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An Analysis of the Factors that Motivate Albanian Students to Learn Mathematics

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Abstract

We all know the importance of mathematics in life, despite that some students want to learn mathematics while others won't. Some of them seem to have motivation in learning new mathematics knowledge while others don't. So, the questions we raise are: Why some students want to learn mathematics while others won't? Which are the factors that motivate students to learn mathematics? Why they aren't similarly motivated?

The purpose of this study is to explore the key factors influencing student's motivation in learning mathematics. A comparison across study fields is made to identify which factors they have stated as more important, are those factors extrinsic or intrinsic ones. The findings reported that across gender we don't have differences. Data findings confirm that our students are more motivated by extrinsic factors then by intrinsic factors. Further, the measurement of attitudes is done using an adapted short version of the Attitudes Toward Mathematics Inventory (short ATMI). Reporting that exists significant differences across study fields.

Keywords: Motivating factors, ATMI, Mathematics education

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1. Introduction

The low achievement and the persisting trends in mathematics performance have negative implications at various levels on everyday life. Beside this now days we are facing the problem of abandonment of Mathematics in all our universities. Based on the data from the last years (by INSTAT) there is a decrease in the number of the students enrolled in tertiary education, Natural Sciences, Mathematics and Statistics (See the figure 1 below). So, we can say that universities are struggling to attract students in Mathematics programs.

The ministry of Education and Sport in Albania and also the universities related to this situation are concerned about underachievement and abandonment of mathematics and they are searching for solutions encouraging stronger mathematics and science education. These actions, aimed at setting the stage for better performance, have not fully addressed the mathematics underachievement problem in our country. Since underachievement in mathematics can be both long and short term, personal and collective negative implications there is need to expand the effort by studying the problem from other perspectives.

In the context of academic achievement, motivational concerns have been the issue of studies for many years since motivation plays a crucial role in student learning. Many researches recently have been focused in identifying factors that motivate students to learn mathematics, classifying them and developing instruments in order to measure the influence they have on attitudes.

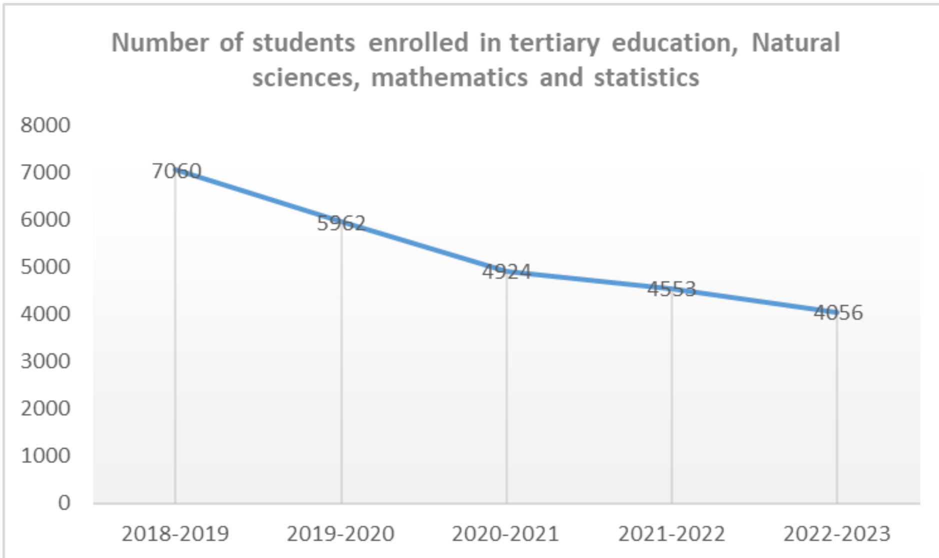


Fig. 1 The number of the students enrolled in tertiary education, Natural sciences, Mathematics and Statistics for the last five years.

Related to this topic we have different findings by an abundant literature on students' attitude toward mathematics in different levels of studies such as middle school, high schools, college and university. After the inventory developed by Tapia 1996 a later study by (Tapia et al., 2002) has confirmed that the four-factor model in the ATMI also holds for college students studying in American universities. At their paper (Klanderman et al., 2019) included students from three different educational levels. Authors revealed that there is a relative paucity of students at all three grade levels who claim to be motivated by intrinsic factors. A study among college students in both Taiwan and the US has suggested that extrinsic motivation has a significant negative impact on intrinsic motivation (Cheng, 2019).

