineering. Furthermore, in the past ten years, there have been several reviews on identity research in mathematics education in general (Darragh, 2016; Heyd-Metzuyanim et al., 2016; Langer-Osuna & Esmonde, 2017; Lutovac & Kaasila, 2018), mathematics learner identity (Radovic et al., 2018) and mathematics teacher identity (Lutovac & Kaasila, 2018). Although there has been quite a lot of research discussing mathematical identity in the last two decades, research discussing the mathematical identity of prospective mathematics teachers is still quite limited and shows some challenges to several theoretical, methodological, and empirical absences (Graven & Heyd-Metzuyanim, 2019).

The idea of mathematics identity is proposed as an alternate way to consider mathematics and mathematics learning. Related to mathematics learning that has been carried out so far, it turns out that there are still many problems, both in cognitive and affective aspects. For example, there are still various problems related to critical thinking ability, mathematical anxiety, mathematics interest, negative self-perception, etc. For example, there are still errors in the critical thinking process in solving mathematical problems (Anjariyah et al., 2018). Juniati & Budayasa (2020) found that a significant negative impact on mathematics performance was caused by the prospective math teachers' high degree of male and female math anxiety. In addition, mathematics has a negative self-perception (Martinot & Désert, 2007). From some of these studies, it can be known that many problems still occur in mathematics learning. However, these problems are still discussed separately between cognitive and affective aspects. These problems have to do with the mathematical identity of prospective mathematics teachers.

One way to overcome this problem is to figure out the mathematical identity of prospective mathematics teachers. By knowing the mathematics identity, a comprehensive picture will be known related to how prospective mathematics teachers' perception of themselves is related to mathematics. That way, the root of the problem is expected to be known, and practical strategies can be determined to overcome the problems in prospective mathematics teachers' mathematics learning. So, the current study aims to determine the mathematics identity of prospective

mathematics teachers, covering interest, recognition, competence, performance, and beliefs about mathematics that prospective mathematics teachers own.

The findings of this study will have a significant impact. It can be used as one of the references in identifying some practical and relevant strategies for helping prospective mathematics teachers develop more positive mathematical identities. So, it will have a positive effect because they will later become mathematics teachers who ought to have a positive mathematics identity. By knowing the prospective mathematics teacher's interest, recognition, competency, performance, and beliefs in mathematics, lecturers can determine which components need more emphasis and attention. Attention to the component of mathematical identity that is felt lacking can help improve the quality of the prospective mathematics teacher, who will ideally become a professional mathematics teacher.

Literature Review

Mathematics Identity

Since this work focuses on mathematical identity, a thorough literature review was necessary to understand the empirical and theoretical scholarship related to the research topic. To get a sense of the setting and people interacting within it, researchers from many disciplines have either used a wide-angle lens or zoomed in on the subject, adopting various theoretical frameworks (Darragh, 2016). Darragh (2016) evaluated 188 publications on mathematical identities published in academic journals between 1997 and 2014 as a literature review. Less than ten individuals were involved in most of the qualitative case studies in the papers (Darragh, 2016). The mathematical identity of kindergarten through college students was the subject of half the papers (Darragh, 2016).

Among the early researchers on mathematical identity, Boaler and colleagues have expanded on their work for almost 20 years. In a previous study, the researchers interviewed 48 students from six different schools to discover how they found out how to learn mathematics and how their identities affected it (Boaler & Greeno, 2000). Based on the findings of this study, Boaler & Greeno (2000) conducted interviews with 72 additional students to learn more about how kids develop a sense of who they are in connection to mathematics in six UK schools. According to the researchers' results, students aspire to succeed in mathematics but do not view themselves as mathematicians or members of a community or culture that engages in mathematics.

According to Philipp (2007), a more comprehensive definition of mathematics identity is the embodiment of a person's knowledge, beliefs, values, commitment, intentions, and affect relating to their participation in a specific community of practice. It is also how they have learned to think, act, and interact. The definition further details how students perceive themselves concerning their communities and how they participate in those communities. The definition that is ultimately adopted needs to consider the intricacies of identity, including how people perceive themselves, how they feel others perceive them, how they perceive their position in particular circumstances, and how they perceive themselves as having many identities (Philipp, 2007).

