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Students' interests and attitudes toward science, technology, engineering, and mathematics careers

Arifin Septiyanto[1], Dwi Oetomo[2], Nurma Yunita Indriyanti[2]
[1]Postgraduate Program of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Pendidikan Indonesia, Bandung, Indonesia
[2]Department of Science Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Indonesia

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ABSTRACT

Science, technology, engineering, and mathematics (STEM) education teaches students critical thinking skills that they can use to solve problems even after they enter the workforce. This study aimed to i) determine student attitudes toward the STEM field in each school area; ii) determine student interest in the STEM field in each school area; and iii) determine the correlation between student attitudes toward the STEM field and school area and student interest in STEM. This was a quantitative study with a cross-sectional survey design. The sample for this study came from Boyolali Regency in Central Java, Indonesia, and was divided into three groups: rural schools (24%), suburban schools (36.2%), and urban schools (39%). The proportional stratified random sampling technique was used to select the research sample of students in grades 7–9. The Spearman Rank technique was used for data analysis. The results showed that there is a strong relationship between students' attitudes toward STEM, school area, and interest in STEM careers. On the other hand, there is a weak correlation between students' attitudes toward STEM, the school environment, and their interest in STEM careers.

Corresponding Author:

Nurma Yunita Indriyanti
Department of Science Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret
Ir. Sutami street No.36, Jebres, Surakarta, Central Java 57126, Indonesia
Email: nurma.indriyanti@staff.uns.ac.id

1. INTRODUCTION

Science, technology, engineering, and mathematics (STEM) education, which was pioneered by the National Science Foundation (NSF), is a synthesis of four distinct disciplines: science, technology, engineering, and mathematics [1]. STEM-based education is designed to provide students with critical thinking skills that will enable them to solve problems even after they enter the workforce [2]. According to Muzana *et al.* [3], the utilization of the STEM learning in science has a significant impact on technological literacy and can improve students' problem solving skills. By applying the STEM model from an early age, students are technologically literate and ready to face STEM competencies in the future. However, based on Organization for Economic Co-operation and Development (OECD) research in the Program for International Student Assessment (PISA), it was explained that the achievement of 15-year-old students in mathematics and science in Indonesia scored lower than the OECD average in terms of reading, mathematics, and science. Furthermore, only 40% of Indonesian students reach level 2 in science (the OECD average is 78% [4]. Meanwhile, according to the NSF, for the next ten years, approximately 80% of jobs will require competence in science, technology, engineering, and mathematics [5]. As a result, for many years, scientists, particularly scientific researchers, have been attempting to discover ways to persuade adolescents to pursue

STEM fields [6], [7]. As a beginning point for this effort to act on them, a comprehensive analysis of the factors influencing this choice is required. Given these situations, the Government of Indonesia should attempt on integration of STEM-based learning into the current education system.

Students must have attitudes toward STEM for the education system to be successful in Indonesia. Students' attitudes toward STEM fields arise to be largely positive [8], [9]— with several resulting from interactions on ethnicity, gender, and particular subject [7], [10]— but their interest in becoming researchers is low. Meanwhile, as the educational system progresses, students' attitudes to science tend to deteriorate. Therefore, it is very important to develop students' positive attitudes toward science from an early age [11]. Based on a study Toma and Greca [12], students' attitudes towards STEM, for example, in terms of STEM learning and career interests in the STEM field, are directly influenced by grade level. This result is reinforced by research Zhou *et al.* [13] that students' attitudes toward STEM in elementary schools show better performance than students above elementary school. This means that the higher the grade level, the student's attitudes toward STEM tend to decrease.

On the other hand, DeWitt *et al.* [14] found that interest in science careers tends to decrease with age. Students do not consider a career in science when they are 14 or 15 years old. Several countries, including the United States, Australia, and Malaysia, have also seen a decrease in student interest in the STEM field. According to Ministry of Education (MOE) data from 2017, STEM-related majors are less appealing to students than non-STEM majors. In 2017, only 45.74% of students majored in STEM, while the remaining 54.26% majored in non-STEM Fields [15].

