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A RESEARCH OF MIDDLE SCHOOL STUDENTS' ATTITUDES TOWARDS STEM EDUCATION IN TERMS OF SOME VARIABLES: WHICH VARIABLES HAD THE GREATEST IMPACT ON ATTITUDES?

Research article

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Abstract

The aim of this paper is to examine the attitudes of upper grades of middle school towards the STEM field depending on several variables. An empirical-non-experimental research was conducted without any treatment on participants. The research included 246 students of seventh, eighth and ninth grade students (ages between 12 and 15) from one public middle school. The obtained results indicate that the students' attitudes with advancing to upper grades are becoming more negative. The results also show the existence of a statistically significant difference in the attitudes between boys and girls, and that the grade/mathematics achievements and grade point average have a significant effect on students' attitudes towards the STEM field.

Keywords: attitudes towards STEM; middle school students; gender, grade, mathematics grade, grade point average

1. Introduction

STEM (science, technology, engineering and mathematics) education can be defined as integrated teaching of four disciplines: science, technology, engineering and mathematics and establishing links between them (Sanders, 2009). It also aims to make students to have interdisciplinary cooperation, systematical thinking, being open to communication, having ethic values, searching, producing, creativity and abilities of solving problems appropriately. (Bybee, 2010b; Dugger, 2010; Rogers & Porstmore, 2004). The STEM approach enables students to improve their achievements in mathematics and science, increase their motivation to learning, and improve their problem-solving ability (Furner & Kum, 2007; Stinson et al., 2009).

The STEM field and the STEM approach in education and research are of public interest of societies around the planet. The priority task of education becomes enabling students to cope with the changes that lie ahead during their lives as successfully as possible because we live in a time when new occupations replace existing ones, and within surviving occupations the requirements are changing and becoming more complex (Avdispahić, 2018). STEM education enables countries to develop technologically, economically and increase their competitive power (Bybee, 2010b; Fan & Ritz, 2014). In addition, we live in a world of continuous innovation that requires the use of 21st century skills such as critical thinking, problem solving, collaboration, leadership skills, adaptability, communication skills (oral and written), access to information and its use, development of curiosity and imagination (Wagner, 2008).

From year to year, the number of students who want to continue their education in the STEM field has declined, and the world's leading economy of the USA has also faced this problem (Stohlmann et al., 2012). With the aim to arouse interest in these areas, which are needed for the training of qualified labor force needed for the development of a country, it is necessary to constantly change and upgrade curricula. With that aim, some countries have integrated the STEM approach into all levels of education (Bybee, 2010a; Çorlu, 2014). It is

important that STEM is integrated in the mathematics curriculum at the earliest level of education.

Due to the significance of the STEM approach for students, but also for the development of society, numerous research has been conducted to examine the attitudes of students and teachers towards the STEM fields, but also to examine the motivation of students to choose a career in the STEM field, and factors such as environment, and that other people may exert influence on the choice of career within the STEM field. Namely, a larger number of studies showcases that younger children have a high level of interest in science and mathematics, but as they go through the education system this interest has declined, especially among girls (Mitchell & Hoff, 2006; Riegle-Crumb et al., 2011). The period of adolescence, especially the ages from 13 to 14, is a critical period when interests are formed. (Super, 1953; Gottfredson, 1996). By growing up and by advancing to upper grades of middle school, a decline occurs in the general interest of students, but also more and more differences start to appear between girls and boys. Research by Burušić et al. (2018), as well as research by Lindahl (2007) showcased that upper grades of middle school (period around the age of 13) represent a critical period for the formation and structuring of interest in the STEM field and in particular, interest in STEM careers.

