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Profile of Hard skills and Soft skills of Mathematics Education Students

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abstract

This study analyzes some hard skills (problem-solving abilities, level of logical thinking, and geometric thinking) and soft skills (students' self-concept and mathematical habits of mind) mathematics education students explicitly in the first year. The research method used is descriptive quantitative. From the population of all mathematics education students in the first year, one group of students was selected as a random sample using analysis techniques, data presentation, and conclusion drawing. Based on the research results, mathematics education students' overall ability in the first year is already good. Students were mastering five reasoning on the test of logical thinking (TOLT). It means they have solved problems with reasoning associated with proportional or ratio, control variables, probability, correlation and combinatorics. Most students have reached the level of thinking geometry at the analysis stage; that is, students have already understood the properties of concepts or geometry based on informal analysis of parts and component attributes. However, students do not have good soft skills. Even though they have a strong habit of mind, students' self-concept is quite sufficient.

Keywords:
Problem-solving, Logical Thinking Level, Geometry Thinking Level, Self-Concept, and Mathematical Habits of Mind.

INTRODUCTION

Preparing for challenges in implementing changes in the higher education curriculum and the 4.0 Industrial Revolution, the Mathematics Education Department, as one of the LPTK (Educational Personnel Educational Institution), is obliged to produce quality in-service teachers the digital era demands. One of them is equipping students with developing their hard skills and soft skills in each lecture process. Mathematics education graduates need hard skills and soft skills to enter the world of work, be it a worker or an entrepreneur. 80% of a person's success is determined by emotional intelligence (EI) in the form of soft skills in the form of attitude/character, and 20% is determined by intellectual intelligence (IQ), which is part of Hard skills (Delita, Elfayetti, & Sidauruk, 2016). The need for hard skills and soft skills in the world of work is inversely proportional to soft skills development in tertiary institutions. Which brings and maintains people for success are 80% soft skills and 20% hard skills (Delita, Elfayetti, & Sidauruk, 2016). For that, each learning process must be designed and implemented to balance hard skills and soft skills.

Hard skills include problem-solving ability, logical thinking, and geometric thinking. These three abilities are high-order thinking skills, which is the basis for some distribution of courses in the mathematics education department. Developing hard skills and awareness of mathematics (soft skills) fulfils curriculum objectives and motivates the growth of broader and deeper accompanying effects. Some of the accompanying effects include (1) a deeper understanding of the connection between mathematical concepts and ideas; (2) better able to think logically, critically, systematically, creatively, and innovatively in solving problems; and (3) care for the surrounding environment (Sumarmo, 2013).

Problem-solving is a high-level ability that mathematics education students must possess. Problem-solving is a fundamental skill needed by students today (Rosidi & Hidayati, 2016). Students need opportunities to formulate, grapple with, and solve complex problems that involve a large amount of effort (Samo, 2017). Rosidi and Hidayati stated that problem-solving involves mental complexes, cognitive skills and behaviours (Rosidi & Hidayati, 2016). So that problem solving is one of the hard skills that are important to be developed by students.

Other hard skills are logical thinking; logical thinking in terms of its scope is part of mathematical reasoning abilities. In contrast, mathematical reasoning is part of the mathematical thinking process, including understanding, connecting, communicating, representing, reason, and solving problems (Sumarmo, 2013). Based on that statement, the authors interpret that logical thinking will describe other mathematical skills. When students are trained to do logical thinking skills, the accompanying abilities are also trained. Developing logical thinking skills also means developing other mathematical thinking skills.

Geometry is; (1) a branch of mathematics that studies visual patterns, (2) a branch of mathematics that connects mathematics with the physical or real world, (3) a way of presenting invisible or invisible phenomena, and (4) an example of a mathematical system. (Nopriana, 2014). Geometry is a part of mathematics that has an important role. Not only is geometry able to foster students' thought processes, but it also supports many other mathematics topics. Concerning student learning outcomes, Yazdani stated a strong positive correlation between the level of thinking geometry and learning outcomes of geometry (Nopriana, 2014). The higher the level of geometric thinking of students, the higher the learning outcomes of geometry.

Pierre and Dina van Hiele suggest that a person will go through five hierarchical levels (Nopriana, 2014). The five levels are level 1 (visualization), level 2 (analysis), level 3 (informal deduction), level 4 (deduction), and level 5 (rigor). Each level describes the students' thought processes in the context of geometry. This level represents how students think and what geometric ideas students think, compared to how much knowledge they have. Students who are supported with the right teaching experience will pass the five levels, where students can not reach one level of thinking without passing the previous level. Each level represents the thinking skills one uses in learning geometric concepts.