Student readiness for STEM careers is a driving force in school systems across the country, as reform efforts are designed to meet the needs of children in the 21st and 22nd centuries [16]. It is known that the relationship between student attitudes and career interests in STEM fields shows a positive relationship for middle-class students in Turkey. Thus, it can be said that students who have a positive attitude toward STEM tend to be interested in careers in physics, engineering, and mathematics [17]. This is reinforced by research Wiebe *et al.* [18] shows there is a strong correlation between students' attitudes toward career interests in the STEM field. The United States Department of Economic Administration and Commerce Statistics, the government agency that tracks job growth figures, noted that STEM-related jobs grew more rapidly from 2019 to 2009 than non-STEM jobs. According to the US Bureau of Labor Statistics (BLS) employment projections for 2019, employment in STEM fields is expected to grow 8% by 2029, compared to 3.7% for all occupations [19]. As a result, STEM education is critical to the future economy.

Unfortunately, in terms of curriculum content as well as infrastructure, access to education in science and technology is less evenly distributed in rural areas [20]. According to a Google and Gallup [21], rural students have the same interest in STEM-related subjects as urban students, but their access is much more limited. When asked if they are interested in studying the field of computer science at the university level, they are enthusiastic about the field regardless of where they live. Rural areas with lower economic capabilities are more interested in STEM fields because future STEM wages will be significantly higher than in non-STEM fields [17]. Meanwhile, students in urban areas have more positive attitudes toward ICT than students in rural areas, according to the study findings [22]. This is because urban areas in developing nations have greater access to technological resources like the internet, communication devices, and electricity than rural ones do. So, a person's interest in something (technology) increases as more people interact with it. Furthermore, rural schools typically have fewer students than urban and suburban schools. As a result, rural teachers earn less than their urban and suburban counterparts on average, which makes it challenging to preserve and hiring elevated teachers in rural schools [23].

The exploration of the progression of STEM Career interest in Indonesia is uncommon. Researchers report their findings. Meanwhile, the advancement of STEM career interest while increasing interest in STEM careers in Indonesia must be studied. The urgency is related geographically the area in Indonesia is divided into three areas, namely rural, suburban, and urban areas. More journal analyses can help other researchers expand their understanding of STEM education in Indonesia. As a result, the values for increasing STEM career interest in school areas have been investigated.

Based on preliminary studies, about 48% of students at schools in rural areas at the junior high school level are more interested in continuing their education at the senior/vocational high school level with STEM majors, 34.4% choose non-STEM majors, and 16.8% are still confused in choosing majors. When asked about wanting to continue to college, students in schools in rural areas have a desired percentage of 63.4%, those who do not want to have a desire are 14.5%, and the rest are still confused. Meanwhile, for students at schools in suburban areas, 54.2% are more interested in continuing their education at the senior/vocational high school level in STEM majors, 18.3% choose non-STEM majors, and 27.5% are unsure of choosing majors. Around 77.1% of students in schools in suburban areas want to continue their education to college, 6.1% do not want to continue their education to college. While 62.4% of students at schools in urban areas at the junior high school level are more interested in continuing their education at the senior/vocational high school level in STEM majors, 10.6% choose non-STEM majors, and the remaining 27% are unsure of their choice. Then on average, students in schools in urban areas are interested in continuing to college with a percentage of 97.2%, and the rest are not sure about continuing to college.

Boyolali Regency is one of the regencies with 25 sub-districts in Central Java Province, Indonesia. Boyolali Regency is located on the island of Java and is not directly adjacent to the sea. In addition, Boyolali Regency is located at an altitude of 75-1500 masl [24]. Based on research data Dewi et al. [25] related to the growth of rural areas to cities, there are regional divisions in Boyolali Regency. For example, urban areas include: Boyolali, Ngemplak, Sawit, Teras, and Mojosongo, urban areas to villages include: Banyudono, Klego, and Sambi, rural areas are only Selo. The division of this area is based on regional access and people's livelihoods. For example, in Selo District, which is geographically located in the mountainous area of the slopes of Merapi, almost part of the population works as farmers. Therefore, it can be said that Selo District is included in the rural zone.