Numerous earlier studies were focused on researching of the impact of various variables, such as gender, grade, school achievements, and mathematics achievement on attitudes toward the STEM field. It is known that gender differences exist in attitudes towards the STEM field and career choices in the STEM fields. Today, more girls attend school than it was the case before, but they do not have always the same opportunities as boys to graduate. This difference is particularly present in the STEM field. According to the UNESCO report *Cracking the code: Girls' and women's education in STEM***,** only 35% of STEM students are females, and only 3% of female students have chosen to study information and communication technologies (ICT). The reason for gender differences in STEM fields is explained by social, cultural and gender norms that shape identities, beliefs, behaviors and choices of women and men. Research by Dönmez İ. (2019), where students of grades 6-8 took part and in which was used the same scale for examining attitudes as in this paper, showed that the difference in attitudes towards gender is statistically significant only for the subscale of engineering and technology, in favor of boys. This research also points out the existence of positive correlation, which is statistically significant ($p<.001$), between attitudes towards the STEM field and the student's grade point average. Research by Demir C. G. et al. (2021) where students of grades 6-8 took part demonstrated the existence of a statistically significant difference between boys and girls for the subscale of technology and engineering, and for general attitudes, both in favor of boys. The results of research revealed that by advancing to upper grades, attitudes become more negative for all subscales and for general attitudes. The results show the existence of a statistically significant difference between 6^{th} and 8^{th} grade students for the subscales of mathematics, engineering and technology and 21^{st} century skills and general attitudes in favor of students of 6^{th} grade ($p<.05$). Regarding mathematics achievements, the results demonstrated that for all subscales, except engineering and technology, and for general attitudes students with higher achievements have significantly more positive attitudes than those with medium and low achievements ($p<.05$). Only for the mathematics subscale, a significant difference was determined between students with medium and low achievements ($p<.05$). The research results also demonstrated that achievements in science, then being a 6^{th} grade student and female gender are the three most important predictors of attitudes towards the STEM field. Research by Aydın et al. (2017), where students of grades 4-8 participated, showed that there is no statistically significant difference between boys and girls in general

STEM attitudes. Unfried et al. (2014) found that as the grade level advances, students' attitudes towards the STEM field become more and more negative.

In Bosnia and Herzegovina (B&H), the introduction of STEM education is at its beginning. In 2012, the Agency for Preschool, Primary and Secondary Education (APOSO) in B&H started working on common cores of curricula defined on learning outcomes. In this process, APOSO has defined eight education-upbringing areas, one of them being mathematics area. However, the integration of the STEM approach into curricula takes place at a very slow pace. Very often, curricula are not harmonized at the level of the entire country, so that students are being taught STEM subjects (science, mathematics, informatics, technical education) separately. The PISA research in B&H was conducted for the first time in 2018. The results showed that 58 percent of students in mathematics failed to reach the minimum level of functional literacy and 57 in sciences. B&H occupies a low 64th place. In the TIMSS study from 2007 and 2019, students from B&H accomplished results that are below average of the TIMSS scale. In the TIMSS 2019 study for the fourth grade, the difference in achievements by gender among students in B&H in mathematics is 9 points in favor of boys and it is statistically significant. The difference in achievements in science is 7 points in favor of girls, which is statistically significant. In the OECD countries in PISA surveys in 2018, the results of boys in mathematics were on average five points higher than the results of girls. The difference also exists in B&H, but not statistically significant since it is somewhat over two points in favor of boys. PISA results demonstrate that girls and boys have different attitudes towards school and importance of effort in school. In B&H, girls generally have more positive opinion about school.

Since variables such as gender, grade, mathematics achievements and grade point average may have a significant effect on attitudes towards the STEM field, and positive attitudes exert a positive impact on achievements, through this research the aim was to examine students' attitudes in B&H depending on the mentioned variables. Poor results that the B&H students achieved in international tests in the STEM field, increased motivation and interest in the STEM field, which is generated by the STEM approach in teaching, were also the reason to conduct the research described in this paper. The goal is that the results obtained serve the holders of education policy in B&H use to finally undertake significant steps in integration of the STEM approach into the educational process.

1.1. Purpose of Research

The aim of the research was to examine the attitudes of upper middle school students depending on several variables. Accordingly, the following research questions were asked:

1. Do students' attitudes towards the STEM field differ according to gender?
2. Do students' attitudes towards the STEM field differ according to grade?
3. Do students' attitudes towards the STEM field differ according to mathematics grade?
4. Do students' attitudes towards the STEM field differ according to grade point average?
5. Which variable has the greatest impact on attitudes?

2. Method

2.1. Research Model

An empirical-non-experimental study (Survey research method) was conducted with the aim of determining the relationship between two or more variables without any

treatment of participants and without taking the variables under control. Variables used in this research included gender, grade, final grade in mathematics in the previous grade, and grade point average in the previous grade.

2.2. Research Group

A total of 246 upper grade students (7th, 8th and 9th grade) from a state school in B&H took part in the research. The research was conducted at the beginning of 2020/21 school year. Prior to this research, students were taught in the traditional way and through this research they were introduced to STEM for the first time. Only students for whom prior written consent from their parents/guardians had been obtained participated in the research. The research was also approved by the relevant ministry. Demographic data about participants are shown in the Table 1.