Method

Design

A descriptive design utilizing a questionnaire was employed to address the broader study aims of understanding the mathematics identity of prospective mathematics teachers. Descriptive studies clearly describe a specific situation (Büyüköztürk et al., 2011). Such research seeks to define an event and its constituent parts to comprehend, evaluate, compare, and categorize it (Cohen et al., 2000). Furthermore, this research is descriptive design research using a survey approach. Surveys are an approach that can be used in collecting data in a descriptive study (Siedlecki, 2020). The advantages of survey methods for data collection are that they can be relatively inexpensive and easy to do (Siedlecki et al., 2015). Survey methods use questionnaires to elicit information from subjects (respondents). This is useful when the researcher is interested in perceptions, beliefs, attitudes, or opinions (Edmonds & Kennedy, 2016).

Participants

The selection of participants was carried out using a non-probability survey sampling technique (Rowley, 2014). Non-probability survey sampling techniques be used because there is no readily available and complete list of the population under investigation (Galloway, 2005). In terms of determining respondents, many descriptive study researchers use a combination of approaches, for example, network sampling, as part of the sampling framework, which is determined by the desired sample and phenomena being studied (Doyle et al., 2020; Hibberts et al., 2012). Network sampling was used in this study to obtain data on the mathematical identity of prospective mathematics teachers with as many respondents as possible. When using network sampling, the researcher begins by obtaining a probability sample of some large population that is likely to have some connection to the target population (Hibberts et al., 2012). Members of the initial probability sample are then asked to provide contact information for target population members (Hibberts et al., 2012). Researchers collected data by distributing questionnaires online via the Google form link because, generally, questionnaires with open-ended free-text survey responses have been identified as valuable data sources in descriptive studies, particularly online open-ended questions, which can have an extensive geographical reach (Kim et al., 2017; Seixas et al., 2018).

Questionnaires were distributed through several social media groups owned by researchers, and researchers asked recipients to redistribute them. From the results of distributing the questionnaires over one month, it turned out that 225 respondents came from 7 universities spread across five provinces in Indonesia, namely East Java, West Kalimantan, Madura, Aceh, and Palu. All students involved in the research are prospective mathematics teachers who are still actively studying. In addition, from the results of distributing the questionnaires, it was found that there were differences in gender, previous levels of education, and different levels of lecture years owned by prospective mathematics teachers as the characteristics of the respondents. A more detailed explanation of the demographics of the respondents has been explained in the research results section.

Data Collection Instrument

This descriptive research using survey approach was conducted using a questionnaire as a data collection instrument. The stages of data collection using a questionnaire carried out by researchers refer to survey research using questionnaires previously carried out by Rowley

(2014). Initially, the researcher conducted a literature study to determine the components of the mathematical identity to be used. The researcher selects the five components from the literature study results to see the prospective mathematics teacher's mathematical identity. The researcher then developed five questions representing each component. Before distributing the questionnaire, the researcher wrote down a guide for filling out the questionnaire to ensure that respondents answered the questions accurately. Researchers then distributed questionnaires to potential respondents through social media groups and colleagues.

Data were collected from the five open-ended questions prepared about mathematics identity. Open-ended questions consist of five questions: (1) Are you interested in mathematics? Explain your reasons, (2) How do you think others' views of you relate to mathematics? (3) What do you think is your ability to understand mathematics? (4) According to you, what is the result of your work or achievements in mathematics? (5) According to you, what is mathematics?

Participants must answer questions based on their experience, feelings, and thoughts about mathematics while studying on campus. The content validity of open-ended questions has been measured using expert assessment based on the Aiken index (Aiken, 1980, 1985). The experts were asked to assess the suitability of the questions in the questionnaire with the components used in the mathematical identity. After the experts provide an assessment, the researcher determines the Aiken index obtained based on this assessment. Validation results from seven experts obtained the Aiken index value in the range of 0.821 – 0.929, so the five open-ended question instrument was valid.

The survey was conducted for about one month. Researchers share open-ended questions by utilizing Google form links. The researcher distributed the Google form link through several social media groups owned by the researcher and asked for it to be redistributed by the message recipient. Apart from that, the researchers also contacted several lecturers in the department of mathematics education at several universities to pass on to prospective mathematics teachers to fill in and distribute questionnaires through their social media groups. The time required for respondents to complete the survey was less than 15 minutes. After the data is obtained, the respondent's answer data is analyzed.