Based on the facts and circumstances, this study intends to investigate students' passion for STEM careers in terms of their attitudes and school areas. The study's specific objectives are to: i) identify students' attitudes toward STEM fields and school areas; ii) explore students' interest in STEM fields and school areas; and iii) identify the correlation between students' attitudes toward STEM, school areas, and STEM career interest among students.

2. RESEARCH METHOD

2.1. Research design

This study aimed to determine: i) student attitudes toward the STEM field in each school area; ii) STEM career interest among students in each school area; and iii) the correlation between student attitudes towards the STEM and school area with STEM career interest among students as illustrated in Figure 1. This is a quantitative study that used a cross-sectional survey design. The methodology of cross-sectional survey is a cross-sectional or rapid survey that collects data separately at one time [26]. This study uses a dual paradigm with two independent variables: students' attitudes towards the STEM field and the school area and one dependent variable: students' interest in STEM careers.

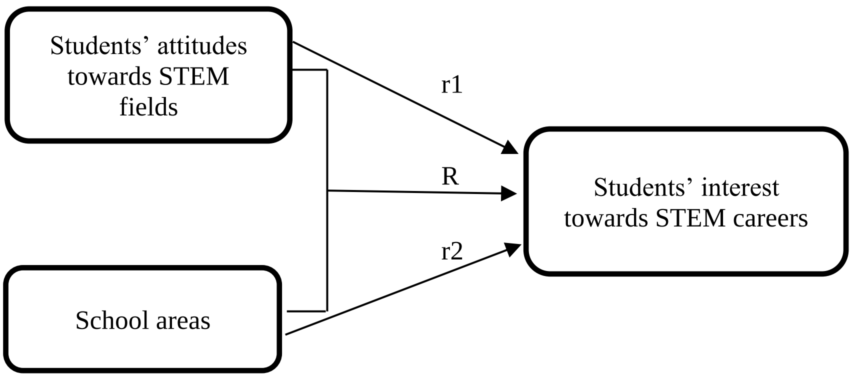

Figure 1. Research framework

2.2. Sample

This study's samples were selected from three junior high school districts in Boyolali Regency, Indonesia. The research samples were drawn from grades 7 to 9 using a proportional stratified random sampling technique. There were 1,514 students from three school districts represented in this study, but the sample size was only 90 (24.9%) students from rural junior high schools, 131 (36.2%) students from district junior high schools, and 141 (39%) students from urban junior high schools. The research location was chosen based on the geographical conditions of each school based on previous research [25].

2.3. Instruments and data analysis

The data collection method employed a non-test measurement tool in the form of a survey. The research questionnaire was adapted from an instrument developed by Faber *et al.* [27] to assess students' attitudes toward STEM and their interest in STEM careers. The research survey on student attitudes toward STEM consists of 35 statements, including six statements regarding student attitudes toward science, nine statements about student attitudes toward mathematics, nine statements concerning student attitudes toward engineering and technology, and 11 statements about student attitudes toward 21st-century learning. The student interest questionnaire in STEM careers contains 12 statements that refer to students' future STEM job interests. The statements were rated from 1 to 5 on the Likert scale: 1=strongly disagree, 2=disagree, 3=elements, 4=agree, and 5=highly agree. In urban, suburban, and rural schools, Google Forms were used to collect data on students' views about STEM and their interest in STEM jobs. Table 1 contains the summary of the student attitude questionnaire regarding the STEM field, while Table 2 contains the student's interest in a career in the STEM sector.

Table 1. Instrument outline for students' attitudes towards STEM

Aspect	Indicator
Student attitudes towards mathematics field	Passion for mathematics, learning achievement in mathematics, interest in a career in mathematics in the future, the importance of mathematics in daily life.
Student attitudes towards science field	Passion for science subjects, learning achievement in science subjects, interest in a career in science in the future, the importance of science in daily life.
Attitudes towards technology and engineering field	Interest in technology and engineering, Confident in technology and engineering, Creative in finding and creating things.
Student attitudes towards 21st century learning	Critical thinking, creative thinking, working together, communicative.