Table 1. *Demographic information about the participants*

Variables	Groups	Frequency	%
Gender	Male	121	49.2
	Female	125	50.8
Grade level	7th grade	81	32.9
	8th grade	85	34.6
	9th grade	80	32.5
Math achievement	Low	79	32.1
	Medium	70	28.5
	High	97	39.4
Grade point average	Low	81	32.9
	Medium	85	34.6
	High	80	32.5

Considering that a scale of five grades is used in B&H: excellent (5), very good (4), good (3), satisfactory (2) and poor (1), grades in mathematics and grade point average are divided into three groups: poor, satisfactory = *low*, good = *medium*, very good, excellent = *high* (Demir, C. G. et al., 2021).

2.3. Data Collection Tool

For the needs of conducting research, a questionnaire was created, which in the first part consisted of questions about gender, grade and group, then final grade in mathematics in the previous grade and grade point average in the previous grade. The second part of the questionnaire consisted of a STEM attitude scale (Unfried et al., 2014) translated into Bosnian language, which consists of four subscales (the first subscale refers to attitudes towards mathematics, the second refers to science, the third refers to engineering and technology, and the fourth one refers to 21st century skills) and 37 claims. Each claim is rated on a Likert scale from 1 to 5, given that 1 indicates “strongly disagree” and 5 “completely agree”. One of the claims that appears in this questionnaire reads "Mathematics is my most difficult subject". It was determined that the coefficient of reliability of Cronbach's alpha for the original scale was 0.83 and higher. In this research, the values of coefficient of reliability of Cronbach’s alpha for the whole scale totaled 0.88. For subscales, it has been determined that the reliability coefficients range from 0.76 to 0.88. These values indicate that the reliability of the measurement is at acceptable level.

2.4. Data Analysis

IBM SPSS Statistic 20 software was used for data analysis. The significance level was determined as .05. Before data analysis, it was examined whether the data were normally

distributed. One criterion for the fulfillment of normality assumption is that the skewness and kurtosis coefficients are between -1 and +1 (Morgan et al., 2004). The results are provided in the Table 2.

Table 2. *Mean scores and standard deviations for the whole scale and its subscales*

	N	Mean	SD	Skewness	Kurtosis
Mathematics	246	3.32	.70	-.08	-.37
Science	246	3.47	.56	-.71	.94
Engineering and Technology	246	3.53	.65	-.34	.51
21st century skills	246	3.85	.54	-1.07	4.03
General attitude	246	3.57	.42	-.58	1.44

Considering that data are not normally distributed for the subscale of 21st century skills and for general attitudes, Mann Whitney-U and Kruskal Wallis tests were applied.

3. Results

The first research question was to examine whether students' attitudes towards the STEM field differ with regard to gender. The Mann-Whitney U test was applied. The test results are provided in Table 3.

Table 3. *The results of Mann-Whitney U test for gender variable*

	Gender	N	Mean Rank	Sum of Ranks	U	Z	p
Mathematics	F	125	126.16	15770.50	7229.50	-.598	.550
	M	121	120.75	14610.50			
Science	F	125	134.63	16828.50	6171.50	-2.500	.012*
	M	121	112.00	13552.50			
Engineering and Technology	F	125	108.85	13606.50	5731.50	-3.287	.001*
	M	121	138.63	16774.50			
21st century skills	F	125	128.39	16049.00	6951.00	-1.098	.272
	M	121	118.45	14332.00			
General attitude	F	125	122.98	15372.50	7497.50	-.117	.907
	M	121	124.04	15008.50			

*p<.05

From Table 3 it is evident that the students' attitudes regarding gender statistically significantly differ for the subscale of science, and the subscale of engineering and technology.

The second research question was to examine whether the students' attitudes toward the STEM field differ with respect to grade. The Kruskal Wallis test was applied. The test results are provided in Table 5. Table 4 demonstrates the mean value and standard deviations for the scale of attitudes towards the STEM field for each grade.

Table 4. *Frequency, mean score and standard deviation for grade level*

		Mathematics		Science		Engineering and Technology		21st century skills		General attitude	
Grade level	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
7th grade	81	3,40	0,60	3,59	0,52	3,70	0,52	3,94	0,46	3,68	0,34
8th grade	85	3,30	0,80	3,45	0,54	3,54	0,63	3,91	0,52	3,58	0,40
9th grade	80	3,25	0,68	3,36	0,61	3,35	0,75	3,71	0,62	3,44	0,48

The results show that the mean value of results, for each subscale and for general attitudes, declines by advancing to upper grades.