Influence of motivation on the perception of mathematics by secondary school students was studied by H. Hossein-Mohand et al. (2023). In their paper they revealed that student motivation appears to be significantly related to perceptions of teaching practices and the use of resources for study. Results from other studies appear to confirm the role of motivation as a fundamental variable for learning mathematics (Rojo-Robas et al., 2020; Trujillo-Torres et al., 2020). Attitude toward mathematics among the students were investigated by Karjanto, (2017) at Nazarbayev University which confirmed the hypothesis on a positive correlation between previous high achievement in mathematics and favourable attitude toward it. Related to gender reported there is no significant difference between male and female students, but he reported that there is a very significant difference between students who specialize in International Relations Economics and Mathematical Physics in terms of their attitude toward mathematics. Whereas in other studies (Abosalem, 2015) no statistically significant differences across gender were reported in self-confidence, value, motivation and enjoyment among Khalifa university students.

Regarding gender, more positive attitudes toward mathematics in males compared to females was reported by Galende et al. (2020).

Another aspect of attitudes is math anxiety for which Paechter et al. (2017) has reported higher levels of math anxiety in females compared to males. In their paper Kinser-Traut (2019) reported findings for the importance of connecting mathematics to other subjects, to future careers, and to everyday life.

This study aimed to explore which are the factors that influence students' motivation in learning mathematics in Albania. Are our students motivated by intrinsic or extrinsic factors? Do male and female differ between each other in factors that influence their motivation? In this study, a Likert scale survey is used to make an analysis of student's attitudes in order to improve the estimation of attitudes they have toward mathematics.

As soon as the data were collected, we used a variety of descriptive methods to analybze the data. First, the

Likert scale responses were converted to a numerical scale, with 1 denoting "strongly disagree" and 5 denoting "strongly agree". Five items of this instrument were reversed items.

Research questions

The purpose of this study is to obtain an estimation of the factors of attitude toward mathematics for that we designed a research study to address the following questions:

- Question 1: What factors influence university students' attitudes toward mathematics?
- Question 2: What similarities and differences exist among the primary motivation factor to learn mathematics for students at different study fields?
- Question 3: What is the preponderance of intrinsic versus extrinsic motivation factors for students at these study fields?
- Question 4: What similarities and differences exist among the primary motivation factors to learn mathematics between males and females?
- Question 5: Is there any significant difference in the four subscales?
- Question 6: Is there any significant difference across study fields for each subscale of the short ATMI subscale?
- Question 7: Is there any significant difference across gender for each subscale of the short ATMI subscale?

What do these results tell us about how these students approach mathematics?

Research design

To answer the above questions, we choose to use the adapted version made by (Klanderman et al., 2019) to a survey originally developed by Tapia (1996) and later shortened by Lim and Chapman (2013), focusing on four subscales the enjoyment of mathematics, motivation to do mathematics, self-confidence in mathematics and perceived value of mathematics.

There were 21 questions on the questionnaire 20 of them are coded with a five-point Likert scale and for question 21 (free response) we used more qualitative analysis.

As the responses for the question 21 were quite abroad, different categories were constructed and eventually grouped as follows (like Klanderman et al., 2019):

- Teacher/Professor – includes general term and specific names of teachers
- Family and friends - includes "my mum", "my dad", or other family members (siblings, grandparents etc.) and friends
- Future/Job/Application – includes references to a career goal, future financial and related activities and other applications in the surrounding world or other related factors
- Grades – includes good grades on tests or assessments or the course
- Intrinsic – includes personal challenge and satisfaction of solving difficult problems and exercises, features of the mathematical concepts or other related factors
- Other – includes responses which were essentially unique (e.g. Pythagoras, Albert Einstein, etc.)

2. Methodology

2.1 *Participants in this study*

The participants in this study were the students of the two faculties in an Albanian university from the fields of study: Mathematics (16.5 %), Economics (25.1%), Information Technology (19.3%), Nurse (27 %) and Social Sciences (12.1%). They were contacted purposely and were given the questionnaire. There are 363 respondents in total, 33.6 % males and 66.4 % females.