Data Analysis

This research is descriptive design research using content analysis. Even though content analysis is the most straightforward approach that can be used in a descriptive study, it does not mean that they produce low-quality research findings (Sandelowski, 2000; Vaismoradi et al., 2013). Furthermore, while open-ended questions were analyzed using summative content analysis, demographic data were analyzed using descriptive frequencies. In order to understand a situation, important phrases are selected and quantified using this analytical technique, which is frequently used for open-ended survey questions (Hsieh & Shannon, 2005). In order to enable an analysis of the terminology used in response to the questions given, this technique was taken.

Two researchers independently read the text to extract significant terms from the responses and compare the results obtained. The inter-coder reliability was calculated using the Holsti formula with a minimum reliability score of 0.7 (Mao, 2017). The inter-coder reliability obtained by the researcher for interest is 0.80, for recognition is 0.81, for competence is 0.82, for performance is 0.85, for beliefs about the nature of mathematics is 0.91. The inter-coder reliability numbers showed that the two coders were more reliable than the Holsti formula's minimum requirement. Then, these were sorted into related categories and subcategories. After that, frequency counts

were used to quantify these. This strategy was thought to be the most appropriate given that responses were provided in relatively short formats. The major categories and subcategories were then defined to facilitate further analysis.

Results

Demographic Characteristic

From the open-ended question questionnaire distribution, as many as 225 students gave responses. As many as 76% of respondents are female prospective mathematics teachers, and 24% are male prospective mathematics teachers. Of all respondents, there were differences in previous levels of education; namely, 51.1% came from Senior High School (SHS), 30.2% came from Vocational High School (VHS), and 18.7% from Islamic Senior High School (ISHS). Students who wish to be respondents also consist of several levels of lecture years; as many as 18.2% are first-year students, 34.2% are second-year students, 20% are third-year students, 23.1% are fourth-year students, and 4.4% are fifth-year students. Characteristics of respondents are provided in Table 1.

Table 1. Sample Characteristic

	N	**%**
Gender		
Female	171	76
Male	54	24
Previous Education		
SHS	115	51.1
VHS	68	30.2
ISHS	42	18.7
Student Level		
1st	41	18.2
2nd	77	34.2
3rd	45	20
4th	52	23.1
5th	10	4.4

Overall, the research results obtained from the respondents' answers are shown in Figure 1. From the results of the categories and subcategories obtained, the researcher then uses this information and represents it in a circular dendrogram using RAWGraphs 2.0. Figure 1 shows the categories that arise from each component of the mathematical identity of prospective mathematics teachers. The dots represent the results of categories and subcategories of mathematical identity identified by content analysis from 5 open-ended questions posed to 225 prospective mathematics teachers. The dots size in the subcategories is proportional to the number of citations by all respondents.