In the mathematics education department, every course requires students to be proficient in carrying out higher-order thinking processes in solving problems. The ability to solve problems, think logically and think geometry is needed by students in learning and understanding most of the concepts contained in advanced courses such as advanced calculus, algebraic structures, geometry, differential equations, and many more. In obtaining these three abilities, students need to be refracted to have good soft skills, such as self-concept towards learning mathematics.

Self-concept (Self-concept) plays a significant role in developing motivation and academic behavior (Möller, Retelsdorf, Köller, & Marsh, 2011). Improving academic self-concept needs to be a substantial concern in educational settings and the development of an individual. According to Hurlock, Brooks, self-concept is a person's image or perception of himself, which includes physical, psychological, social, emotional, aspirations and achievements that he has achieved and how the comparison between himself and others and how the idealism he has developed (Widodo, 2011; Djaali, 2014). Students who have a low self-concept tend to give up easily and are afraid of making mistakes (Sundawan & Nopriana, 2019). Self-concept is essential, especially when dealing with mathematics (Shapka & Keating, 2005). The study results (Andinny, 2015; Hanifah & Abadi, 2019) show an influence of self-concept on mathematics learning achievement. However, some research results show that students show a tendency to have a low or negative self-concept (Widiarti, 2017; Hidayat, 2017)

Furthermore, soft skills that are no less important for mathematics education students to have are habits of mind. Habits of mind are essential mathematical dispositions that need to be possessed and developed, especially for students studying high-level mathematical abilities (Hendriana, Rohaeti & Sumarmo, 2017). Costa and Kallick (2008) define habits of mind as a tendency to behave intellectually or intelligently when facing problems, especially problems for which the solution is not immediately known. Millman and Costa and Kallick (2008) Jacobs identified several mathematical habits of mind indicators, including identifying problem-solving strategies that can be applied to solve broader mathematical problems (Hendriana, Rohaeti & Sumarmo, 2017).

Based on the background above, the writer considers it necessary to examine more intensely to get a real picture of the problem-solving ability, logical thinking, geometric thinking, self-concept, and mathematical habits of minds of first-year students.

METHODS

The research will be conducted using quantitative descriptive methods. Things that are described are problem-solving skills, logical thinking, and geometric thinking skills. The soft skills include the self-concept and mathematical habits of mind of first-year students at the Mathematics education department. The samples are 30 students with a random sampling technique.

Tobin & Capie has developed a tool to measure logical thinking skills in the form of reasoned multiple-choice, namely the Test of Logical Thinking (TOLT) (Tobin & Capie, 1981). A total score of 0-1 corresponds to the stage of concrete development, 2-3 corresponds to the transitional development stage, and 4-10 corresponds to formal development. Valanides divides the formal development stage into two sub-stages, namely the formal operational stage (score 4-7) and the final formal stage (score 8-10) (Valanides, 1997). The test used to measure geometric thinking skills is the van Hiele Geometry Test (VHGT) developed by The Cognitive Development and Achievement in Secondary School Geometry Project (CDASSG) (Usiskin, 1982). VHGT is a multiple-choice test containing 25 questions arranged into 5 levels of geometric thinking presented by van Hiele. The subtest reliability coefficients presented by Usiskin (Fryhklon, 1994: 9) for levels 1 to 5 are as follows: 0.79; 0.88; 0.88; 0.69; and 0.65.

In the instrument test that measures the Level of Geometric Thinking compiled by Usiskin (1982), each level contained five questions. Based on the correct answer, the following criteria are given (Nopriana, 2014);

a) If students can answer 3-5 questions correctly at level 1, they reach the first level of geometric thinking.
b) If students can answer 3-5 questions correctly at level 2, then the student reaches the second level of geometric thinking, and so on.
c) If the student does not correctly answer 3 or more questions at levels 3,4 and 5, the student reaches the second level of geometric thinking.

RESULT AND DISCUSSION

Students' Problem Solving Ability

Researchers classified the results of the answers from the test using questions based on the problem-solving abilities of all students into three levels of cognitive ability based on statements from Abdul Wahab et al., namely high levels with a score of 70-100, moderate with a score of 50-69, and low with a score 0 - 49 (Abdulwahab, Oyelekan & Olorundare, 2019). The three levels are then classified into Table 1 along with the grouped value data.