2.1 Procedure

This survey was conducted during the academic year 2022-2023 with the approval from the University were the questionnaire was administered. Before submitting the questionnaire, the respondents were informed by researchers for the purpose of this study and all the necessary explanations regarding the study. The questionnaire was handed by researches and a sufficient time was given to the respondents. Then the questionnaires were collected and submitted for further analysis.

2.3 Instruments for the data collection

The main instrument was a 21 questions questionnaire (20 of the questions coded with Likert scale the question 21 includes free response) developed version by (Klanderman et al., 2019) and adapted in which the students were asked about their opinions, how they think, like, feel and their evaluation regarding mathematics.

The measurement of attitudes is done based on non-overlapping 95% confidence intervals like Klanderman et al., 2019 and by adapting a shortened version of the Attitudes Toward Mathematics Inventory (short ATMI) which measures four subscales—enjoyment of mathematics, motivation to do mathematics, self-confidence in mathematics, and perceived value of mathematics. For each question there was a five-point scale, namely: 1-Stongly Disagree, 2-Disagree, 3-Neutral, 4- Agree and 5-Strongly agree. This choice enabled the researchers to adequately measure the student's responses regarding the study objectives.

2.4 Data analysis

Both the IBM SPSS Statistics (Version 20) and Excel 2016 were used to perform the statistical analysis of the data. Descriptive analysis as well as advanced statistical analysis was performed in function to the study questions.

3. Results

In this section, we provide an overview of the findings from these survey and try to answer the questions we raised in section 1. Table 1 provides a summary of the mean scores for the entire sample and for each of the five different study program. Overall, 363 students completed the survey (122 males and 241 females), which we grouped by creating the subsamples by study fields: Economics (N=91), Information Technology (IT) (N=70), Math Education (Math. Edu.) (N=60), Nurse (N=98) and Social science (Soc. Sci.) (N=44).

As seen in table 1, the combined sample showed mean responses in the "neutral" range (between 2.5 and 3.5) with some exclusions. Items 5, 11,12,14,15 were in "agree" range, meaning that our students appeared to admit that mathematics is a very interesting subject, is worthwhile, important in everyday life, helpful to what they decide to study in the future and in life. Item 16 is also in "agree" range meaning that getting good grades motivate them do better in mathematics.

The values on Table 1 which are printed in boldface indicates cases where the mean of the subsample and the mean of the combined sample for that item were determined to be different based on non-overlapping 95% confidence intervals (CIs). For example, for item number 1, the 95% CI for the combined sample would be [3.42, 3.63].

The 95% CI for the Economics subsample would be [3.40, 3.79] which overlaps with the combined sample CI. Whereas, the 95% CI for the Mathematics education subsample would be [4.14, 4.46] which does not overlap with the combined sample CI and hence is statistically different.

By applying this analysis we see that the subsample of Economics and Information Technology do not differ by the combined sample. A great similarity is seen also between subsample of Nurse and combined sample, it has only two items 4 and 14 with a statistical difference indicating that, on average, Nurse subsample students feels less happier in mathematics class than in any other class and they have a "neutral" range opinion about the fact that mathematics lessons will help them in the future. The items showing a difference between Social science subsample and combined sample are items 3, 4, 6, 7, 8, 9.

Table 1 Item Mean Score

Item Number	Combined Sample N=363 MoE=0.08*	Economics N=91 MoE=0.16	IT N=70 MoE=0.14	Math. Edu. N=60 MoE=0.09	Nurse N=98 MoE=0.14	Soc. Sci. N=44 MoE=0.21
1	3.5	3.6	3.3	**4.3**	3.3	3.1
2	3.5	3.5	3.2	**4.5**	3.2	3.0
3	3.3	3.2	3.0	**4.7**	3.0	**2.6**
4	2.7	2.7	2.4	**4.6**	**2.3**	**2.0**
5	3.7	3.5	3.5	**4.6**	3.5	3.2
6	3.0	2.8	3.0	**4.2**	2.9	**2.4**
7	3.2	3.1	3.3	**4.1**	3.1	**2.6**
8	3.2	3.0	3.3	**4.2**	3.0	**2.6**
9	3.2	3.0	3.1	**4.0**	3.1	**2.7**
10	2.8	2.6	2.8	**3.6**	2.7	2.4
11	4.0	3.8	4.0	**4.6**	3.8	3.7
12	3.8	3.8	3.8	**4.3**	3.7	3.7
13	3.5	3.3	3.4	**4.4**	3.3	3.2
14	3.6	3.8	3.7	**4.6**	**3.0**	3.3
15	3.7	3.8	3.7	**4.5**	3.3	3.4
16	3.9	4.0	3.9	**4.4**	3.8	3.4
17	2.8	2.7	2.8	**3.5**	2.7	2.7
18	3.2	3.1	3.1	**3.7**	3.1	2.9
19	3.3	3.2	3.5	**4.1**	3.0	3.1
20	2.8	2.6	2.7	**3.8**	2.6	2.4

*Constructing 95% confidence intervals (CIs) for the mean produces the stated margin of error (MoE) in each case.