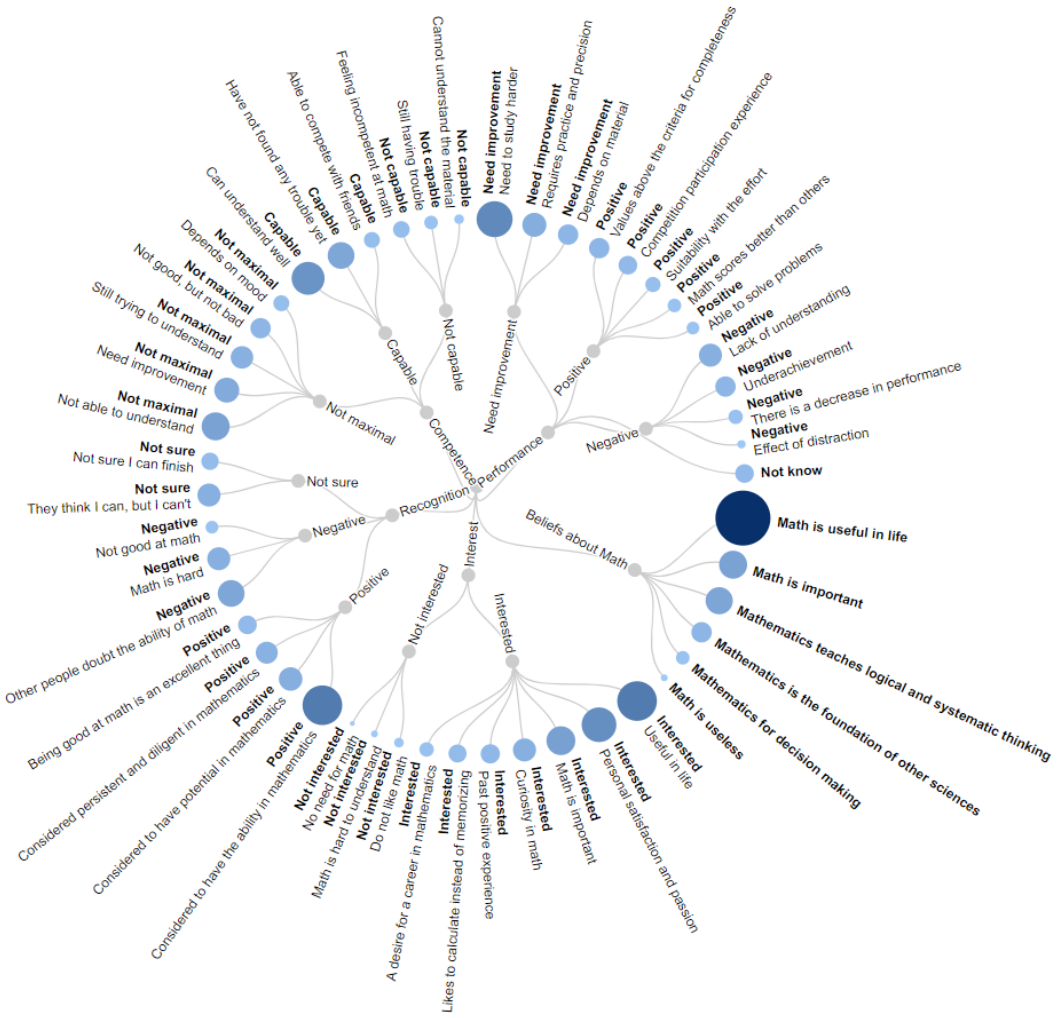

Figure 1. Outcome Categories Regarding the Mathematics Identity

Interest of Prospective Mathematics Teachers

After analysis, the response to the first question (i.e., components interest) is got a response consisting of two categories; namely, as many as 96.9% of students answered that they were interested in mathematics, but it turned out that there were still prospective mathematics teachers who answered not interested in mathematics, which was 3.1%. Various reasons were given for the respondents' answers to each category. Table 2 shows the mathematical identity of prospective mathematics teachers, especially on the interest component.

Table 2. Mathematics Identity - Interest

Interest ***Question: Are you interested in mathematics? Explain your reasons***		**N**	**%**
Interested in math		218	96.9
	Useful in life	68	30.2
	Personal satisfaction and passion	52	23.1
	Math is important	36	16
	Curiosity in math	23	10.2
	Past positive experience	16	7.1
	Likes to calculate instead of memorizing	14	6.2
	A desire for a career in mathematics	9	4
Not interested in math		7	3.1
	Do not like math	4	1.8
	Math is hard to understand	2	0.9
	No need for math	1	0.4

Students who expressed interest in mathematics reasoned that they were interested in mathematics because mathematics is beneficial to life (30.2%), there is personal satisfaction and passion for mathematics (23.1%), and they are interested in mathematics because mathematics is essential (16%). Curiosity about mathematics also underlies the interest of prospective mathematics teachers (10.2%). In addition, interest is also based on the existence of positive past experiences related to mathematics (7.1%). Liking numeracy compared to memorization (6.2%) and the desire to make a career in mathematics (4%) are other reasons for prospective mathematics teachers' interest.

It turns out that not all prospective mathematics teachers are interested in mathematics. 3.1% of respondents stated that they were not interested in mathematics. The reasons are diverse. For example, not liking mathematics (1.8%), mathematics is an elusive material (0.9%), and feeling that it does not yet need mathematics (0.4%).

Recognition of Prospective Mathematics Teachers

The analysis of the responses to questions about recognition asked by prospective mathematics teachers gave varied responses. In general, there are three categories related to the recognition of prospective mathematics teachers, namely positive perception (56.9%), negative perception (27.1%), and 'not sure' (16%). Table 3 shows the mathematical identity of prospective mathematics teachers, especially in the recognition component.

Table 3. Mathematics Identity - Recognition

Recognition ***Question: How do you think others' views of you relate to mathematics?***		**N**	**%**
Positive perception		128	56.9
	Considered to have the ability in mathematics	68	30.2
	Considered to have potential in mathematics	24	10.7
	Considered persistent and diligent in mathematics	21	9.3
	Being good at math is an excellent thing	15	6.7
Negative perception		61	27.1
	Other people doubt the ability of math	31	13.8
	Math is hard	23	10.2
	Not good at math	7	3.1
Not sure		36	16
	They think I can, but I can't	23	10.2
	Not sure I can finish	13	5.8

As many as 30.2% of prospective mathematics teachers perceive that others think they have abilities in mathematics. They are also considered to have potential in mathematics (10.7%), are seen as someone persistent and diligent in mathematics (9.3%), and have the perception that having good abilities in mathematics is an excellent thing (6.7%).