Table 1.
Students' Problem Solving Ability Based on Cognitive Level

Interval Score	Cognitive Level	Number of Students	Interval Percentage (%)
70 – 100	High	11	50
50 – 69	Moderate	10	45
0 – 49	Low	1	5
Total		22	100

Based on table 1, it can be concluded that the problem-solving ability for students with high cognitive level abilities reaches 50%, 45% moderate level, and the rest 5% low level. It is shown that problem-solving can be achieved with good scores for the Mathematics Education Students, only reaching 50%. High student cognitive means that students have good problem-solving abilities, and students can achieve higher achievement (Reta, 2012; Ulya, 2015).

Students' Logical Thinking Ability

The overall description of mathematics education students' level of logical thinking will be presented in Table 2.

Table 2
Student Logical Thinking Level
Based on Logical Development Stage

Interval Score	Category Logical Development Stage	Number of Students	Percentage (%)
0-1	Concrete	0	0
2-3	Transitional	5	16,67
4-10	Formal	25	83,33
	Total	30	100

Based on table 2, mathematics education students' logical thinking level has mostly reached the formal thinking stage. 83% of mathematics education students can solve proportional reasoning, variable reasoning, correlational reasoning, and combinatorial reasoning. The formal stage is also related to the student's ability to solve a proof of problem (Syawahid & Nurhardiani, 2018). Meanwhile, 17% of mathematics education students are still at the transitional stage, meaning that students can only solve proportional reasoning problems. Furthermore, to get a more in-depth description of the level of logical thinking, students will be differentiated based on their school origin and gender.

Table 3
Student Logical Thinking Level
Based on Logical Development Stage Based on School Origin

Interval Score	**Category Logical Development Stage**	**Science**		**Social**		**Vocational**		**Total**	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
0-1	Concrete	0	0	0	0	0	0	0	0
2-3	Transitional l	3	10%	0	0	2	7%	5	17%
4-10	Formal	19	63%	2	7%	4	13%	25	83%
Total		22	73%	2	7%	6	20%	30	100%

Base on table 3, 83% of students had solved problems related to proportional, variable, correlational, and combinatorial reasoning. 63% come from the Science major and 7% come from the Social major, and 13% come from the Vocational major. Besides, from 17% of mathematics education students who were only able to solve problems related to proportional reasoning, 10% of them came from Science major, 7% came from the vocational major, and none of the students came from social major reaching the transitional thinking stage. None of the mathematics education students entered the lowest logical thinking stage, namely the concrete thinking stage. Overall, students' logical thinking stage has reached the formal thinking stage, and the students came from the Science major when they were in high school. According to Rizkiyah, high school students are included in the formal operational stage, thinking abstractly using certain symbols or operating inference formal logic rules, etc. (Riskiyah, Jannah, & Aini, 2018).

The student's level of logical thinking based on gender will be described. This is intended to see whether there are differences in the level of logical thinking of male and female students. This will be shown in Table 4.

Table 4
Student Logical Thinking Level
Based on Logical Development Stage Based on Gender

Interval Score	Category Logical Development Stage	Female N	Female %	Male N	Male %	Total N	Total %
0-1	Concrete	0	0	0	0	0	0
2-3	Transitional l	3	10%	2	7%	5	17%
4-10	Formal	18	60%	7	23%	25	83%
Total		21	70%	9	30%	30	100

Based on table 4, it can be seen that as many as 70% of mathematics education students are female students. 83% of mathematics education students have solved proportional reasoning, variable reasoning, correlational reasoning, and combinatorial reasoning. There are 23% male students and 60% female students. Furthermore, from Table 4, it can be seen that 17% of students can only solve problems related to proportional reasoning, only 7% of them are male students, and 10% are female students. Based on the data above, with a ratio of 3: 7 female and male students, it can be concluded that the logical thinking stages of male and female students have the same tendency, namely the formal thinking stage. In line with Aini and Hidayati in their research, it shows that male and female students have reached the formal stage where women are more dominant in reaching the formal stage (Aini & Hidayati, 2017). The formal logical thinking stage is the highest stage of logical thinking. Overall, mathematics education students, both boys and girls, have a good logical thinking level.

Students Level of Geometry Thinking

The description of level of thinking of mathematics education students will be presented in Table 5.

