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Factors Causing Elementary School Teacher Education Students' Difficulties in Understanding Mathematics Courses

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Abstract. This study investigates the main factors causing difficulties faced by PGSD students in learning mathematics, driven by internal issues like low motivation and anxiety, as well as external factors such as teaching methods and the learning environment. The findings aim to serve as a foundation for improvements in teaching practices, student support, and institutional strategies. This study used a mixed-methods survey design using factor analysis to identify the underlying dimensions of students' learning difficulties. The population comprised second-semester PGSD students at Ahmad Dahlan University (2024/2025), with 41 survey participants. Instruments included an observation checklist, a structured questionnaire, and a semi-structured interview guide. The collected data were tested for validity using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The MSA value was 0.707 in the first stage and 0.751 in the second stage, both exceeding the threshold of 0.50. Bartlett's Test showed a significance level of 0.00, which is smaller than 0.05, indicating that the data is suitable for factor analysis. The results showed that there are four main factors that contribute to students' difficulties in learning mathematics, namely: (1) Learning and Academic Support Factor (eigenvalue 4.858, variance 34.703%), (2) Individual Ability and Attitude Factor (eigenvalue 2.156, variance 15.396%), (3) Family Environment Factor (eigenvalue 1.639, variance 11.710%), and (4) Health Factor (eigenvalue 1.171, variance 8.363%). These findings were supported by interviews with six students, whose experiences aligned with the identified factors, providing a more comprehensive understanding of the challenges they faced in learning mathematics.

Keywords: Factor Analysis; Student Difficulties; Mathematics Course

1. Introduction

Education has a central role in shaping human life, both in broad and narrow senses. According to Ki Hadjar Dewantara (2009), education must have a clear purpose so that it does not deviate from its direction. Education is not only the process of acquiring knowledge but also the process of living a meaningful life, guiding students to succeed in society (D'Olimpio & de Ruyter, 2025). In a broad sense, education is a lifelong process that can occur in various places and situations and contributes positively to personal development (Long Life Education). In a narrower sense, education is institutionalized in schools and universities, which serve as formal institutions that prepare individuals to recognize their environment, use resources, achieve social status, and grow physically, emotionally, and mentally (Dilbaz, 2023; Pristiwanti et al., 2022).

Quality education is highly dependent on the professionalism of teachers in carrying out their duties to achieve educational goals (Purnomo et al., 2022; Cahyani et al., 2024). A qualified teacher has a greater influence on student achievement than class size, financial resources, or student background (Westley, 2011). Teachers must master subject matter and pedagogical content knowledge (Shulman, 1987), as well as various teaching skills such as asking questions, explaining, varying learning methods, guiding groups, and giving (Abai et al., 2021; Gultom et al., 2020; Isnaniah & Imamuddin, 2022). In addition, they need to create a supportive learning environment to ensure student success and to optimally develop the potential within each learner (Lase et al., 2022). These competencies are critical for improving student outcomes, especially in mathematics (Yang & Kaiser, 2022).

Therefore, a professional educator needs to have an academic background that is relevant to the field of study being taught in order to provide a positive impact on students and achieve the best outcomes according to their competencies (Febriana, 2019; Kryshtanovych et al., 2021). However, before becoming professional teachers, students of Elementary School Teacher Education (PGSD) must acquire various competencies through higher education (Borremans et al., 2024; Schel & Drechsel, 2025). This preparation includes mastery of different subjects taught in elementary school, including mathematics (Kepmendikbudristekdikti, 2022).

Mathematics is widely recognized as one of the most challenging subjects to teach and learn (Mangarin & Caballes, 2024). Teachers and students alike often face difficulties in understanding and teaching mathematics, from school to university levels (Nicolescu & Petrescu, 2022; Sawitri, 2020; Yayuk & Husamah, 2020). This challenge is visible in PGSD students who are preparing to be future elementary school teachers but also experience difficulties in learning mathematics themselves. Such difficulties are concerning, given that these students are expected to later guide their pupils in learning mathematical concepts effectively.

1.1. Problem Statement

Initial observations in mathematics lectures at Ahmad Dahlan University revealed that the learning atmosphere was less engaging. Many students appeared passive, sleepy, and reluctant to participate actively. Questionnaire results from 40 students showed that 15% considered mathematics very difficult, 30% difficult, 45% moderately difficult, and only 10% easy. None of the students rated mathematics as very easy. These findings indicate that most PGSD students experience learning difficulties in mathematics, ranging from moderate to high levels. Short interviews further revealed difficulties in understanding questions, lack of interest in mathematics, and negative influences from previous teaching experiences.

At the school level, mathematics learning difficulties also arise due to limited teaching time, facilities, curriculum, student understanding, and external support systems (Karalı, 2022; Nguong et al., 2023). At the university level, similar challenges persist, compounded by the transition from school culture to academic culture (Nardi, 1999). Internal factors include low attention during class, lack of preparation, and difficulties applying concepts (Permata et al., 2022). External factors involve teaching methods, media use, family support, and the broader learning environment (Atiaturrahmaniah et al., 2021). This shows that mathematics learning difficulties are multidimensional, requiring systematic investigation.

The persistence of mathematics difficulties among PGSD students is problematic because it directly affects their preparedness as future teachers. If not addressed, these difficulties may hinder their ability to effectively assist their own students in mastering mathematics concepts (Putri & Dirgantoro, 2019). Thus, investigating the dominant factors influencing these difficulties is an urgent and important step to improve the quality of teacher education.

1.2. Related Research

Previous studies have identified various causes of mathematics learning difficulties. Raj Acharya, (2017) found that weak connections between new and prior knowledge, negative attitudes, economic conditions, and disorganized assessment systems contribute significantly. Mangarin & Caballes (2024), highlighted emotional and anxiety factors, while Munthe & Lase (2022) emphasized the role of physical and psychological conditions, fatigue, and external influences such as family and environment.

Other studies classified mathematics difficulties into ontogenic obstacles (e.g., fear and lack of prerequisite mastery), epistemological obstacles (e.g., difficulties solving story problems), and didactic obstacles (e.g., teaching focused on calculation over understanding) (Aini et al., 2023; Sidik et al., 2021). These studies confirm that the challenges are complex and influenced by both internal and external aspects.