The mean score of item 4 was significantly lower than the combined sample and also the lower mean related to other study fields.

Mean score for item 4 (2.0) and 6 (2.4) are in the "disagree" range (less than 2.5 but above 1.5). This means that Social science subsample students don't really like mathematics, they feel nervous when studying mathematics and experiencing terrible strain and confusion in math classes. They "disagree" the fact that they are happier in math class.

Unsurprising were the results of Math education subsample which were very different to the combined sample. As it seen in table 1 all means for this subsample were significantly higher than the combined sample. Items 3, 4, 5, 11 and 14 are in "strong agree" range while the other items in "agree" range.

Using the same analysis we proceeded with analysis of the subsamples related to gender, results of which are presented in Table 2. As seen by the comparison of mean we don't have differences between male subsample and female subsample to the combined sample.

Table 2 Item Mean Score (gender)

Item Number	Combined Sample N=363 MoE=0.08*	Male N=121 MoE=0.12	Female N=242 MoE=0.11
1	3.5	3.5	3.5
2	3.5	3.4	3.5
3	3.3	3.3	3.3
4	2.7	2.8	2.7
5	3.7	3.7	3.6
6	3.0	3.1	3.0
7	3.2	3.5	3.2
8	3.2	3.4	3.1
9	3.2	3.3	3.1
10	2.8	2.9	2.8
11	4.0	4.1	3.9
12	3.8	3.9	3.8
13	3.5	3.7	3.4
14	3.6	3.8	3.6
15	3.7	3.8	3.7
16	3.9	3.9	4.0
17	2.8	2.8	2.9
18	3.2	3.3	3.2
19	3.3	3.6	3.3
20	2.8	3.0	2.7

*Constructing 95% confidence intervals (CIs) for the mean produces the stated margin of error (MoE) in each case.

Let now analyze the qualitative data provided in item 21. We compared responses from the five different fields of study between each other and with the combined sample and produced bar graphs to summarize the findings in each case. Comparing this bar charts we see that the first five categories differ from one study field to another.

The five most commonly cited motivation factors in combined sample are the categories of teacher/professor, my family, future/job, school/university and good grades.

By contrast, categories as exercises/problems, passion/curiosity, my friends or life/real world occur less frequently and categories as America, myself, or competitions occur a few times.