Table 5
Description of Students' Geometry Thinking Level
Based on Level and Overall Score Average

Level	N	Average Score
Pre-1	8	
1	9	
2	11	
3	2	8.77
4	0	
5	0	
Total	30	

N = Number of Students

Based on Table 5, it can be concluded that only two students reach the level of informal deduction thinking, which is the highest geometric thinking stage that students achieve. Students can sequence concepts logically, from abstract definitions, and distinguish a set of properties necessary and sufficient condition in determining a concept. But overall, most of the sampled students still had a geometric thinking stage at the analysis stage. Musa (2016) states that only students with high geometrical abilities reach the informal deduction stage where others only reach the analysis stage (Musa, 2016). Students have understood the properties of geometric concepts or shapes based on an informal analysis of the parts and their component attributes at the analysis stage. According to their figures and properties, students can determine types based on geometric figures (Kurniawati, Junaidi & Mariani, 2015). Based on the study results, it can be concluded that most of the students in the first year have van Hiele's geometry thinking Level at the analysis stage. It is different from the research results conducted by Rafianti (2016), who researched prospective elementary school teachers; the results showed that 50% of students only arrived at the stage of thinking of introduction or visualization (Rafianti, 2016).

Furthermore, to get a deeper description of the level of geometrical thinking, students will be differentiated based on their high school major and gender. There are three groups of students based in high school; Science, Social, and Vocational. The description can be seen in Figure 1.

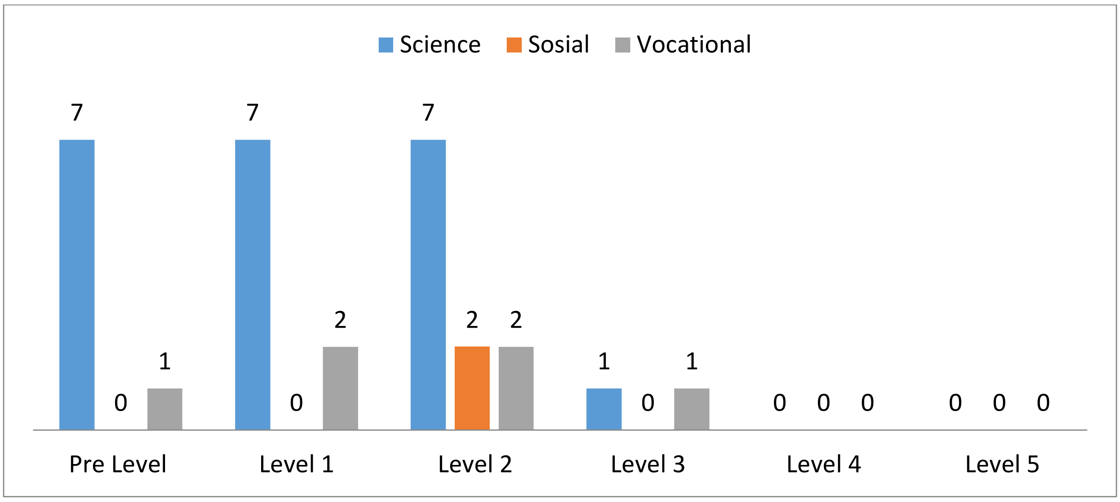

Figure 1
Description of Student's Level of Geometry Thinking Based on Highschool Major

Based on Figur 1, we can see that most first-year students of mathematics education come from the science major. Students from Vocational majors obtain the second highest thinking stage. It showed that even though students' mathematics material in the Sciences major is generally more profound than the mathematics material at the vocational major, it does not rule out the possibility of developing geometric thinking skills in these students. It is because vocational students are also guided to have a resilient character and hard work accustomed to solving problems (Leasa & Batlolona, 2017). Furthermore, the level of geometry thinking of students based on gender will be described in Figure 2.