Not all students have positive recognition. From the results of the questionnaire answer response, 27.1% of prospective mathematics teachers have a negative perception related to recognition, which is based on the doubtful ability of mathematics of others (13.8%), the assumption of others that mathematics is complicated (10.2%), and the perception that they are not good at mathematics (3.1%).

Interestingly, as many as 16% of prospective mathematics teachers who were respondents to the study revealed that they felt unsure about their recognition. Although others think they are capable, it turns out that they feel inadequate (10.2%). In addition, some prospective mathematics teachers also feel they are not sure they can complete the process of studying mathematics (5.8%).

Competence of Prospective Mathematics Teachers

Responses to questions about competence as one of the components of the mathematics identity of prospective mathematics teachers turned out to be varied. Half of the respondents stated that their competence was not maximal (49.8%). For the rest, respondents felt capable (39.6%) or even incapable at all (10.7%). Table 4 shows the mathematical identity of prospective mathematics teachers, especially in the competency component.

Table 4. Mathematics Identity - Competence

Competence ***Question: What do you think is your ability to understand mathematics?***		**N**		**%**	
Not maximal		112		49.8	
	Not able to understand		34		15.1
	Need improvement		27		12
	Still trying to understand		22		9.8
	Not good, but not bad		18		8
	Depends on mood		11		4.9
Capable		89		39.6	
	Can understand well		47		20.9
	Have not found any trouble yet		31		13.8
	Able to compete with friends		11		4.9
Not capable		24		10.7	
	Feeling incompetent at math		12		5.3
	Still having trouble		8		3.6
	Cannot understand the material		4		1.8

The reasons expressed by the respondents are pretty varied. They feel that their competence in mathematics has not been maximized due to a mood dependency (4.9%), feel that their abilities are so-so (8%), still trying to understand the material (9.8%), need improvement (12%), and are less able to understand the material (15.1%).

The good news is that more than a quarter of the respondents said they had competency in math. The expressions given by respondents are based on experience during the lecture process; they can understand well the lecture material (20.9%), have not encountered difficulties while learning mathematics (13.8%), and feel able to compete with friends (4.9%).

Unfortunately, in the competency component, as many as 10.7% of prospective mathematics teachers are in the poor category. The reason is that they feel inadequate in mathematics (5.3%), still often encounter difficulties (3.6%), and cannot understand the material even though they have tried (1.8%).

Performance of Prospective Mathematics Teachers

After getting responses to questions related to performance, there are four main categories on the performance of prospective mathematics teachers, namely the need for increased performance (44%), positive performance (25.8%), negative performance (23.6), and ignorance of their performance (6.7%). Table 5 shows the mathematical identity of prospective mathematics teachers, especially in the performance component.

Table 5. Mathematics Identity - Performance

Performance ***Question: According to you, what is the result of your work or achievements in mathematics?***		**N**	**%**
Need improvement		99	44
	Need to study harder	56	24.9
	Requires practice and precision	25	11.1
	Depends on material	18	8
Positive performance		58	25.8
	Values above the criteria for completeness	18	8
	Competition participation experience	15	6.7
	Suitability with the effort	10	4.4
	Math scores better than others	8	3.6
	Able to solve problems	7	3.1
Negative performance		53	23.6
	Lack of understanding	23	10.2
	Underachievement	18	8
	There is a decrease in performance	9	4
	Effect of distraction	3	1.3
Not know		15	6.7

As many as 44% of prospective mathematics teachers believe that they need to improve in terms of performance in mathematics. This increase, for example, required more effort to study (24.9%), more practice, and increased accuracy (11.1%) and required performance improvement, but it depended on specific materials (8%). The purpose required for improvement that depends on certain materials is that sometimes a material requires more practice and thoroughness in working on it, while other materials do not.

Students who believe that their performance is positive are based on several reasons. For example, the score factor obtained that has exceeded the completeness criteria limit (8%), the experience of successfully participating in a competition (6.4%), obtaining results that are felt to be suitable with the effort (4.4%), obtaining better math scores than previously (3.6%), as well as their success in solving problems (3.1%). These reasons underlie their belief that they perform well in mathematics.