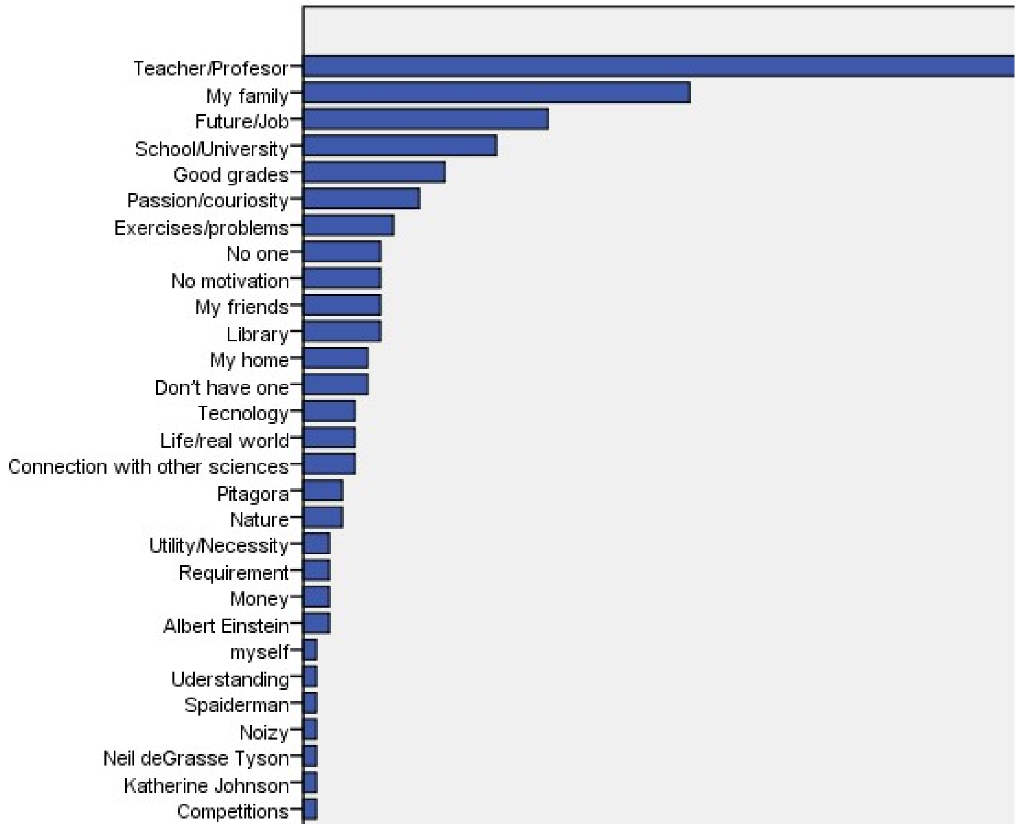


Fig.2 Summary of responses for item 21 (combined sample)

In general the sample of students whom quote teacher/professor as motivating person consist of 28.9% of the total, the sample of students whom quote family and friends 18.2% of the total, 10.2% is the sample quoting future/job/applications as motivation, 5.8 % of total stated good grades as motivational factor and intrinsic motivational factor (8%) occurred somewhat less frequently.

As seen in the Fig. 2 the respondents have classified in first place of motivation the teachers or professors as the one person whom motivate them to learn mathematics, in the second place they have classified the family (my mum, my dad, my sister, etc.) and in the third place future/job. In the first place category of teacher/professor is also in results (Fig. 3) of students in Economics, Nurse and Social sciences on the other side students of Information Technology has stated future/job in the first place and students of Mathematics Education has stated their family in the first place and the teachers in the second place.

Summarizing this results is notable that most of the students are motivated by extrinsic factors and a smallness of them are motivated by intrinsic factor. By this results we understand the important role of teachers and professors motivating their students to learn mathematics.