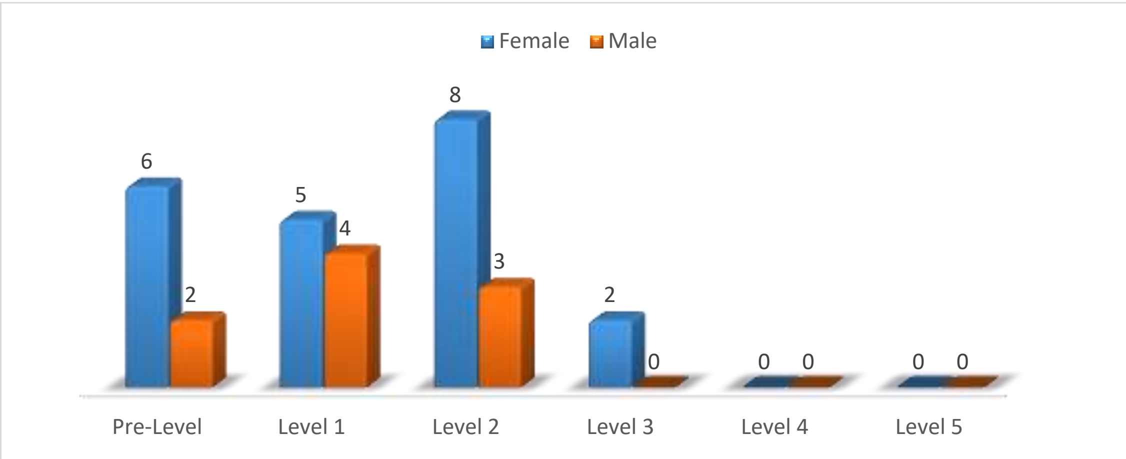

Figure 2
Description of Students' Geometry Thinking Level by Gender

Based on Figure 2, the first-year students in mathematics education are mostly women. The level of geometric thinking in female students who dominates the number of students in mathematics education study program tends to be higher than the level of geometric thinking of male students as a minority. Therefore, the researcher cannot conclude that female students' ability or geometric thinking stages are better than male students. This result is in line with Musa's research which states that male subjects have better visual-spatial tasks than girls. However, in terms of verbal ability, female subjects are better than male subjects (Musa, 2016).

From the research results, it can only be concluded that from the 30 students who were sampled in the study, the two students who had the highest geometric thinking stage came from the female student group. Based on Figure 2, the researchers concluded that overall, the stages of thinking of geometry in first-year students in mathematics education reached informal deduction thinking. Students from science major obtained and vocational major and both were female students. However, most of the students sampled in this study only reached the analysis stage's geometric thinking level. It is in line with Mulyatna & Muhassanah in his research, which resulted in students' geometric thinking levels, according to van Hiele, which turned out to have different levels of thinking. From these results, it can be seen that many students are still at the visualization level and the analysis level (Mulyatna & Muhassanah, 2020). However, it is different from Rafianti's research which states that the geometric thinking stage of prospective teachers in terms of Van Hiele's thinking stage mostly reaches the introduction or visualization stage (Rafianti, 2016). Based on the descriptions, it can be concluded that most of the female mathematics education students who came from science major only reach the geometric thinking informal analysis stage.

Students' Self Concept

Table 6
Recapitulation of Student Self-Concept

Number of Students	Score Min	Score Max	Average	Category
30	58	85	69,37	Better

Table 6 stated that first-year student on mathematics education has a better category. It means that students had a better perception of themself, including physical, psychological, social, emotional, aspirations, and achievements that he has achieved. Classroom instruction and teachers' feedback strategies help to shape students' self-concept (Van der Beek, Van der Ven, Kroesbergen, & Leseman, 2017). Mathematical self-concept was moderately related to mathematics anxiety and was more highly correlated with arithmetic skills, acceptance of erroneous beliefs about mathematics, and mathematics procedural knowledge (Gourgey,1982; Afgani Suryadi, & Dahlan, 2019).

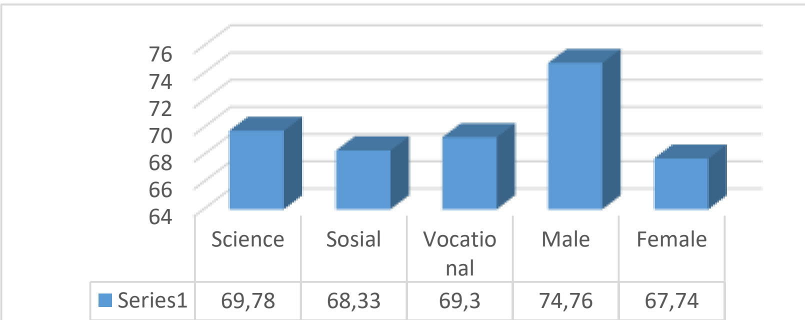

Figure 3.
Description of Student Self Concept Based on Highschool Major and Gender.