The novelty in this study lies in the analytical model used. Previous studies tended to employ descriptive qualitative approaches, semi-structured interviews, or were based solely on final semester assignments. In contrast, this study uses factor analysis techniques with more complex instruments, namely preliminary observations, questionnaires, and interviews, providing a deeper level of analysis compared to previous studies that relied on simpler approaches.

1.3. Research Objectives

The purpose of this study is to identify and analyze the main factors that cause PGSD students' difficulties in learning mathematics. The focus is on distinguishing the dominant internal and external influences that affect student learning experiences.

The expected outcome of this study is to provide valuable input for students, lecturers, and educational institutions. For students, the results may help them recognize and address their own learning difficulties. For lecturers and institutions, the findings may serve as a foundation to design strategies that enhance teaching practices, student support, and academic environments, thereby improving mathematics learning outcomes among future elementary school teachers.

2. Theoretical Framework

2.1. Learning Difficulties

Learning difficulties can be defined as specific barriers in the learning process. These difficulties not only occur in the short term but may persist for more than six months, even after efforts have been made to address the issues (Stepanovic & Ilic, 2025). This condition is understood as a neurological disorder related to cognitive factors that affect the brain's ability to receive, process, store, and analyze information necessary for learning (Espinas et al., 2025).

Individuals who experience learning difficulties will struggle to develop skills such as reading, writing, and mathematics (Freitas & Castro, 2025; Stepanovic & Ilic, 2025). Learning difficulties generally arise in learning activities and are usually shaped by a combination of internal factors within the learner and external factors from the learning environment (Atiaturrahmaniah et al., 2021; Freitas & Castro, 2025; Permata et al., 2022).

2.2. Causes of Learning Difficulties

2.2.1. Internal Factors

Internal factors refer to elements that come from within the student and directly influence the quality of engagement and achievement in learning mathematics. One important aspect is the student's attitude towards learning, such as the perception of whether mathematics is important to learn. Wen and Dubé (2022) showed that a positive attitude is linked to improved learning outcomes. Conversely, negative attitudes can reduce engagement in learning and encourage students to avoid mathematics tasks.

In addition to attitude, learning motivation is also a significant internal factor. Motivation acts as a driver that encourages students to persist when faced with complex problems, to practice diligently, and to choose the right strategies to understand the material. Over time, motivation shapes self-efficacy, which is positively associated with mathematics achievement. The higher the self-efficacy, the greater the encouragement to persevere and maintain consistency in learning (Muhtadi et al., 2022).

Another internal factor is math anxiety, a negative emotional response when students face activities related to mathematics (Hopko et al., 2003). Emotional aspects associated with anxiety and negative perceptions play a crucial role in hindering engagement in learning (Mangarin & Caballes, 2024). This anxiety can trigger avoidance behavior, reducing study time and weakening mastery of mathematical concepts. As a result, students tend to avoid activities related to mathematics, which ultimately impacts their performance (Barroso et al., 2021).

Finally, physical health also influences students' ability to absorb and process information. Chronic illnesses during childhood not only disrupt physical health but can also impact academic performance. This occurs due to the intensive care needed, fatigue from illness, increased absenteeism, and difficulty catching up with missed lessons, which cumulatively result in academic setbacks (Buchardt et al., 2025).

2.2.2. External Factors

Several external factors contribute to learning difficulties and can be categorized into three main aspects: the teacher, family, and environment. From the teacher's perspective, motivation from the instructor is typically reflected through emotional and academic support (teacher support), providing clear guidance, and offering feedback that helps students understand mistakes and develop problem-solving strategies (López-Martín et al., 2023). The assessment system used in evaluating learning activities is also an important external factor in learning difficulties. A fair assessment system, which includes fairness in outcomes (grades that reflect the quality of student learning) (Chory, 2023) and fairness in procedures (rules and assessments) (Sonnleitner et al., 2020), greatly influences student motivation and learning success.

Moreover, the use of appropriate learning media can improve students' understanding of mathematical concepts and procedures, especially when integrated with clear pedagogical strategies (Rakes et al., 2020). A monotonous teaching method can contribute to learning difficulties in mathematics. Therefore, teaching should include clear explanations of concepts, examples, worked examples, structured practice opportunities, error analysis, and formative feedback (Patall et al., 2024).

Meanwhile, a supportive school environment, with a safe, orderly, relational, and supportive learning climate, helps students become more confident to try, ask questions, and persevere when facing difficulties in learning (Erdem & Kaya, 2023). Furthermore, teaching should balance the content with the students' initial needs. This adaptive learning aims to adjust the level of support, pace, and practice to ensure that students do not fall behind in future lessons (Smale-Jacobse et al., 2019). A supportive home environment also plays a vital role in learning difficulties. Time available for studying at home can reinforce students' concepts through repetition and practice done outside school hours (Fan et al., 2017).

Regarding family aspects, there are several factors that influence students' learning difficulties. Parents' educational background can have a positive effect, such as providing quality academic interaction and support for learning at home (Horoz et al., 2025). Parents' understanding of their child's interests and abilities is also crucial, as it can provide strength in helping children choose the right educational path (Pinquart & Ebeling, 2020). Parental involvement in guiding children to complete homework, offering constructive support (without excessive or intrusive control), can improve students' learning performance (Jiang et al., 2022). Another factor is family economic status, which can influence access to learning resources, school quality, home environment stability, and opportunities for additional tutoring outside of school (Tan et al., 2025).

2.3. Barriers in Mathematics Learning

Mathematics learning is often influenced by ontogenetic, epistemological, and didactic barriers (Aini et al., 2023; Sidik et al., 2021). Ontogenetic barriers are related to students' mental, cognitive, and psychological readiness to receive new material. These barriers arise when the level of difficulty of the material does not match students' cognitive development, lack of motivation, or inability to master prerequisite concepts. For example, a student who does not understand basic concepts will struggle to learn more advanced material (Sidik et al., 2021).

Epistemological barriers occur when students' understanding is limited to certain contexts or when mathematical concepts are not understood deeply. These barriers often arise because students tend to memorize procedures without understanding the meaning behind the concepts, or because the material in textbooks is not systematically organized. For example, students may be able to solve routine problems but fail when confronted with non-routine problems or the application of concepts in more complex (Chandra et al., 2025).