Table 2. Instrument outline for students' interests towards STEM careers

Aspect	Indicator
STEM-related jobs	Interest in working in the fields of physics, environment, biology and zoology, veterinary medicine, mathematics, pharmacy and medicine, geosciences, computers, medicine, chemistry, energy, engineering in the future.

Prior to usage, the research instrument underwent validity and reliability testing. The Gregory formulation is used by the expert to confirm the validity of the instrument. With a score of 0.92, the instrument was deemed valid by two experts in the fields of biology education and science education. Later, 45 students from the population other than the research sample were examined using the instrument. Cronbach's alpha coefficient is used to assess the instrument's reliability. The dependability score for the student attitude survey on the STEM fields was 0.902. While the reliability of the student interest questionnaire in STEM careers is 0.831. According to the reliability test results, the student attitude questionnaire toward the STEM field and students' interest in STEM careers are in the high category, allowing them to be used for research [28]. The data was then analyzed to provide an answer to the problem formulation. The Kolmogorov-Smirnov test was used to determine normality, and the F test was used to determine homogeneity. The Spearman Rank test is used to test partial correlation hypotheses and multiple correlation hypotheses. As shown in Table 3, the data are grouped according to the grouping rubric to determine students' attitudes toward STEM and interest in STEM careers.

Table 3. Research data categorization rubric

Category	Criteria interval
Very low	$x \leq M–1.5\ Sd$
Low	$Mi-1.5\ Sd< x \leq Mi –0.5\ Sd$
Moderate	$Mi-0.5\ Sd < x \leq Mi +0.5\ Sd$
High	$Mi +0.5\ Sd < x \leq Mi +1.5\ Sd$
Very high	$x < M +1.5\ Sd$

3. RESULTS AND DISCUSSION

3.1. Student attitudes towards STEM fields

The obtained data on students' attitudes toward the STEM field was then statistically described, including central tendency measurements and dispersion. The mean (x), median (Me.), and mode (Mo.) are measures of central tendency, while the minimum (Min.), maximum (Max.), estimates (JD), and standard deviation (σ) are measures of dispersion. After obtaining the central tendency and dispersion, the data on student attitudes toward the STEM field were then categorized according to Azwar [29]. The data categorization of student attitudes towards the STEM field on each indicator can be seen in Figure 2.

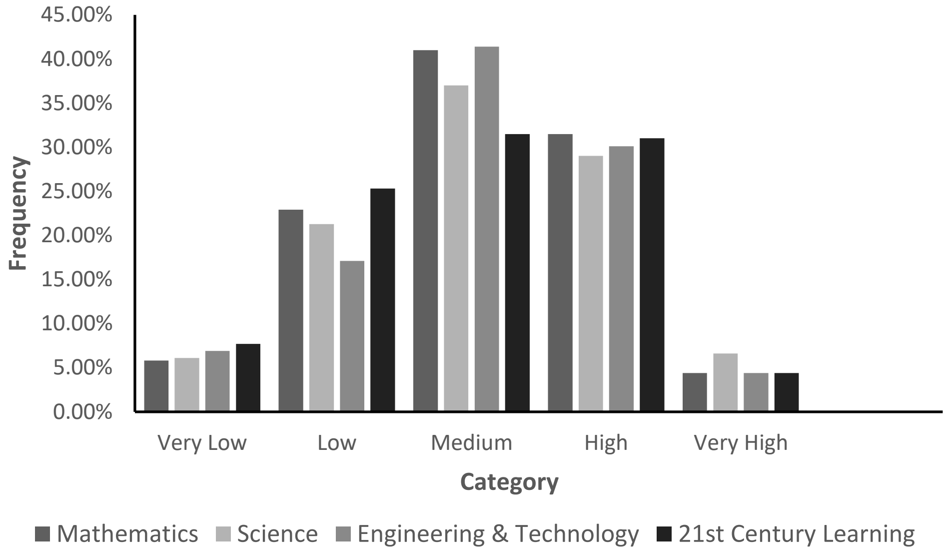

Figure 2. Categorization of student attitudes towards the STEM field on each indicator