Not a few students believe that they have poor performance. This belief is based on a lack of understanding of mathematical material (10.2%), lack of achievement in mathematics (8%), a decrease in performance compared to before (4%), and the influence of distractions from other things that do not support their mathematical performance (1.3%).

The study results also found that there were not a few students who did not know how they

performed in mathematics (6.7%). So far, they have only attended lectures as they should without making any problems and paying attention to their mathematical performance. So, they feel they do not know how they perform in math.

Beliefs about the Nature of Mathematics of Prospective Mathematics Teachers

From the research results, students' beliefs in mathematics education on the nature of mathematics can be grouped into five main categories. More than half of prospective mathematics teachers who become respondents believe that mathematics is useful in life (58.2%), mathematics is essential (15.1%), mathematics teaches logical and systematic thinking patterns (14.2%), mathematics as the foundation of other sciences (8%), and mathematics was used for decision making (3.6%). However, it turns out that there are still respondents who believe that mathematics is less valuable (0.9%). Table 6 shows the mathematical identity of prospective mathematics teachers, especially on the component of beliefs about the nature of mathematics.

Table 6. Mathematics Identity – Beliefs about the Nature of Mathematics

Beliefs about the Nature of Mathematics ***Question: According to you, what is mathematics?***	**N**	**%**
Math is useful in life	131	58.2
Math is important	34	15.1
Mathematics teaches logical and systematic thinking	32	14.2
Mathematics is the foundation of other sciences	18	8
Mathematics for decision making	8	3.6
Math is useless	2	0.9

Discussion

The current study aims to determine the mathematics identity of prospective mathematics teachers. In this study, the mathematics identity consists of five components: interest, recognition, competence, performance, and beliefs about the nature of mathematics. The open-ended questions yielded rich data about prospective mathematics teachers' mathematics identity.

Interest of Prospective Mathematics Teachers

There are many reasons behind students' interest in learning mathematics. In general, the awareness that mathematics is useful in everyday life is given by prospective mathematics teachers. Even so, a person's sense of personal satisfaction and passion when doing mathematics is also an essential point for someone when interested in mathematics. The existence of satisfaction and passion that a person feels can affect the learning process he does (Rahimi & Vallerand, 2021). This understanding of passion is essential in fostering student self-adjustment and knowledge (Ruiz-Alfonso & León, 2016). In addition to passion, past positive experiences also impact a person's interest in learning mathematics. This finding confirms previous research, which stated that prior mathematics achievement positively predicted later mathematics interest (Du et al., 2021). In addition, interest in mathematics has a direct and positive effect on students' mathematics learning achievement; the positive relationship between interest in mathematics and mathematics achievement is partially mediated by self-efficacy and mathematics anxiety (Zhang & Wang, 2020). A person with a positive experience in mathematics becomes interested in mathematics in the future. This argument is consistent with Thomaes et al. (2020). They said that a person's memories of their early mathematics experiences could influence their attitude toward math, motivation for math, and future goals

for studying math even years after the experience. Our findings are somewhat surprising since we found that only a few students decided to continue their studies in mathematics education because of the desire for a career in mathematics. The desire to avoid a career in mathematics can be influenced by math anxiety or confidence in career choice (Chipman et al., 1992).

Not all prospective mathematics teachers are interested in mathematics. Some still think that mathematics is an elusive material; they do not like it. Other factors, such as the demands of parents to continue their education in the mathematics education department, turned out to make them have to study mathematics which they did not like. It is an exciting finding, as it is contrary to what we know from previous studies, which say that mothers' and fathers' attitudes about math relate to a range of math attitudes and beliefs held by their children (Hildebrand et al., 2022). This evidence is a new challenge for lecturers or mathematics educators. They need to try to invite students to like mathematics in order to support the success of the learning process carried out. The existence of teacher support can increase one's interest when learning mathematics (Lazarides et al., 2019).

Recognition of Prospective Mathematics Teachers

Prospective mathematics teachers positively perceive other people's views of them in mathematics. When entering the mathematics education department, prospective mathematics teachers have potential and ability in mathematics. In addition, they are considered persistent figures in mathematics. These findings contrast with the data reported by (Miele et al., 2022) . They found that although behavioral persistence on mathematics problems and general views of perseverance were not correlated, significant indirect effects of general perceptions through math-specific perceptions of perseverance were found. Furthermore, to others who do not like or do not have sufficient ability in mathematics, someone who studies math is considered someone great (Darragh, 2015). This presumption is natural because many math learners still think that mathematics is a complicated subject, so when someone dares to study or work in mathematics, that person is considered impressive (Purwaningtyas et al., 2020).