Didactic barriers arise from the teaching system, such as the sequence in presenting material, teaching methods, or the quality of teaching materials. These barriers can occur if the teacher does not understand didactic transposition, the sequence of material does not align with students' needs, or material is presented too abstractly without proper contextualization. For example, poorly structured textbooks can exacerbate these didactic barriers, making it difficult for students to understand and apply the material being taught (Hendriyanto et al., 2024).

3. Method

3.1. Research Design

This study employed a mixed-methods research approach. Quantitative research emphasizes the collection and analysis of numerical data to measure relationships between variables and explain phenomena using statistical analysis (Mohajan, 2020), prioritizes objectivity, systematic measurement, and the ability to generalize findings (Hasan, 2024). In contrast, qualitative research focuses on exploring participants' experiences, meanings, and perspectives in depth within their natural context, allowing researchers to develop a richer understanding of how and why a phenomenon occurs (Creswell, 2014). Quantitative data were collected via a questionnaire and analyzed using exploratory factor analysis, while qualitative data were obtained through semi-structured interviews to corroborate and elaborate the quantitative findings. The research design used was survey research with factor analysis, which aims to identify, and group interrelated variables into several latent factors.

3.2. Participant or Respondent

The participants in this study are 41 second-semester students from the Elementary School Teacher Education (PGSD) program at Universitas Ahmad Dahlan for the academic year 2024/2025. Participants were selected using the accidental sampling technique due to the ease of the researcher in directly interacting with the research sample. Table 1 shows the frequency and percentage of respondents based on gender.

Table 1. Participants' Characteristics

Gender	Frequency	Percentage
Male	9	22%
Female	32	78%
Total	41	100%

3.3. Data Collection

Data collection in this study was conducted using three techniques: observation, questionnaires, and interviews. Observation was conducted during the pre-research stage to identify students' initial attitudes and abilities in mathematics by observing their behavior and interactions during the learning process. The goal was to gain an initial understanding of students' conditions regarding any difficulties they may have in participating in mathematics learning. At the research stage, the researcher distributed questionnaires to gather data on external and internal factors contributing to students' difficulties in learning mathematics. Furthermore, interviews were conducted with willing students to validate data from the observations and questionnaires, using semi-structured questions to explore their experiences with learning difficulties in mathematics.

3.4. Data Analysis

The initial observation activity was conducted to identify the underlying issues that prompted this study. The data results have been explained in the introduction, specifically in the problem statement section. Meanwhile, the data from the questionnaire results were collected and analyzed using multivariate statistics with interdependence techniques, namely factor analysis. Factor analysis was conducted to reduce dimensions by grouping interrelated variables into latent factors that cannot be directly measured but can explain the relationship patterns between observed variables (Gower, 1972).

The steps of factor analysis included: (1) determining variables to be analyzed, (2) calculating the correlation matrix using Bartlett's Test of Sphericity and the Measure of Sampling Adequacy

(MSA), (3) extraction using Principal Component Analysis (PCA), (4) determining the number of factors, (5) factor rotation, and (6) determining factor scores (Watkins, 2021; Wangge, 2021). The results of the questionnaire analysis are further supported by data obtained from the interviews conducted by the researcher with six respondents who were willing to provide additional information for the research.

3.5. Validity and Reliability

In this study, the validity and reliability of the data collection instruments are crucial to ensure that the research results can be scientifically justified. The validity of the instruments is tested to ensure that each tool used, whether observation, questionnaire, or interview, truly measures what it is intended to measure. Meanwhile, the reliability of the instruments is tested to ensure the consistency of the results obtained from data collection.

The validity and reliability testing in this study is based on previous research that has identified both external and internal factors affecting mathematical learning difficulties, so the instruments used in this study can be confirmed as valid and reliable for accurately measuring these variables. Each questionnaire item underwent expert validation, and the final version was deemed suitable for use (the complete list of items is provided in the Appendix).

Especially for questionnaire data, to ensure data quality, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA) and Bartlett's Test of Sphericity were applied. If the MSA value exceeds the threshold of 0.50 and Bartlett's Test shows a significance level less than 0.05, the instrument used in the study can be considered to have met the validity and reliability requirements.

4. Findings

Based on the data analysis points explained, the findings from the observations have been presented in the problem statement section of the introduction as the initial data supporting the rationale for conducting this research. Meanwhile, the analysis of the questionnaire data was conducted using factor analysis, based on steps 4.1 to 4.6, and the results of the interviews are presented in section 4.7.

4.1. Formulating the Variables to be Analyzed

There are 15 variables that will be analyzed with each consisting of 2 questions, so that there is a total of 30 questions. The questions in the questionnaire and interview were prepared based on indicators that are the variables that cause difficulties in learning mathematics as listed in Table 2.

Table 2. Table of Indicators of Difficulty for PGSD Students Learning Mathematics

Indicators	Observed Aspects
Math anxiety (attitude)	X_1
Basic skills when a student	X_2
Lack of hard work/self-motivation	X_3
Student health	X_4
Motivation from lecturers	X_5
Rating system	X_6
Use of learning media	X_7
Teaching methods (teacher guidance)	X_8
Supportive school environment	X_9
Learning according to initial abilities and needs	X_{10}
More time to study at home	X_{11}
Parents' educational background	X_{12}
Parents' understanding of children's interests and abilities	X_{13}
Parental guidance	X_{14}
Family economic status	X_{15}

The questionnaire was completed by all PGSD students, while interviews were conducted with 6 out of the 41 students in the same class.

4.2. Calculating Correlation Matrix and Variable Analysis

The data from this questionnaire was analyzed using the help of SPSS version 27 application, with the following analysis results:

Table 3. MSA and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.707
Bartlett's Test of Sphericity	Approx. Chi-Square	282.963
	Df	105
	Sig.	.000

Table 3 states the value of the MSA (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) of 0.707. This means that the value is more than 0.50, so that the data meets the data adequacy value (valid). For *Bartlett's Test of Sphericity* (*Sig.*) value of 0.00 < 0.05, the correlation between the variables is met. It can be concluded that the data sufficiency test (validity) has been fulfilled with the variables, so the analysis is continued. The next stage is to analyze the Anti-Image Matrices table with the provision that variables that have an MSA value of less than 0.5 are excluded from the selection of variables.