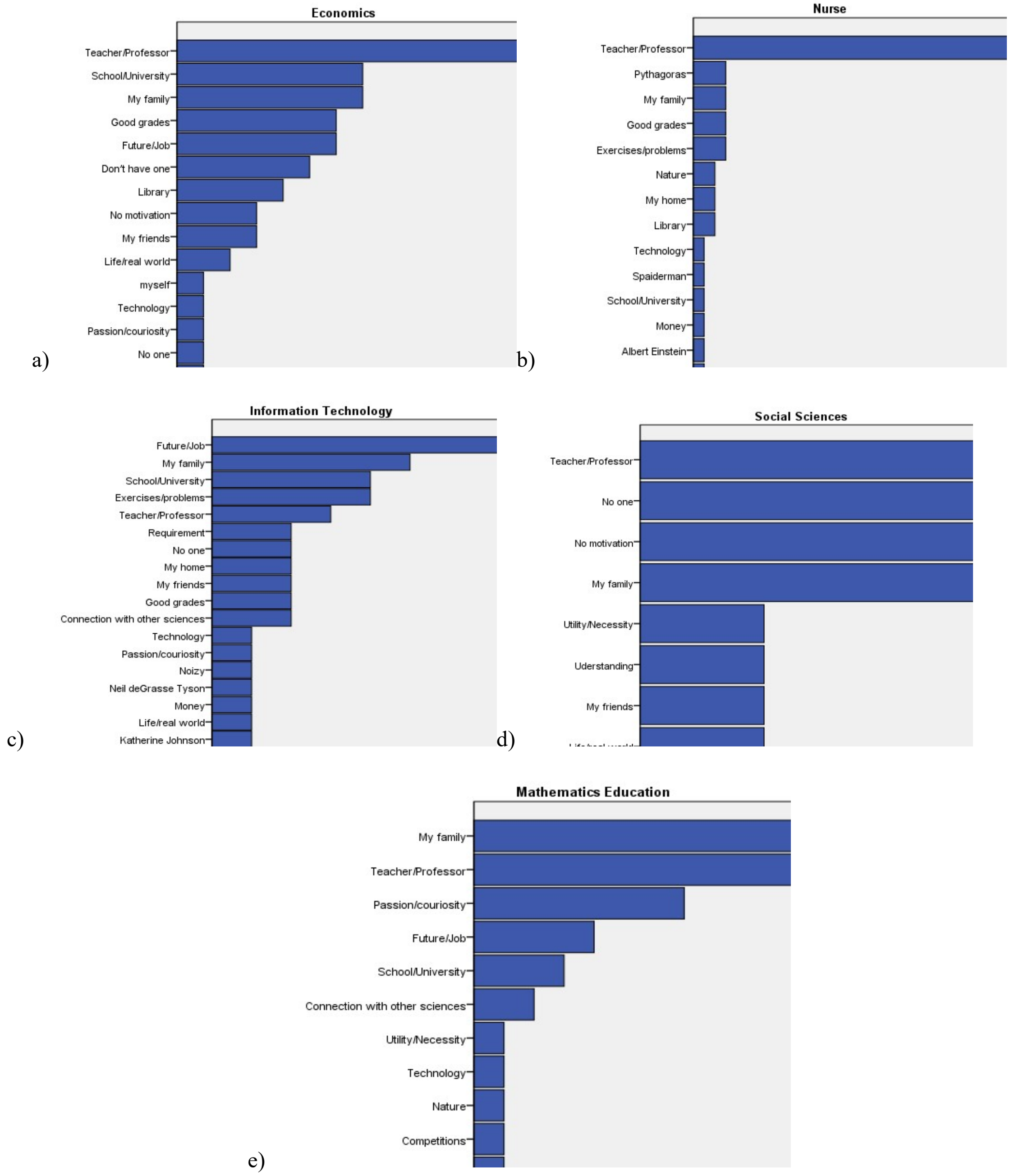
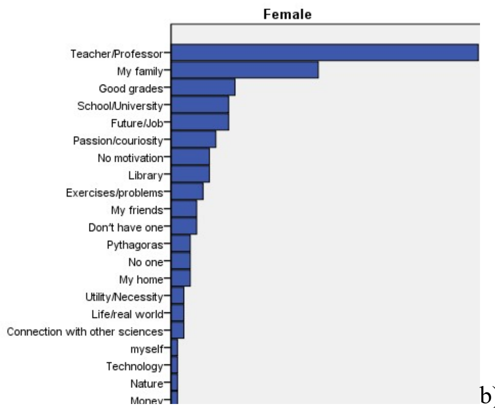


Fig.3 Summary of responses for item 21 for each study field

We were interested to see also whether there was a difference between male and female subsamples in primary motivational factors. Regarding males in top five positions have stated categories teacher/professor, future/job, my family, school/university and technology as factors that mostly motivate them to learn mathematics.

Meanwhile the females have the same categories in the top five positions same as combined sample. If we see the bar graphs results for males and females (Fig.4) we can notice that both of them have stated teachers or professors in the first place as the person who motivate them to learn mathematics and in the second place males have stated future/job and females their family. In the third place females have stated good grades whereas males have stated their family as a motivation factor. So both of them have identified extrinsic factors as the most important motivation factors related to intrinsic factors. With their response they have expressed that the primary motivation factor for them are teachers and professors.

a) 

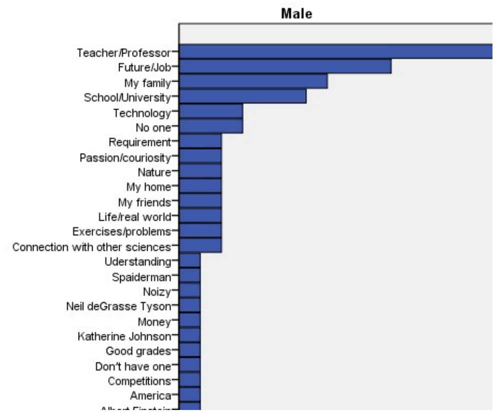
b) 

Fig.4 Summary of responses for item 21 (gender)

Results for significant differences in subscales

We combined the items in each of the four subscales creating the variables VA, SC, MO and EN for further analysis. High Cronbach's alpha values were obtained for the overall scale (0.94) and all the subscales: Self-confidence (SC) (0.910), Value (VA) (0.875), Enjoyment (EN) (0.833) and Motivation (MO) (0.793) (Table 3). Results in Table 3 indicates that subscale reliability estimations at the acceptable levels with the subscale of self-confidence with the highest reliability estimate. All scale reliability estimates fell within acceptable to good ranges demonstrating strong internal consistency. This indicates the survey is a reliable instrument and more than adequate for research purposes. Descriptive statistics were also computed to analyze the mean and standard deviation for each of the factors of scale.