Based on Figure 2, the results of the categorization of students' attitude scores towards mathematics include 5.8% of students classified as very low, 22.9% of students classified as low, 41% of students are moderate, 31.5% of students are high, and 4.4% are very tall. The results of the categorization of students' attitude scores towards the science field include 6.1% of very low students, 21.3% of students classified as low, 37% of students being moderate, 29% of high students, 6.6% as very high. The results of students' attitude scores towards the field of engineering and technology, among others, were 6.9% of students in the very low group, 17.1% of students were classified as low, and 41.4% of students were classified as moderate, 30.1% of students were high, and 4.4% were very high. The results of the categorization of student attitudes towards 21st-century learning include 7.7% of students in very low groups, 25.3% of low students, 31.5% of moderate students, 31% of high students, and 4.4% of very high students. From the graph, conclusions can be drawn, which can be seen in Table 4.

Table 4. Categorization of student attitude data towards the STEM fields

No	Indicator	Percentage	Level
1	Students' attitudes towards mathematics	41.2	Moderate
2	Students' attitudes towards natural science	37	Moderate
3	Students' attitudes towards engineering and technology	41.4	Moderate
4	Students' attitudes towards 21st century learning	31.5	Moderate
	Total	37	Moderate

Based on the results of the analysis contained in Table 4, students' attitudes towards the STEM field were the highest on the indicators of students' attitudes towards the engineering and technology fields with a percentage of 41.4 (moderate category). Meanwhile, students' attitudes towards mathematics got a percentage of 41.2 or were in the medium category, students' attitudes towards the science field got a percentage of 37 or were in the medium category, students' attitudes towards 21st century learning got a percentage of 31.5 or in the medium category. Overall, students' attitudes towards the STEM field were dominant in the moderate category with a percentage of 37. These findings support the findings of Perdana *et al.* [30], who found that total students' attitudes toward STEM and 21st-century skills are moderate.

Based on these findings, students' attitudes toward the engineering and technology field are more positive than other indicators. This is due to the fact that engineering and technology are more advanced disciplines than mathematics and science [31]. Engineering and technology are used in STEM-based learning to develop STEM literacy and motivation, as well as to provide a real-world context for studying mathematics and science concepts through the process of engineering design [32]. Engineering and technology are also used by students to be creative and innovative by developing and introducing engineering and technology-based activities in science and mathematics learning.

On the other hand, mathematics is a subject that is quite difficult for students to master, so students who master mathematics tend to be less than other fields. This is supported by research conducted by Siregar [33], which states that about 45 of students in Indonesia consider mathematics as a subject that is quite difficult to master. Then science in STEM-based education is used to identify principles or concepts obtained from all natural phenomena that exist around them through empirical evidence and logical evidence [34].

However recently, due to the pandemic, the online learning process has resulted in learning that, initially, students could interact directly with the environment has now become limited, for example, in laboratory activities. This can lead to a decrease in students' interest in STEM fields and mastery of 21st-century skills. As we know, students' attitudes toward STEM fields are critical in 21st-century learning. Students' attitudes toward STEM are a significant factor in their motivation to learn STEM disciplines and pursue a career in STEM fields in the 21st century [35]. This is because STEM-based education was created to address the challenges of the 21st century, in which students must be both cognitively smart and skilled [36]. Then, Figure 3 depicts the average student attitude toward STEM fields.