Table 4. Anti Image Matrices

		X_{1}	X_{2}	X_{3}	X_{4}	X_{5}	X_{6}	X_{7}	X_{8}	X_{9}	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
Anti-image Covariance	X_{1}	.591	-.122	-.085	.108	-.084	-.003	.069	.012	-.119	-.091	.062	.018	.006	-.133	-.062
	X_{2}	-.122	.573	-.067	-.042	.083	-.015	-.063	.019	.047	-.029	-.219	.022	.028	-.017	.182
	X_{3}	-.085	-.067	.412	-.050	-.027	.003	.008	-.017	.019	-.147	-.082	-.022	.016	.101	-.055
	X_{4}	.108	-.042	-.050	.702	-.046	-.027	.056	.021	-.219	.008	-.087	.075	.010	-.096	-.124
	X_{5}	-.084	.083	-.027	-.046	.208	.016	-.132	-.045	.123	-.023	-.094	.036	-.023	.024	.062
	X_{6}	-.003	-.015	.003	-.027	.016	.297	-.063	-.111	.016	-.029	.037	-.070	.106	-.065	.080
	X_{7}	.069	-.063	.008	.056	-.132	-.063	.198	-.031	-.193	.097	.054	.011	-.016	.005	-.038
	X_{8}	.012	.019	-.017	.021	-.045	-.111	-.031	.172	.049	-.088	-.031	-.043	-.026	.006	-.066
	X_{9}	-.119	.047	.019	-.219	.123	.016	-.193	.049	.525	-.112	-.029	-.050	.019	.032	.068
	X_{10}	-.091	-.029	-.147	.008	-.023	-.029	.097	-.088	-.112	.354	.031	.040	-.043	.035	.053
	X_{11}	.062	-.219	-.082	-.087	-.094	.037	.054	-.031	-.029	.031	.435	-.024	-.015	-.100	-.035
	X_{12}	.018	.022	-.022	.075	.036	-.070	.011	-.043	-.050	.040	-.024	.373	-.216	.018	-.092
	X_{13}	.006	.028	.016	.010	-.023	.106	-.016	-.026	.019	-.043	-.015	-.216	.363	-.162	.077
	X_{14}	-.133	-.017	.101	-.096	.024	-.065	.005	.006	.032	.035	-.100	.018	-.162	.460	-.171
	X_{15}	-.062	.182	-.055	-.124	.062	.080	-.038	-.066	.068	.053	-.035	-.092	.077	-.171	.574
Anti-image Correlation	X_{1}	**.724**[a]	-.210	-.172	.168	-.241	-.007	.201	.037	-.214	-.198	.123	.038	.013	-.255	-.106
	X_{2}	-.210	**.587**[a]	-.138	-.066	.241	-.037	-.188	.059	.085	-.065	-.439	.048	.062	-.034	.318
	X_{3}	-.172	-.138	**.840**[a]	-.093	-.093	.009	.029	-.064	.040	-.384	-.194	-.056	.042	.231	-.113
	X_{4}	.168	-.066	-.093	**.517**[a]	-.119	-.059	.149	.060	-.361	.016	-.157	.147	.021	-.169	-.196
	X_{5}	-.241	.241	-.093	-.119	**.721**[a]	.062	-.648	-.236	.371	-.085	-.313	.128	-.084	.077	.180
	X_{6}	-.007	-.037	.009	-.059	.062	**.791**[a]	-.259	-.493	.040	-.089	.104	-.212	.322	-.175	.194
	X_{7}	.201	-.188	.029	.149	-.648	-.259	**.609**[a]	-.165	-.598	.366	.184	.040	-.058	.016	-.113
	X_{8}	.037	.059	-.064	.060	-.236	-.493	-.165	**.836**[a]	.164	-.356	-.115	-.169	-.104	.020	-.211
	X_{9}	-.214	.085	.040	-.361	.371	.040	-.598	.164	**.316**[a]	-.259	-.060	-.114	.044	.064	.124
	X_{10}	-.198	-.065	-.384	.016	-.085	-.089	.366	-.356	-.259	**.729**[a]	.079	.110	-.119	.087	.117
	X_{11}	.123	-.439	-.194	-.157	-.313	.104	.184	-.115	-.060	.079	**.768**[a]	-.059	-.037	-.223	-.069
	X_{12}	.038	.048	-.056	.147	.128	-.212	.040	-.169	-.114	.110	-.059	**.750**[a]	-.586	.043	-.198
	X_{13}	.013	.062	.042	.021	-.084	.322	-.058	-.104	.044	-.119	-.037	-.586	**.679**[a]	-.395	.169
	X_{14}	-.255	-.034	.231	-.169	.077	-.175	.016	.020	.064	.087	-.223	.043	-.395	**.679**[a]	-.332
	X_{15}	-.106	.318	-.113	-.196	.180	.194	-.113	-.211	.124	.117	-.069	-.198	.169	-.332	**.559**[a]

In Table 4, variables that have an MSA value of less than 0.50 are excluded from selection, i.e. only the X_9 variable will not be further analyzed. Meanwhile, other variables will be repeated for the MSA and Bartlett's Test tests, until all variables get a > value of 0.50.

Table 5. MSA and Bartlett's Test 2

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.751
Bartlett's Test of Sphericity	Approx. Chi-Square	263.474
	Df	91
	Sig.	.000

Table 5 above shows the value of the MSA (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) of 0.751, which means more than the minimum limit of 0.50. So that the data has sufficient sufficiency to be analyzed (valid). For the significance value on Bartlett's Test of Sphericity is 0.00, which is below 0.05, it can be concluded that there is a correlation between the variables. Since both tests have been met, the analysis can proceed to the next stage.