However, prospective mathematics teachers still have negative perceptions. These findings align with the literature, where college students endorsed more negative attitudes about mathematics material (Mielicki et al., 2022). They assume that their abilities are doubted by others and are not good at math. The results of this study confirm previous research, which found that rural female students perceived mathematics as a complicated subject, masculine and irrelevant to their future aspirations, thus affecting their participation in mathematics (Gudyanga et al., 2016). This assumption can lower their confidence in their ability in mathematics. Perceptions can affect the effectiveness of achieving mathematics learning objectives (Ní Fhloinn et al., 2014). As a result, this negative perception can hinder the learning process of mathematics, so they cannot show their best performance. This negative perception can be changed using a different learning approach (Prabhu, 2022). For example, by implementing encouraging learning helping each other, discussing solutions, challenging each other's reasoning, and exploring more than one way of solving a problem (Herrmann, 2013; Retnowati et al., 2017) or learning that emphasizes peer interaction (Attard, 2014; Retnowati et al., 2017).

Prospective mathematics teachers who feel unsure about how others see them make them feel confident that they can complete their studies. Even though other people think they are good at math, they do not believe it themselves. The existence of positive perceptions from parents, teachers, and friends is needed as an effort to convince themselves that they are indeed capable

and worthy of a career in mathematics. A cyclical relationship between students' self-perceptions and their teachers' judgments supported the notion of a reciprocal strategy-effort interaction (Meltzer et al., 2004).

Competence of Prospective Mathematics Teachers

In general, the competencies possessed by prospective mathematics teachers are not maximal. Many things still need to be done to maximize their competence. This less-than-maximal competence is because they feel they are less able to understand mathematics and still need improvement and are always trying to understand mathematics. Interestingly, the self-feeling factor (mood) contributes to their belief in their competence. This finding is consistent with the findings of (Stephanou, 2014), which suggest that emotions and feelings increased the impact of competence beliefs on learning motivation, particularly in mathematics, and had moderately positive effects on competence beliefs and learning motivation (low in learning goals). The existence of negative emotions related to one's mathematics performance (Gilbert, 2016).

Although many prospective mathematics teachers feel that their competence is not maximal, some prospective mathematics teachers say that they can understand the mathematics material being studied at this time. They feel that their efforts in mathematics enable them to understand mathematics well. Effort in mathematics is mainly explained by mastery goals and competence beliefs (Chouinard, 2011). These findings are in line with results reported by other publications in the literature. Math competence beliefs positively affected math achievement and negatively affected perceived math effort expenditure (Pinxten, 2013). Furthermore, students' beliefs about their competence are also shown by the absence of difficulties they have encountered, assuming they can compete with their friends.

Prospective mathematics teacher still often encounters difficulties in mathematics even though learning mathematics has become their daily life. These findings align with those found in the literature, where motivation tends to be lower at the end of the academic year than at the beginning (Chouinard et al., 2007). That is, when students have gone through several years of lectures and find increasingly difficult material, students will experience feelings of inadequacy due to difficulty understanding. This feeling of inadequacy because they often encounter difficulties is a problem that mathematics educators need to find a solution for. The solution that mathematics educators can do is to change the way of teaching mathematics to improve student competence, for example, by using software to improve mathematical competence (O'Reilly & Barry, 2021). So, perhaps what has to be changed about mathematics at that level is how it is taught and learned rather than the level itself (Henderson, 2008). In addition, feelings of inadequacy can also be overcome by oneself by utilizing self-talk, such as the results of previous research, which found that children's mathematics performance benefits from internally asserting that they will deliver effort (Thomaes et al., 2020).

Performance of Prospective Mathematics Teachers

In terms of performance, prospective mathematics teachers feel that they still need improvement. This is because they feel that their math performance and scores are still not optimal (Aronson et al., 1999). This performance improvement can be made in various ways, for example, by doing practice questions or using a different learning method approach to optimize their mathematical performance. The learning method approach used is, for example, the problem-centered approach. The problem-centered approach appeared to significantly

enhance performance and attitude toward mathematics (Ridlon, 2009). In addition, getting used to math exercises can often be one solution to improve student mathematics performance.