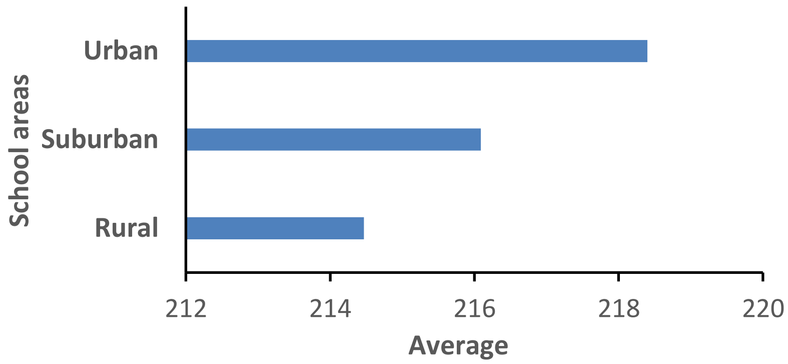

Figure 3. Average student attitudes towards STEM fields in each school area

Based on Figure 3, the highest average student attitude toward the STEM field is the student's attitude towards the STEM field at schools in urban areas, with an average of 218.4. Meanwhile, the average student attitude toward the STEM field at schools in rural areas was 214.47, and the average student attitude toward the STEM field at schools in suburban areas was 216.09. This result is supported by Uğraş [9] which states that students' attitudes toward science tend to decrease with progress in the education system.

The Indonesian education system is generally more advanced in urban schools than in rural ones. Meanwhile, urban areas in developing countries have greater access to technological resources such as the internet, communication tools, and electricity than rural areas. As a result, the more people interact with something (technology), the more interested they become. Additionally, rural schools have fewer students than urban and suburban schools. As a result, rural teachers earn lower average salaries than their urban and suburban counterparts, making it difficult for most rural schools to attract and retain quality teachers, which has a significant impact on students' attitudes toward STEM [19].

3.2. Student interest in STEM careers by school area

In this section, students' interest in STEM careers is described based on the location of the school area. There were 362 students who were divided into 90 students at schools in rural areas, 131 students at schools in suburban areas, and 141 students from schools in urban areas. The results of data categorization of student interest in STEM careers in each school area can be seen in Table 5.

Table 5. Categorization of student interest data in STEM careers

No	School area	Percentage	Level
1	Rural schools	50	Moderate
2	Sub urban schools	38.9	Moderate
3	Urban schools	36.2	Moderate
	Total	40.6	Moderate

According to the analysis in Table 5, students in rural schools have the most significant interest in STEM careers, with a percentage of 50 (moderate category). The student's interest in STEM careers was lowest among students in urban schools, with a percentage of 36.2 in the moderate category. Meanwhile, students' interest in schools in suburban areas was 38.9%, which was in the moderate range. Overall, student interest in STEM careers from all regions is most prevalent in the moderate category (40.6%), with the rest dispersed across all categories.

3.3. Correlation between students’ attitudes toward the STEM field and students’ interest in STEM careers

The significant normality test results were computed using Kolmogorov-Smirnov. A data normality test value of 0.200 is greater than 0.05. The results of the homogeneity test had a significance of 0.648 in the data on student attitudes toward the STEM field in the school area. Simultaneously, the homogeneity test of student interest in STEM careers with school areas had a significance of 0.452. If the significant value is greater than 0.05, the two groups are homogeneous. Students' attitudes toward STEM are associated with their interest in STEM careers after passing the prerequisite hypothesis test in this section. The relationship between students' opinions toward STEM fields and their interest in STEM careers was then examined using the Spearman Rank correlation technique. Results of the Spearman Rank correlation test is shown in Table 6.

Table 6. Correlation between students’ attitudes and students’ interest in STEM

Spearman Rank			Students’ attitudes towards STEM fields	Student interest in STEM careers
	Students’ attitudes towards STEM fields	Correlation coefficient	1	0.548
		Sig. (2-tailed)		0.000
		N	362	362
	Student interest in STEM careers	Correlation coefficient	0.548	1
		Sig. (2-tailed)	0.000	
		N	362	362

Calculations were done, resulting in a Spearman rank coefficient of 0.548 and a significance level of 0.000. The degree of correlation between X1 and Y is in the 0.51-0.75 range. According to these findings, the significance level (0.000) is 0.05, and the correlation coefficient is 0.548. At the 0.01 level, this appears to indicate a significant and positive correlation between students' attitudes toward STEM and their interest in STEM careers. This implies that the more positive students' attitudes toward STEM fields are the more students will be interested in STEM career opportunities in the future. The Spearman Rank correlation technique was then used to determine the relationship between students' attitudes toward STEM fields and their interest in STEM careers [16], [17].