Out of the four subscales of short ATMI, Value (VA) has the highest mean (3.7) (Table 3) interpreted as positive while the other three subscales (SC (3.1), MO (3.3), EN (3.2)) have mean scores all interpreted as neutral.

Table 3 Descriptive statistics and Reliabilities for short ATMI Subscale

Subscale	k*	Mean	SD	α
SC	5	3.1	1.021	.910
VA	5	3.7	.829	.875
MO	5	3.3	.836	.793
EN	5	3.2	.836	.833
All 20 items				**0.940**

*k indicates number of items that make up each subscale

The Friedman test is used for identifying the differences between the four subscales. There was a statistically significant difference in these four subscales ($\chi 2$ (3) =210.089, p=0). To examine where the differences actually occur, we run post hoc analysis with separate Wilcoxon signed-rank tests on the different combinations. So, there was a statistically significant difference between VA and SC (Z=-11.298, p=0), MO and SC (Z=-5.039, p=0), EN and SC (Z=-3.861, p=0), MO and VA (Z=-10.845, p=0) and EN and VA (-11.024, p=0). But there is not a significant difference between EN and MO (Z=-1.646, p=0.1).

Results for significant differences related to study fields

Descriptive statistics and Reliabilities for short ATMI Subscale are presented in Table 4 related to each study field in each subscale. Math. Edu. has the highest mean in the subscales (SC(4.0), VA(4.7), MO(4.1), EN(4.3)) and Social science has lowest mean for SC (2.6), MO (2.9) and EN (2.8) and Nurse has the lowest mean for VA (3.4).

In order to answer the question if there is any significant difference across study fields for the short ATMI subscales we performed Kruskal Wallis H test for each subscale across study fields separately. The test showed that there was a statistically significant difference in SC subscale regarding the study fields ($\chi 2$ (4) =73.510, p<.001), in the VA subscale regarding the study fields ($\chi 2$ (4) =70.706, p<.001), in the MO regarding the study fields ($\chi2$ (4) =92.186, p<.001) and in the EN regarding the study fields ($\chi2$ (4) =112.453, p<.001) with a mean rank higher for the Mathematics study field in each case.

Table 4 Descriptive statistics and Reliabilities for short ATMI Subscale (for each study field)

		Economics			Nurse			IT			Math. Edu.			Soc. Sci.		
Subscale	k	Mean	SD	α	Mean	SD	α	Mean	SD	α	Mean	SD	α	Mean	SD	α
SC	5	2.9	1.003	.893	2.9	1.028	.911	3.1	.794	.862	4.0	.624	.818	2.6	1.035	.905
VA	5	3.7	.823	.877	3.4	.800	.845	3.7	.697	.832	4.7	.461	.815	3.5	.891	.877
MO	5	3.2	.889	.834	3.1	.823	.770	3.2	.613	.587	4.1	.405	.556	2.9	.779	.705
EN	5	3.2	.881	.855	3.0	.783	.781	3.1	.680	.744	4.3	.421	.602	2.8	.783	.712

The post hoc test was performed to determine where the differences lie between groups of the study fields in each subscale. Post hoc test in the case of SC subscale showed a statistically significant difference between the Mathematic Education and other study fields and also between Social sciences and Information Technology where the Social Sciences has the lowest mean rank in all study fields. Post hoc test in the case of VA subscale showed a statistically significant difference only between the mathematics and other study fields. Post hoc test in the case of MO subscale also showed a statistically significant difference only between the mathematics and other study fields. And finally, the Post hoc test in the case of EN subscale also showed a statistically significant difference only between the mathematics and other study fields. The significance level is .05.

Results for significant differences related to gender

Descriptive statistics were also computed to analyze the mean and standard deviation for each of the factors of scale related to gender.

In order to answer the question about the statistical significant differences between males and females in each of the subscales, we performed Man Whitney U-test.