Table 5. *The results of Kruskal Wallis test for grade variable*

	Grade level	n	Mean Rank	df	Chi-Square	p	Significant Difference
Mathematics	7	81	132.02	2	2.608	.271	
	8	85	124.32				
	9	80	114.00				
Science	7	81	140.15	2	8.428	.015*	7-9
	8	85	122.47				
	9	80	107.73				
Engineering and Technology	7	81	142.99	2	11.566	.003*	7-9
	8	85	122.36				
	9	80	104.97				
21st century skills	7	81	133.21	2	7.480	.024*	7-9
	8	85	130.99				
	9	80	105.71				
General attitude	7	81	144.15	2	14,584	.001*	7-9
	8	85	124.64				
	9	80	101.38				

*p<.05

As seen in Table 5, the difference in attitudes regarding grade is not statically significant only for the subscale of mathematics. For all other subscales and general attitudes, the difference is statistically significant between the students of 7th and 9th grade.

The third research question was to examine whether students' attitudes towards the STEM field differ regarding the final grade in mathematics. The Kruskal Wallis test was applied. The test results are given in Table 6.

Table 6. *The results of Kruskal Wallis test for math achievement variable*

	Math achievement	N	Mean Rank	df	Chi-Square	P	Significant Difference
Mathematics	Low	79	66.30	2	110.444	.000*	Low-Medium, Low-High, Medium-High
	Medium	70	112.27				
	High	97	178.19				
Science	Low	79	119.24	2	1.087	.581	
	Medium	70	130.80				
	High	97	121.70				
Engineering and Technology	Low	79	126.87	2	.513	.774	
	Medium	70	118.66				
	High	97	124.25				
21st century skills	Low	79	100.18	2	13.768	.001*	Low-High
	Medium	70	127.39				
	High	97	139.69				
General attitude	Low	79	92.94	2	26.119	.000*	Low-Medium, Low-High
	Medium	70	123.99				
	High	97	148.04				

*p<.05

As seen from Table 6, the difference in attitudes considering achievements in mathematics is statistically significant for the subscales of mathematics and 21st century skills, and for general attitudes.

The fourth research question was to examine whether students' attitudes toward the STEM field differ concerning grade point average. The Kruskal Wallis test was applied. The test results are provided in the Table 7.

Table 7. *The results of Kruskal Wallis test for grade point average variable*

	Grade point average	N	Mean Rank	df	Chi-Square	P	Significant Difference
Mathematics	Low	13	84.42	2	38.479	.000*	Low-High, Medium-High
	Medium	80	87.97				
	High	153	145.40				
Science	Low	13	113.23	2	.401	.818	
	Medium	80	121.91				
	High	153	125.21				
Engineering and Technology	Low	13	108.19	2	1.726	.422	
	Medium	80	131.07				
	High	153	120.84				
21st century skills	Low	13	59.31	2	25.848	.000*	Low-High, Medium-High
	Medium	80	102.48				
	High	153	139.95				
General attitude	Low	13	76.23	2	16.721	.000*	Low-High, Medium-High
	Medium	80	105.09				
	High	153	137.14				

*p<.05

As seen from Table 7, the difference in attitudes regarding grade point average is statistically significant for subscales of mathematics and 21st century skills, and for general attitudes.

The fifth research question was to examine which variable had the greatest impact on students' attitudes towards the STEM field. An appropriate statistical analysis was conducted, multiple regression (Leeper, 2000; according to Michelli, M. P., 2013) and presented in Table 8.

Table 8. *Results of the multiple regression analysis concerning the variables predicting the attitudes towards STEM*

Dependent Variable	Predictors	B	Std. Error	Beta	t	Sig.	R	R^2	F	p
Mathematics	(Constant)	3.264	.407		8.027	.000	.671	.450	49.245	.000*
	Grade	-.129	.042	-.150	-3.063	.002				
	Gender	.092	.068	.066	1.347	.179				
	Math achievement	.605	.052	.730	11.642	.000				
	Grade point average	-.119	.075	-.101	-1.575	.117				
Science	(Constant)	4.616	.429		10.759	.000	.236	.056	3.561	.008*
	Grade	-.111	.044	-.159	-2.486	.014				
	Gender	-.184	.072	-.163	-2.543	.012				
	Math achievement	-.015	.055	-.022	-.265	.791				
	Grade point average	.015	.080	.016	.194	.846				
Engineering and Technology	(Constant)	4.640	.490		9.478	.000	.294	.086	5.704	.000*
	Grade	-.188	.051	-.233	-3.702	.000				
	Gender	.254	.082	.194	3.082	.002				
	Math achievement	.034	.063	.044	.548	.584				
	Grade point average	-.022	.091	-.020	-.243	.808				
21st century skills	(Constant)	3.889	.398		9.762	.000	.352	.124	8.518	.000*
	Grade	-.093	.041	-.138	-2.246	.026				
	Gender	-.007	.067	-.007	-.107	.914				
	Math achievement	.023	.051	.036	.450	.653				
	Grade point average	.261	.074	.285	3.532	.000				
General attitude	(Constant)	4.113	.301		13.663	.000	.407	.165	11.935	.000*
	Grade	-.128	.031	-.247	-4.104	.000				
	Gender	.035	.051	.042	.689	.492				
	Math achievement	.142	.038	.286	3.702	.000				
	Grade point average	.050	.056	.071	.900	.369				