3.4. Correlation between school area and student interest in STEM careers

This section examines the correlation between school districts, which include rural, suburban, and urban schools, and students' interest in STEM careers. The Spearman rank analysis technique was used to determine the correlation between school area and students' interest in STEM careers. Table 7 displays the correlation Spearman rank test results.

Table 7. Correlation between school area and students’ interest in the STEM fields

Spearman Rank			School area	Student interest in STEM careers
	School area	Correlation coefficient	1	- 0.152
		Sig. (2-tailed)		0.004
		N	362	362
	Student interest in STEM careers	Correlation coefficient	- 0.152	1
		Sig. (2-tailed)	0.004	
		N	362	362

The results of calculations with a Spearman Rank correlation coefficient of -0.152 with a significance of 0.004. Based on the degree of correlation, the relationship between school area and student interest in STEM careers is in the interval 0.10-0.25. These results indicate that the significance (0.02)<0.05 and the correlation coefficient of -0.152 means that there is a negative and significant relationship at the 0.01

level between the relationship between school area and student interest in STEM careers. with the level of correlation that is very weak.

In general, the more advanced a region is, the more positive attitudes toward the STEM field will grow. This is demonstrated by the fact that the average attitude of STEM students in urban schools is higher than that of students in rural schools, as shown in Figure 2. This, however, is very different from the outcomes of students' interest in STEM careers. According to the analysis findings in Table 7, the further away students are from urban areas, the more interested they are in pursuing a future career in the STEM field. These findings are supported by research from other developing countries, such as Kazakhstan. There are significant differences in STEM career interest in rural, suburban, and urban school districts. STEM careers are more appealing to rural students than to urban students. This finding is consistent with Chachashvili *et al.* [37], who discovered that students from rural areas are more interested in STEM careers. People in rural areas, according to Peterson *et al.* [38], genuinely believe that STEM education can solve some of their most difficult economic and social problems; as a result, most rural students are interested in STEM careers [38], [39].

Astalini's research [40] found significant differences in science career interest between students in rural and urban schools, which supports this finding. Rural students are more interested in careers in science than urban students. Students living in rural areas have high self-confidence when pursuing a career in science [41]. Knowing the differences that students possess allows the government to create regulations that will assist schools and educators in deciding which teaching methods to implement.

3.5. Correlation between student attitudes towards the STEM field and the school area with student interest in STEM careers

This section describes the multiple correlation test that was conducted to determine the relationship between students' attitudes toward the STEM field and school area with students' interest in STEM careers. The correlation test used Spearman's Rank test. Multiple correlation test results can be seen in Table 8.

Table 8. Correlation analysis

				Change statistic				
R	Rsquare	Adjusted Rsquare	Std. Error of the Estimate	R square change	Fchange	df1	df2	Sig F change
0.589	0.347	0.342	7.296	0.347	95.196	2	359	0.000

The results of calculations get a correlation coefficient of 0.589 with a significance of 0.000. The r_{table} is 0.102 with a significance of 5%, which means that $r_{count} > r_{table}$. Meanwhile, the value of r_{square} is 0.347. These results indicate that the significance (0.000)<0.05 and r_{count} (0.589)> r_{table} (0.102) means that there is a positive and significant relationship between students' attitudes towards the STEM field and the school area and students' interest in STEM careers.

Based on these findings, it is possible to conclude that the tendency of students' positive attitudes toward the STEM field and school area is followed by student interest in STEM careers. In contrast, the tendency of students' negative attitudes toward the STEM field and school area is followed by a decrease in student interest in STEM careers. Thus, both internal and external factors influence student interest in STEM careers. The r square value was 0.347, according to the regression test. It is possible that students' attitudes toward the STEM field and the school environment influence students' interest in the STEM field by 34.7%. While its remaining 65.3% is influenced by factors other than students' attitudes toward STEM and school areas.