Table 5 Descriptive statistics and Reliabilities for short ATMI gender

		Male			Female		
Subscale	k	Mean	SD	α	Mean	SD	α
SC	5	3.2	.857	.877	3.0	1.090	.920
VA	5	3.8	.776	.861	3.7	.855	.881
MO	5	3.3	.775	.773	3.3	.866	.803
EN	5	3.2	.827	.818	3.3	.910	.840

In each case the test showed that there was not a statistically significant difference in the subscales regarding gender. For SC: Z= -1.545, p=0.122, for VA: Z=-0.687, p=0.492, for MO: Z=-0.627, p=0.531 and for EN: Z=-0.088 and p=0.930. So, regarding the gender there is no significant difference between male and female students regarding the short ATMI subscales, which is similar result as at Karjanto (2017) and Abosalem (2015).

4. **Discussion and Conclusions**

This research study was conducted to investigate the factors influencing attitudes toward math between students in different study programs and also related to gender. Based on the findings in the previous sections, we bring out several important conclusions.

Related to first research question (What factors influence university students' attitudes toward mathematics?) findings reveal that most commonly cited motivation factors are the categories of teacher/professor, my family, future/job, school/university and good grades. By contrast, categories as exercises/problems, passion/curiosity, my friends or life/real world occur less frequently and categories as America, myself, or competitions occur a few times. Showing that extrinsic factor are those who mostly influence in the learning of mathematics.

Related to Question 2 (What similarities and differences exist among the primary motivation factor to learn mathematics for students at different study fields?) in overall we have as top three factors which mostly influence students to learn mathematics, teacher/professor in first position, as second family and third future/job. These factors are the primary sources of motivation for our students and serve to remind us the important role of a teacher or professor in classroom. In comparison to other studies (Klanderman, et.al., 2019) in overall we have the same results related to motivational factors.

Findings related to Question 3 (What is the preponderance of intrinsic versus extrinsic motivation factors for students at these study fields?) reveal a paucity number of students motivated by intrinsic factors (8%) related to extrinsic ones.

Findings about Question 4 (What similarities and differences exist among the primary motivation factors to learn mathematics between males and females?) reveal that the primary motivation factor for both of them are teachers and professors. Meanwhile we have a difference in the second factor as males have stated to be more motivated by future/job and females by their family. In an overall both of them have seems to be more motivated by extrinsic factors than by intrinsic ones.

The findings revealed that Math students at our university show a positive attitude toward math in the four factors short ATMI, which suggests that students have moderate to high preference and acceptance of learning math.

Running a Friedman test for differences between four variables of short ATMI to answer Question 5 (Is there any significant difference between four variables of short ATMI?) findings confirmed that exist a significant difference which consisted by the findings of post hoc analysis with separate Wilcoxon signed-rank tests on a statistically significant difference between VA and SC, MO and SC, EN and SC, MO and VA and EN and VA. But there were not a significant difference between EN and MO ($Z=-1.646$, $p=0.1$).

Applying Kruskal Wallis H test for each subscale of the short ATMI to answer the Question 6 (Is there any significant difference across study fields for the short ATMI subscale?) in our research revealed that exist a significant difference across study fields. And by running a post hoc test in each case findings revealed for SC subscale that exists statistically significant difference between Mathematic Education and other study fields, math students appear to be more confident when working with mathematics than other study fields and also a difference exists between Social sciences and Information Technology students. Post hoc test in the case of VA, MO, EN subscales showed a statistically significant difference only between the mathematic education and other study fields.

In case of gender we performed Man Whitney U-test to answer Question 7 (Is there any significant difference across gender for the short ATMI subscale?) for each subscale. Results showed that there was not a statistically significant difference between males and females who participated in the study.

Beside gender difference and study field, an interesting future direction of this research is to conduct a similar test to the same group of students and investigate whether there exist a significant difference in the attitude towards mathematics among students who have taken advanced mathematics during high school or other backgrounds too, such as academic achievement, or the place of the origin (urban or rural) and socioeconomic status of the students.

As last conclusion, the findings in this study will be beneficial to teachers and professors in our country which give math lessons in study programs like ours, as this study provides an understanding to the underlying factors that influence student's motivation in learning Mathematics. Thus, by monitoring these factors, the student's motivation in learning mathematics can be increased and their achieves in mathematics will be improved in the near future.

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