Table 6. Anti Image Matrices Test 2

		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
Anti-image Covariance	X_1	.620	-.118	-.085	.071	-.069	.001	.041	.025	-.130	.059	.007	.011	-.132	-.049
	X_2	-.118	.577	-.069	-.026	.085	-.017	-.073	.015	-.021	-.219	.027	.027	-.020	.181
	X_3	-.085	-.069	.413	-.049	-.037	.003	.024	-.019	-.153	-.082	-.020	.016	.100	-.058
	X_4	.071	-.026	-.049	.807	.008	-.024	-.045	.049	-.048	-.114	.063	.021	-.096	-.112
	X_5	-.069	.085	-.037	.008	.241	.014	-.156	-.067	.004	-.102	.056	-.032	.019	.054
	X_6	.001	-.017	.003	-.024	.014	.297	-.089	-.116	-.027	.038	-.070	.105	-.066	.079
	X_7	.041	-.073	.024	-.045	-.156	-.089	.309	-.020	.094	.068	-.012	-.013	.026	-.021
	X_8	.025	.015	-.019	.049	-.067	-.116	-.020	.176	-.085	-.030	-.040	-.029	.003	-.076
	X_{10}	-.130	-.021	-.153	-.048	.004	-.027	.094	-.085	.380	.027	.032	-.041	.045	.073
	X_{11}	.059	-.219	-.082	-.114	-.102	.038	.068	-.030	.027	.437	-.027	-.014	-.099	-.032
	X_{12}	.007	.027	-.020	.063	.056	-.070	-.012	-.040	.032	-.027	.378	-.217	.021	-.088
	X_{13}	.011	.027	.016	.021	-.032	.105	-.013	-.029	-.041	-.014	-.217	.364	-.164	.076
	X_{14}	-.132	-.020	.100	-.096	.019	-.066	.026	.003	.045	-.099	.021	-.164	.462	-.178
	X_{15}	-.049	.181	-.058	-.112	.054	.079	-.021	-.076	.073	-.032	-.088	.076	-.178	.583
Anti-image Correlation	X1	**.780a**	-.197	-.168	.100	-.178	.002	.093	.075	-.269	.113	.014	.023	-.248	-.082
	X2	-.197	**.601a**	-.142	-.038	.227	-.041	-.172	.046	-.045	-.436	.058	.059	-.039	.311
	X3	-.168	-.142	**.836a**	-.085	-.117	.008	.066	-.072	-.388	-.192	-.052	.040	.229	-.119
	X4	.100	-.038	-.085	**.624a**	.017	-.048	-.090	.130	-.086	-.191	.115	.039	-.157	-.163
	X5	-.178	.227	-.117	.017	**.773a**	.051	-.572	-.324	.012	-.314	.184	-.108	.058	.145
	X6	.002	-.041	.008	-.048	.051	**.780a**	-.294	-.507	-.081	.106	-.209	.320	-.178	.191
	X7	.093	-.172	.066	-.090	-.572	-.294	**.735a**	-.085	.273	.185	-.035	-.040	.068	-.049
	X8	.075	.046	-.072	.130	-.324	-.507	-.085	**.831a**	-.329	-.107	-.153	-.113	.009	-.236
	X10	-.269	-.045	-.388	-.086	.012	-.081	.273	-.329	**.765a**	.066	.083	-.111	.108	.155
	X11	.113	-.436	-.192	-.191	-.314	.106	.185	-.107	.066	**.768a**	-.066	-.034	-.220	-.063
	X12	.014	.058	-.052	.115	.184	-.209	-.035	-.153	.083	-.066	**.757a**	-.586	.050	-.187
	X13	.023	.059	.040	.039	-.108	.320	-.040	-.113	-.111	-.034	-.586	**.678a**	-.399	.165
	X14	-.248	-.039	.229	-.157	.058	-.178	.068	.009	.108	-.220	.050	-.399	**.677a**	-.343
	X15	-.082	.311	-.119	-.163	.145	.191	-.049	-.236	.155	-.063	-.187	.165	-.343	**.575a**

The results of the analysis in Table 6 can be seen that the entire variable gets an Anti-image Correlation value showing a > number of 0.50, so that the analysis can be continued at the next stage. To see a comparison of the MSA values of the first and second stages, see Table 7.

Table 7. Comparison of MSA Values

	Variable	MSA I	MSA II
X_1	Math anxiety (attitude)	.724	.780
X_2	Basic skills when a student	.587	.601
X_3	Lack of hard work/self-motivation	.840	.836

	Variable	MSA I	MSA II
X_4	Student health	.517	.624
X_5	Motivation from lecturers	.721	.773
X_6	Rating system	.791	.780
X_7	Use of learning media	.609	.735
X_8	Teaching methods	.836	.831
X_{10}	Learning according to initial abilities and needs	.729	.765
X_{11}	More time to study at home	.768	.768
X_{12}	Parents' educational background	.750	.757
X_{13}	Parents' understanding of children's interests and abilities	.679	.678
X_{14}	Parental guidance	.679	.677
X_{15}	Family economic status	.559	.575

4.3. Extracting/Factoring Process

Next, it is to determine the method used in factor analysis. This study uses *the Principal Components Analysis* (PCA) method. This analysis aims to reduce the number of highly correlated variables and simplify the data, thereby facilitating interpretation and helping to identify the key information derived from the analysis (Mishra et al., 2017).

Table 8. Communalities

	Variable	Initial	Extraction
X_1	Math anxiety (attitude)	1.000	.569
X_2	Basic skills when a student	1.000	.567
X_3	Lack of hard work/self-motivation	1.000	.698
X_4	Student health	1.000	.705
X_5	Motivation from lecturers	1.000	.790
X_6	Rating system	1.000	.734
X_7	Use of learning media	1.000	.832
X_8	Teaching methods	1.000	.864
X_{10}	Learning according to initial abilities and needs	1.000	.735
X_{11}	More time to study at home	1.000	.661
X_{12}	Parents' educational background	1.000	.724
X_{13}	Parents' understanding of children's interests and abilities	1.000	.698
X_{14}	Parental guidance	1.000	.713
X_{15}	Family economic status	1.000	.533

The *value of Communalities* indicates the value of the variable being researched whether it can explain the factor or not. The variable can explain the factor if *the Extraction* value is more than 0.50. Based on Table 8, it is known that *the Extraction* value for all variables is more than 0.50. Thus, it can be concluded that all variables can be used to explain the factor.