*p<.05

From Table 8 it is evident that the variable grade has a statistically significant effect (Sig. <.05) on all subscales, as well as on general attitudes, while the variable gender significantly influences on attitudes towards science and technology and engineering. Mathematics grade has a statistically significant effect on attitudes towards mathematics and general attitudes, and grade point average has a statistically significant effect on the 21st century skills subscale.

4. Discussion

Positive attitudes of students towards science, technology and engineering, and mathematics are critical for the success of students in subjects belonging to the STEM field. Therefore, it is of great importance to develop positive attitudes of students towards the STEM field, primarily in the first levels of education. Moreover, increasing interest in the STEM field is an important factor for the development of students' careers towards the STEM field. Introducing STEM activities in the teaching process has a positive effect on students' attitudes and achievements (Çaycı & Tabaru-Örnek, 2019; Gülhan & Şahin, 2016; Han et al. 2016; Judson, 2014; Rehmat, 2015; Sari et al. 2018; Ugras, 2018; Yamak et al, 2014).

One of the aims of this research was to examine differences in attitudes towards the STEM field between boys and girls. Based on the results provided in Table 3, it is seen that the difference in attitudes regarding gender is statistically significant for the subscales of science in favor of girls, and the subscale of engineering and technology in favor of boys. Females have more positive attitudes for the other two subscales (mathematics and 21st century skills), while regarding general attitudes, males have more positive attitudes (Mean Rank), but this difference is not statistically significant. The PISA 2019 report for B&H suggests that 62% of females in B&H want to graduate from faculties, while less than half of males, 44% want that. The high expectations of females regarding their future education are reflected in the high rates of enrollment of females in universities. However, even though women are more represented among university students, still an insufficient number of females exists in certain fields of study, such as science and engineering. On average, in OECD countries, three times more males graduate in engineering than females (OECD, 2016). The results of research conducted by Đapo N. et al. (2020), where students of 8th and 9th grade in B&H participated, demonstrate that females express higher interest than males in STEM subjects (Chemistry, Biology, Mathematics) except for the subject Informatics, for which males show higher interest. The research has also shown that females express more positive attitudes towards mathematics and science subjects compared to males. Statistically significant differences in attitudes towards informatics were not found. The results of research obtained for the needs of this paper to a large extent match the mentioned results for B&H, as well as with data published in the publication "Women and Men in Bosnia and Herzegovina" of the B&H Statistics Agency for 2022. According to this publication, in the 2020/2021 school year, more than half of high school students attended technical schools, while every fifth high school student attended a gymnasium. Differences in gender representation are the highest in vocational schools, where the number of males is about 75%. In other types of high schools (gymnasiums, technical schools, high school of applied arts), females are more represented. Regarding enrolled students at all levels of higher education from 2016/17 to 2019/20 school year, the number of females was constantly higher than the number of males. In addition, looking at the number of graduate students from the 2016/17 until 2020/21 school year, the number of females has been constantly higher than the number of males. Out of those who graduated in 2020, 60% are females and 40% are males. Thus, in the field of *Science, Mathematics and Statistics* there are more females (76%), while in the field of *Information and Communication Technology* there are more males (66%), as well as in the field of *Engineering, Production and Construction* where 58% are males. However, concerning employment, males have an advantage over women. This is a consequence of the extremely traditional society in B&H.