Prospective mathematics teachers perceive their performance as positive because there is a match between the effort they put in and the results they get. This finding is in line with previous research, which found that positive beliefs that students valued putting effort into improving their mathematical skills and thought that mathematics was essential in their daily lives (Giovanni & Sangcap, 2010). Past experiences also impact performance beliefs (Kurniawati & Noviani, 2022). From the aspect of the value obtained, they consider that their performance is quite good because the math score they get makes them pass the course. In this regard, a large proportion of mathematics performance can be directly predicted by students' metacognitive experiences (Zhao et al., 2014). On the other hand, the ability to solve problems also makes them think that their performance is good.

A decrease in performance can make prospective mathematics teachers believe their performance is negative. This situation could be related to their working memory; working memory across modalities contributes significantly to the mathematics performance and achievement of mathematically competent students (Berkowitz et al., 2022; Juniati & Budayasa, 2020). So, innovation in learning, for example, using technology in mathematics learning, is needed to improve performance (Juniati & Budayasa, 2021). In addition, the lack of understanding of a specific material and the presence of interference when learning mathematics impact performance. One thing that is considered a disorder is math anxiety, for example. Mathematics anxiety correlates significantly negatively with mathematics performance, but no significant correlation is detected with academic hardiness (Karimi & Venkatesan, 2017). Due to these disturbances, there is a decrease in the performance felt by prospective mathematics teachers. The interesting thing found in this study is there are still prospective mathematics teachers who do not know how their actual performance in mathematics has been. This is known from the empirical data obtained in this study, which states that as much as 6.7% of prospective mathematics teachers are unaware of their actual performance in mathematics. One of the reasons why this happens is because they lack the metacognitive ability to tell how good and bad, they are (Kruger & Dunning, 1999).

Beliefs about the Nature of Mathematics of Prospective Mathematics Teachers

Prospective mathematics teachers believe mathematics has benefits and is essential for everyday life. Mathematics is essential for life because mathematics improves all elements of personal development (Hodaňová & Nocar, 2016). Consistent with the previous study, we showed that pre-service teachers had formal and personal belief clusters with similar beliefs and differing strengths (Haser & Doğan, 2012). Their beliefs on the nature of mathematics support the belief in the teaching-learning process in mathematics classrooms (Muhtarom et al., 2019). When studying mathematics, they believe that mathematics can teach logical and systematic thinking patterns that are the foundation for other sciences. Mathematics can be used as the basis for reasoning patterns to make decisions when encountering problems. In line with prior literature, The implication of solving the problem and one's belief system are closely connected (Muhtarom et al., 2017). Students beliefs about the nature of mathematics impact decisions to pursue optional math education (Hurst & Cordes, 2017). Furthermore, a person's beliefs also impact motivation and solving mathematical problems (Kurniawati et al., 2022b). So, it is unsurprising that most prospective mathematics students have positive beliefs. Related to prospective mathematics teachers' beliefs, Muhtarom et al. (2017) found that 0.546% of prospective teachers consistently have instrumentalist beliefs; 80.328% have platonist beliefs;

0.546% have constructivist beliefs, and the rest is inconsistent with each category of beliefs. However, from the results of this study, this is surprising given that there are still prospective mathematics teachers still believe that mathematics is less useful. One of the reasons is the lack of emphasis on understanding the benefits of mathematics in learning mathematics (Stylianides & Stylianides, 2007). Furthermore, unhealthy belief systems may underlie student difficulties in mathematics (Mtetwa & Garofalo, 1989).

Conclusion and Recommendations

In general, prospective mathematics teachers have a positive mathematical identity but still need improvement and more attention to the components of competence and performance. The mathematical identity currently possessed by prospective mathematics teachers can be developed and strengthened by providing effective treatment, significantly improving their competence and performance. Therefore, research on applying specific strategies or interventions to improve the mathematical identity of prospective mathematics teachers must be sought. On the other hand, due to limited research time, researchers did not analyze mathematical identity based on gender differences or level of the year study. In addition, it is necessary to conduct research that looks at mathematical identity based on gender differences and the level of the year of study because there may be specific differences in mathematical identity components across gender or at different lecture levels, which have the potential to affect one's mathematical identity. By obtaining this information, mathematics educators are expected to overcome the main problems related to the mathematical identity of prospective mathematics teachers. Thus, the hope that prospective mathematics teachers have a positive mathematical identity in all components can be realized.

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