4.4. Determining the Number of Factors with Eigenvalues

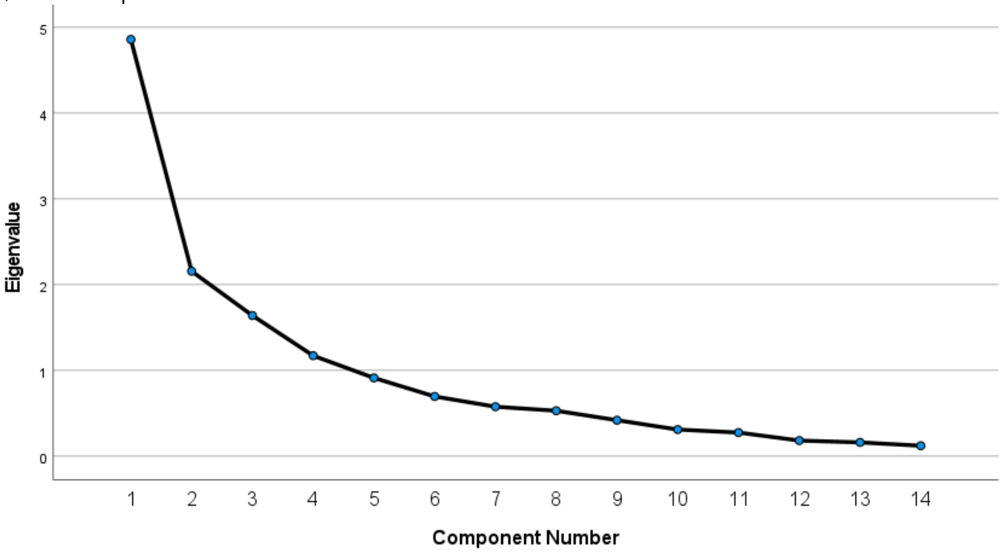
To determine the number of factors formed from the remaining variables, it can be determined by *eigenvalue*. Based on the foundation of *eigenvalue* theory, more than or equal to 1 (one) can be included as a common factor. With the help of SPSS 27 software, the *eigenvalue* can be obtained as shown in Table 9.

Table 9. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.858	34.703	34.703	**4.858**	34.703	34.703
2	2.156	15.396	50.099	**2.156**	15.396	50.099
3	1.639	11.710	61.809	**1.639**	11.710	61.809
4	1.171	8.363	70.172	**1.171**	8.363	70.172
5	.912	6.511	76.684			
6	.695	4.967	81.650			
7	.576	4.114	85.764			

8	.529	3.777	89.541
9	.419	2.990	92.532
10	.309	2.210	94.742
11	.274	1.960	96.702
12	.181	1.294	97.996
13	.160	1.141	99.137
14	.121	.863	100.000

From this, it can be observed that there are 4 components that have *an eigenvalue* of more than 1 (one), with *the eigenvalue* and percentage of each variant obtained, namely: (1) 4,858 with 34,703%; (2) 2,156 with 15,396%; (3) 1,639 with 11,710%; and (4) 1,171 with 8,363%. For more details, see Graph 1.



Graph 1. Scree Plot

In the *Scree Plot Graph*, there are only 4 points whose *eigenvalue* is above line 1. So, the *eigenvalue* for components 5 to 14 is not calculated because it is below line 1. This means that there are only 4 common factors that can be formed from this analysis.

4.5. Rotating the Formed Factors

Before interpreting the results of the factor, the step that must be done is to rotate the factor first, namely, to find out the correlation between the factor and the variable, and only the correlation represented by *the factor loading* (correlated factor) that has a value above 0.30 is strong enough.

Table 10. Component Matrix

Variable		Component			
		1	2	3	4
X_1	Math anxiety (attitude)	**.493**	-.293	**.360**	-.333
X_2	Basic skills when a student	.294	-.569	**.355**	.177
X_3	Lack of hard work/self-motivation	**.639**	-.484	.182	-.148
X_4	Student health	.200	-.027	**.433**	**.690**
X_5	Motivation from lecturers	**.791**	-.085	-.356	.176
X_6	Rating system	**.737**	-.065	-.423	.087
X_7	Use of learning media	**.626**	.072	-.563	**.343**
X_8	Teaching methods	**.889**	.023	-.266	-.045
X_{10}	Learning according to initial abilities and needs	**.602**	-.473	.144	-.358
X_{11}	More time to study at home	**.657**	-.101	**.389**	.262
X_{12}	Parents' educational background	**.602**	**.528**	-.010	-.286
X_{13}	Parents' understanding of children's interests and abilities	**.557**	**.529**	.175	-.279
X_{14}	Parental guidance	**.437**	**.569**	**.438**	.083
X_{15}	Family economic status	.269	**.616**	.271	.092

Table 10 shows the value of the correlation or relationship between each variable and the factors to be formed. For factor 1 it correlates with the variables X_1, X_3, X_5, X_6, X_7, X_8, X_{10}, X_{11}, X_{12}, X_{13}, and X_{14}. Meanwhile, factor 2 correlates with the variables X_{12}, X_{13}, X_{14}, and X_{15}. While factor 3 correlates with variables X_1, X_2, X_4, X_{11}, and X_{14}, and factor 4 only correlates with variables X_4 and X_7. However, there is cross-loading between variables, where some variables correlate on more than one factor (e.g. X_{12}, X_{13}, and X_{14} appear on two factors), making it difficult for researchers to interpret the results clearly and to construct a distinctly separate category of factors. This shows that the structure of the factors formed is not optimal and requires a further analysis process, namely factor rotation so that the results obtained are more valid, *interpretable*, and representative. The results of the factor rotation can be seen in Table 11.

Table 11. Rotated Component Matrix[a]

Variable		Component			
		1	2	3	4
X_1	Math anxiety (attitude)	.022	**.732**	.180	.016
X_2	Basic skills when a student	.024	**.565**	-.228	.442
X_3	Lack of hard work/self-motivation	.294	**.771**	-.007	.128
X_4	Student health	.031	.004	.091	**.834**
X_5	Motivation from lecturers	**.837**	.255	.117	.109
X_6	Rating system	**.820**	.225	.102	-.012
X_7	Use of learning media	**.901**	-.085	.061	.100
X_8	Teaching methods	**.786**	.376	.322	-.028
X_{10}	Learning according to initial abilities and needs	.239	**.820**	.012	-.075
X_{11}	More time to study at home	.269	.461	.300	**.535**
X_{12}	Parents' educational background	.343	.131	**.739**	-.208
X_{13}	Parents' understanding of children's interests and abilities	.190	.180	**.785**	-.117
X_{14}	Parental guidance	.024	.042	**.789**	.296
X_{15}	Family economic status	.020	-.148	**.690**	.186

The results above indicate that several variables show strong cross-loading relationships (X_2, and X_{11}); therefore, these variables were removed from the analysis (Howard, 2016). As a result, Factor 1 is strongly associated with variables X_5, X_6, X_7, and X_8. Factor 2 is strongly related to variables X_1, X_3, and X_{10}. Meanwhile, variables X_{12}, X_{13}, X_{14}, and X_{15} are strongly associated with Factor 3, and Factor 4 is strongly associated only with variable X_4. This decision was also made to ensure that the resulting factors are easier to interpret.