The results of this research are partly contrary to the results of previous research according to which mostly males had more positive attitudes. According to the results of Unfried et al. (2014), females have more negative attitudes toward sciences than males in elementary school, but they have more positive attitudes than males in high school. Major differences were not found in the comparison of boys' and girls' attitudes towards mathematics. Attitudes toward

mathematics are somewhat less positive than attitudes toward the science. Their results also show that males and females have explicitly different attitudes toward engineering and technology, whereby girls' attitudes are consistently less positive than boys' attitudes. Research by Babarović et al. (2018) in which 7th grade students (13 year-olds) participated showed that males have more interest in STEM careers and STEM activities than females. Regarding individual STEM areas, Babarović et al. (2018) found the largest difference in interests for the subscale of technology and engineering in favor of boys. The difference in favor of boys was also found in mathematics, while in the field of science was not found gender difference in interests.

The research also aimed to examine attitudes towards the STEM field with students of upper grades of middle school. Based on results presented in Table 5, it can be concluded that only for the subscale of mathematics no statistically significant difference exists in attitudes between grades. For all other subscales as well as for general attitudes, the difference in attitudes is statistically significant between the students of 7th and 9th grade. In addition, based on results in Tables 4 and 5, it is seen that students' attitudes become more negative as they advance to upper grades, which is in accordance with the results of earlier research (Unfried et al., 2014; Demir C. G. et al., 2021). Just as results of Unfried et al. (2014), the results of this research show that attitudes towards mathematics are less positive than attitudes towards science, moreover they are less positive compared to other subscales.

This paper aimed to examine whether students' attitudes towards STEM field differ regarding the final grade in mathematics in the previous grade and with regard to the grade point average at the end of the previous grade. Based on the results shown in Tables 6 and 7, the difference found in attitudes with regard to mathematics achievement and grade point average is statistically significant for the subscales of mathematics and 21st century skills, and for general attitudes, whereby students' attitudes with higher achievements are more positive. Demir C. G. et al. (2021) reached the same result. The results of Timss survey 2019 for B&H, in which younger students (4th grade) participated, also showed that a positive attitude towards mathematics affects positively the student achievements, and it is similar with science. Namely, 49% of students declare that they love mathematics very much and these students have the highest average result, which is above average for B&H, while 20% of students declare they do not like this subject and their achievements are 29 points lower than with students in the first category. Developing positive attitudes towards mathematics *courses* increases students′ achievement. (Yaratan & Kaspoğlu, 2012). Likewise, negative attitudes of students and poor motivation reduce academic achievements. How much and why students will engage themselves in mathematical activities is influenced by their attitudes toward mathematics. Aiken (1970) states that there is a consequential connection between attitudes toward mathematics and achievements. He argues that attitudes affect achievements, and then the degree of achievements affects attitudes and thus concludes that there is a mutual connection.

One of the aims of this paper was to examine which variable has the greatest impact on attitudes. Based on the results shown in Table 8, it is seen that the variable grade has a statistically significant effect on all subscales, as well as on general attitudes, and that this influence is negative (coefficient of correlation is less than 0). These results are in compliance with the results shown in Table 4 which shows how attitudes become more negative with advancing to upper grades. The largest positive effect (correlation coefficient is 0.73) has the achievement in mathematics on attitudes towards mathematics, which is expected. Mathematics achievements also have the greatest effect on general attitudes towards the STEM field (correlation coefficient 0.286).

5. Conclusion

The results of this research show that the attitudes of students of upper grades of middle school with the transition to upper grades are becoming more negative for all subscales and for general attitudes towards the STEM field. Therefore, it is important to research which factors affect it and how to act preventively. One of the preventive measures is certainly the introduction of STEM in the earliest levels of education, because the results of previous research have shown that the STEM approach in teaching exerts a positive effect on students' attitudes towards the STEM field. The results of the research indicate that there is a gender difference in attitudes towards the STEM field. This difference is statistically significant in favor of girls for attitudes toward science, and in favor of boys for attitudes toward engineering and technology. Students' mathematics achievements are often associated with the future economic power and competitiveness of a country. (Kupari & Nissinen, 2013). The results obtained in this research show that excellent students have more positive attitudes than others. Out of all the observed variables, mathematics achievement has the greatest positive effect on attitudes towards mathematics, but also on general attitudes towards the STEM field, which indicates the importance of achievement in mathematics.

This research was conducted with 246 students of one school, so the results cannot be generalized to all students of upper grades of middle school. However, the obtained statistically significant differences between the examined students indicate the need for further research of students' attitudes towards the STEM field. New research can be conducted with a larger sample, and in different schools, and it may include some other variables that may affect attitudes. I hope that the results of this research will serve all holders of education policy in B&H to take steps to include the STEM approach in regular education, from the earliest levels of education.

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