Based on Figure 3, it can be seen that male self-concept is higher than female self-concept. Brookover, Thomas and Patterson's research (in Burns, 1993) reported that male students' self-concept was related to achievement in mathematics, social sciences, and science. While, female students' concepts were related to achievement in the social sciences. It also appears from the number of scientists in the field of exact or mathematics, commonly men. There is a significant difference between male and female self-concepts, where male self-concept is higher (Pajares & Miller, 1994; Kim & Sax, 2018)

Students' Mathematics Habits of Mind

Table 7

Recapitulation of Students' Thinking Habits

Number of Students	Score Min	Score Max	Average	Category
30	60	95	74	Strong

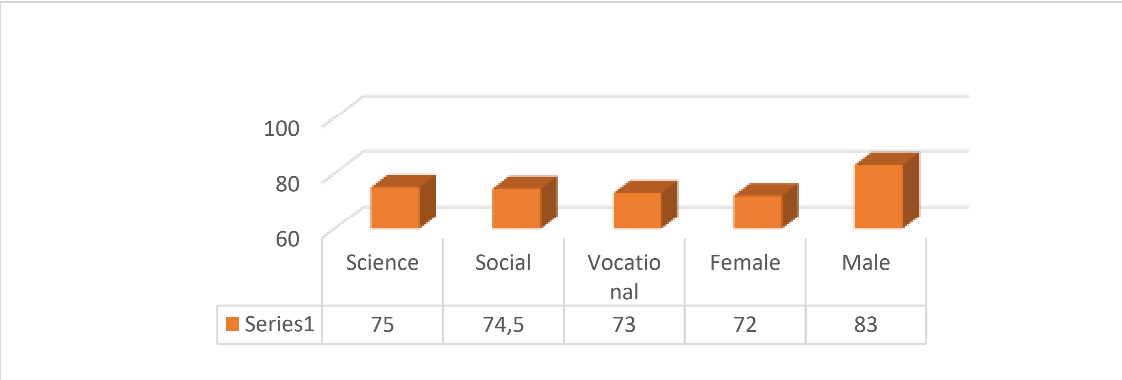

Figure 4

Description of Student Habits of Mind Based on Highschool Major and Gender

Based on Figure 4, the results obtained with 30 mathematics education students all indicators are in a strong category. Overall, mathematics teacher candidate students are in a strong category (Sugandi & Maya, 2019; Masiah & Imran, 2017). Widyastuti, Setiawati, & Triana (2020) have a significant low impact of implementing online learning on students' self-perception mathematical habit of mind.

The highest score of a mathematical habit of mind indicator was "Identifying problem-solving strategies". According to Ali Mahmudi (2009), identifying problem-solving strategies leads to the generalization of mathematical ideas that have been explored and leads to the construction of mathematical concepts. It is because students prefer discoveries and apply them to mathematical concepts. In this case, students are always required to find something new, which causes the students' habits of mind to increase significantly and strong. These habits of mind can improve students' thinking power in solving problems found in lectures and everyday tasks. According to (Foster, 2005), it can be concluded that identifying problem-solving strategies can improve several key points, namely: the ability to formulate problems, seek and collect information, analyze situations, identify problems to produce alternative actions then consider these alternatives about the results. To be achieved, and in the end, carry out the plan by taking appropriate action. A student's ability to solve problems in a study is crucial and can develop thinking power and thinking habits (Habits Of Mind). Based on the above statement that identifying problems is important, students are already accustomed to identifying, which results in the high mathematical habits of mind of grade I mathematics education students.

CONCLUSION AND IMPLICATION

Based on the research results, Overall, first-year students in the mathematics education department were already good. Some students already have good problem-solving skills with high cognitive levels. Most students have formal logical thinking skills. It means students can solve problems using reasoning with proportional or ratio, variable, probability, correlation, and combinatorics. Most students have reached the level of thinking geometry at the analysis stage. It means that students have understood the properties of geometric concepts or shapes based on informal analysis of parts and component attributes. However, students do not yet have good soft skills. Even though they have strong mathematical habits of mind, students' self-concept is still quite sufficient. The results of this study can help lecturers, especially in mathematics education study programs, to find out students' hard and soft skills at the initial level, it is necessary to arrange learning based on the description of students' hard skills and soft skills. Furthermore, the changes in hard skills and soft skills that students have at the final level can be seen.

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