4.6. Determining Joint Factor/Factor Scores

By looking at the previous discussion, the last step in factor analysis is to interpret the variables into the common factors that have been formed. As for the results of the rotation of factors, 4 common factors/main factors are formed which are described in Table 12.

Table 12. Factors Formed

Factor	Eigenvalue	Variable		Name Factor
1	4.858	X_5	Motivation from lecturers	Learning Factors and Academic Support
		X_6	Rating system	
		X_7	Use of learning media	
		X_8	Teaching methods	
2	2.156	X_1	Math anxiety (attitude)	Individual Ability and Attitude Factors
		X_3	Lack of hard work/self-motivation	
		X_{10}	Learning according to initial abilities and needs	
3	1.639	X_{12}	Parents' educational background	Family Environment Factors
		X_{13}	Parents' understanding of children's interests and abilities	
		X_{14}	Parental guidance	
		X_{15}	Family economic status	
4	1.171	X_4	Student health	Health Factors

It can be concluded that from the 15 variables determined at the beginning of the problem, 4 common factors that occur in the difficulties of elementary school teacher education students in learning mathematics, namely the Learning and Academic Support Factor, the Individual Ability and Attitude Factor, the Family Environment Factor, and the Health and Learning Environment Factor.

4.7. Interpretation of the Interview Results

The data processing of the interview results was carried out through several stages. The questions in this activity were taken from the questions in the questionnaire, with the aim of obtaining deeper information that may not have been detected during the questionnaire activity. The interviews were conducted by recording and transcribing each conversation (recording) to ensure that no data was missed. This activity was carried out on April 29, 2025, with six respondents (N_1, N_2, N_3, N_4, N_5 dan N_6) at Universitas Ahmad Dahlan. The following are the key points obtained from the interviews conducted listed in Table 13.

Table 13. Interview Results

Respondent	Factors			
	Personal (X_1, X_2, X_3, X_4)	Teacher (X_5, X_6, X_7, X_8)	Environmental (X_9, X_{10}, X_{11})	Parental (X_{12}, X_{13}, X_{14}, X_{15})
N_1	Not afraid, lost motivation before	Teacher motivates and uses media (Quizizz)	Campus supports, school underutilized	Very supportive, understands learning style, has mentored
N_2	Afraid, anxious, no motivation	Teacher motivates but has no impact	Facilities available but often unused	Supportive, does not provide direct guidance, decent economic status
N_3	Afraid since elementary school, motivation has not paid off	Teacher at school is monotonous, college is better	School and home support, prefers home	Very supportive, attends tutoring, understands difficulties
N_4	Afraid since junior high, motivation remains	Teacher sometimes motivates, methods lack variation	School is suboptimal, prefers studying at home	Supportive but rarely gives direct guidance
N_5	Initially liked, difficulties emerged in junior high	Has been motivated by teacher with media, methods are unappealing	School not optimal, prefers studying at home	Fully supportive, understands difficulties, stable economy
N_6	Initially fine, became difficult since elementary school	Has been motivated, likes visual media	Campus is highly supportive, likes to study outside of home	Very supportive, knows interests, facilitates learning

This table summarizes the interview results conducted with six respondents to provide a deeper understanding of the factors influencing their difficulties in learning mathematics. These results will be used to support the analysis of the questionnaire conducted earlier.

5. Discussion

This study found four main factors influencing the difficulties of PGSD students in learning mathematics. These factors explain 70.172% of the data variation. The most dominant factor is Learning and Academic Support (34.703%), followed by Individual Ability and Attitude

(15.396%), Family Environment (11.710%), and Health (8.363%). These findings not only reinforce that both internal and external factors influence learning difficulties, but they also help explain why certain factors are more dominant, how they interact, and their implications for teacher education.

The component of Learning and Academic Support that most dominated includes motivation from lecturers, the assessment system, use of learning media, and teaching methods. The dominance of this factor suggests that students' difficulties are greatly influenced by the immediate learning conditions (such as teaching methods, pace, examples, feedback, and assessment clarity), not only by the students' "inherent abilities." Unclear assessments and lack of constructive feedback may confuse students about expectations, which in turn affects their perseverance in learning (Arroyo et al., 2025). Additionally, monotonous teaching methods and unclear assessments may make students feel inadequate, thereby lowering their perseverance and motivation to actively engage in learning (Daniel et al., 2024). In teacher education, such learning experiences also shape prospective teachers' beliefs about "how to teach mathematics." If prospective teachers' learning experiences are poor, there is a risk of carrying those patterns into their own teaching. Therefore, improving teaching, communication, and academic support could quickly impact students' understanding (Armellini et al., 2021).

The second dominant factor is Individual Ability, which works alongside the learning demands. This factor includes mathematical anxiety, lack of motivation/effort, and learning according to initial abilities and needs. This means that anxiety and motivation cannot exist in isolation but may be triggered by learning experiences. This aligns with the research by Saha et al. (2024), which indicates that internal factors from students themselves contribute to success and failure in learning mathematics. When the mathematics material does not match students' abilities, they experience repeated failure (negative experiences), increasing anxiety and decreasing motivation, leading to avoidance of practice and less participation during lessons (Ahmmed et al., 2024). This indicates that individual factors are intertwined with academic factors in influencing mathematical anxiety. The solution is not just to tell students to "study harder" but to provide support that reduces threats and enhances self-efficacy, such as guided practice, formative feedback, revision opportunities, and problem-solving strategies.

The next dominant factor is Family Environment. This factor can be seen as both a resource and a barrier for an individual. It includes parental education, understanding, guidance, and family economy. It shows that family context still influences students because families can determine access to learning resources (e.g., tutoring, materials, tools, study time, and space) and emotional support (Roksa & Kinsley, 2018). This factor is also related to the support available at the institution. If the campus provides strong learning support (e.g., learning programs or free tutors), the gap caused by family economic constraints can be reduced (Guryan et al., 2023).

Health is the final factor influencing the difficulties PGSD students face in learning mathematics. Physical health issues such as lack of sleep, poor diet, and insufficient physical activity cause fatigue, lower concentration, and worsen students' academic performance (Rožman & Vreˇ, 2025). Health problems such as chronic illness significantly reduce students' learning performance through absenteeism, cognitive disruption, and psychosocial issues (Lum et al., 2017; Thongseiratch & Chandeying, 2020). Therefore, good health support, from both family and educational institutions, is vital in improving concentration and reducing disruptions caused by health problems.

In conclusion, difficulties in learning mathematics are systemic, influenced by various dominant factors like academic support and learning design, which affect students' learning experiences, motivation, and emotions. Teacher support has been found to be stronger than parental support in improving students' academic performance (Wijaya et al., 2022), although both play a role in reducing stress and enhancing students' emotional well-being. Academic and emotional support from both teachers and parents can help students feel more positive and engaged in mathematics. These factors, along with health, contribute to consistent student engagement, showing that the causes of difficulties in learning mathematics are not singular but the interaction of multiple interconnected factors.

6. Conclusion

Based on the results of the study, there are four main factors that affect the difficulty of PGSD students in learning mathematics: (1) learning and academic support, (2) individual abilities and attitudes, (3) family environment, and (4) health factors. Learning factors and academic support had the largest contribution with a variance of 34.703%. Aspects such as teaching methods, learning media, assessment systems, and motivation from lecturers greatly determine student understanding. The results of the interviews show that monotonous methods reduce interest in learning, so lecturers need to create a more interactive learning atmosphere. The second factor is the individual's ability and attitude, especially anxiety about math and low self-motivation. The family environment also has a significant influence. Emotional, economic, and parental involvement support is very helpful for students in undergoing the learning process. The last factor is health condition and learning environment. Students who are healthy and have a comfortable place to study tend to be more focused and understand the material well. Overall, these findings confirm that learning factors and academic support are the most dominant. Therefore, to improve the understanding of mathematics of PGSD students, it is necessary to improve teaching methods, provide attractive media, a fair assessment system, and a more personalized approach from educators.

Limitation

The limitation of this study is that it was conducted only on students from the Elementary School Teacher Education (PGSD) program at Universitas Ahmad Dahlan, with a sample size that does not meet the minimum requirement of 1:5 participants per question item. However, according to other reliable sources, this does not render the study invalid, as factor analysis can still be accepted even with a sample ratio that does not meet the minimum, provided it meets the following criteria: reliability value >0.5, corrected item-to-total correlation of 0.15, communalities of 0.2, total variance explained of 65.0%, and factor loading of 0.4. Therefore, despite the sample size being smaller than recommended, the results of this study can still be considered a strong factor solution. Nevertheless, this may also be a coincidence factor and could limit the generalizability of the findings to other contexts.

In addition, because the study was conducted in a single institutional context, the findings should be interpreted within the specific characteristics of the PGSD program at Universitas Ahmad Dahlan. Variations in curriculum, mathematics course design, assessment practices, academic support, and socio-cultural factors may shape students' attitudes, anxiety, and learning strategies. Accordingly, transferring these findings to other teacher education contexts should be done with caution, and future multi-institutional studies are recommended to examine the stability and transferability of the results.

Recommendation

For future researchers, it is recommended to explore other variables that may contribute to the mathematics learning difficulties experienced by Elementary School Teacher Education (PGSD) students. Further studies could also investigate the effectiveness of various instructional models, learning media, or teaching strategies in mathematics courses within higher education settings. Such research is expected to provide broader insights and practical solutions to improve mathematical understanding and support the professional preparation of prospective elementary school teachers.

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Conflict of Interest Statement

The authors declares that there is no conflict of interest.

Declaration of Generative AI and AI-assisted Technologies

This manuscript was prepared with the assistance of Generative AI ChatGPT. The AI was used to assist in language refinement (paraphrasing and improving sentence structure), and finding relevant literature sources related to the research. All intellectual contributions, critical analyses, and final revisions were conducted by the authors. The authors take full responsibility for the accuracy, originality, and integrity of the content presented in this work.

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Appendix: Questionnaire Guidelines

Variables	Questions	
	Positive Items	Negative Items
• Mathematics anxiety (attitude) • Basic mathematical ability during schooling • Lack of perseverance and self-motivation • Student health	1. I feel confident when solving mathematics problems. 2. I have had strong basic mathematics skills since school. 3. I have strong curiosity and always try to understand mathematics material. 4. My health condition supports my mathematics learning process.	16. I feel anxious every time I attend mathematics classes. 17. When I was in school, I always had difficulty understanding mathematics lessons. 18. I often feel lazy, give up easily, and lack motivation to learn mathematics. 19. My health often interferes with my concentration when studying mathematics.
• Motivation from the lecturer • Grading system • Use of instructional media • Teaching methods (lecturer guidance)	5. My mathematics lecturer is able to motivate me to study harder. 6. The mathematics grading system is fair and reflects my ability. 7. The lecturer often uses engaging instructional media when teaching mathematics. 8. I find the lecturer's teaching methods helpful and engaging.	20. My lecturer rarely gives encouragement or motivation to learn mathematics. 21. I feel the mathematics grading system is unclear and unfair. 22. The lecturer does not use varied instructional media when teaching. 23. The lecturer's teaching methods are difficult to understand and tend to be monotonous (repetitive).
• Supportive campus learning environment • Instruction aligned with students' prior ability and needs • More study time at home	9. The campus provides a learning environment that supports mathematics learning. 10. Mathematics material is delivered according to students' basic abilities and needs. 11. I have sufficient time to study mathematics at home.	24. Campus facilities do not support me in learning mathematics. 25. I feel the mathematics material is too difficult and does not match my ability. 26. Responsibilities at home prevent me from studying mathematics optimally.
• Parents' educational background • Parents' understanding of the child's interests and abilities • Parental guidance • Family economic status	12. My parents have an educational background that supports my learning of mathematics. 13. My parents understand my abilities and interests in mathematics. 14. My parents actively guided my learning since childhood, including mathematics. 15. My family's economic condition is sufficient to support learning needs, such	27. My parents' education does not help me much in learning mathematics. 28. My parents do not understand my difficulties in learning mathematics. 29. I rarely receive learning guidance from my parents. 30. My family's financial limitations make it difficult for

	as taking tutoring or extra lessons outside school.	me to study, such as joining tutoring outside school.