Students' interest in a field is strongly influenced by motivation. Students who tend to be motivated in a subject tend to persist in studying the topic to a stronger level of understanding [42]. Meanwhile, the amount of experience in certain fields, especially in the STEM field can cause the level of interest and self-efficacy of students to be higher, so that later it can increase students' motivation and attitudes regarding the STEM field and their career choices in the STEM field in the future [43]. It can be said that students who can enjoy and have a positive attitude towards STEM fields regardless of where they come from are most likely to choose jobs in the same field in the future.

4. CONCLUSION

The study's novelty is that it was initiated in three distinct areas with rural, suburban, and urban backgrounds, concentrating on students' attitudes towards STEM and STEM careers interest. Based on the research results and discussions, it is reasonable to draw the conclusion that students' attitudes toward the

STEM fields are generally in the medium range, with technology and engineering representing the greatest percentage. The results show that students' attitudes toward the STEM field at urban schools are more favorable than those at rural and sub-urban schools, which can be distinguished based on the location of the school. Students in rural schools are more interested in STEM jobs than students in urban and sub-urban schools in terms of interest.

There is, however, a significant and positive correlation between junior high school students' attitudes toward STEM and interest in STEM careers in Boyolali Regency, with a r correlation coefficient of 0.548 (strong correlation) and a significance of 0.000. In Boyolali Regency, moreover, there is a significant and negative correlation between school location and student interest in STEM careers, with a correlation coefficient of -0.152 (very weak correlation) and a significance of 0.002. Then, in Boyolali Regency, there is a significant and positive correlation between junior high school students' attitudes toward STEM and the school area and students' interest in STEM careers together or in groups with r count=0.589>0.102 r table and the significance of f change is 0.000.

This research also implies that students who study in rural, suburban, and urban areas can cultivate a positive attitude toward the STEM field so that later it can generate interest in being able to work in the STEM field in the future. This is because 80% of future jobs require expertise in the STEM field. Meanwhile, for future research, the data collection process is carried out with the same method so that researchers can control the respondent's work process properly and optimally.

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REFERENCES

[1] M. Sanders, "STEM, STEM Education, STEMmania," *The Technology Teacher*, vol. 68, no. 4, pp. 20–28, 2009, [Online]. Available: https://www.teachmeteamwork.com/files/sanders.istem.ed.ttt.istem.ed.def.pdf.

[2] H. B. Gonzalez, J. Kuenzi, and D. White, "What Is STEM Education and Why Is It Important?" *Florida Association of Teacher Educators Journal*, vol. 1, no. 14, pp. 1–9, 2014, [Online]. Available: https://www.ccc.edu/departments/Documents/STEM_labor.pdf.

[3] S. R. Muzana, J. Jumadi, I. Wilujeng, B. E. Yanto, and A. A. Mustamin, "E-STEM project-based learning in teaching science to increase ICT literacy and problem solving," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 10, no. 4, pp. 1386–1394, Dec. 2021, doi: 10.11591/ijere.v10i4.21942.

[4] Organisation for Economic Co-operation and Development (OECD), *PISA for Development Assessment and Analytical Framework: Reading, Mathematics and Science*. 2018, doi: https://doi.org/10.1787/9789264305274-en.

[5] L. A. Harris, "The National Science Foundation: An Overview," Congressional Research Service, 2021.

[6] European Commission, "Europe needs more scientists: EU blueprint for action," Brussels, 2004. [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/IP_04_444.

[7] P. Potvin and A. Hasni, "Interest, motivation and attitude towards science and technology at K-12 levels: a systematic review of 12 years of educational research," *Studies in Science Education*, vol. 50, no. 1, pp. 85–129, Jan. 2014, doi: 10.1080/03057267.2014.881626.

[8] R. Yavich and N. Davidovitch, "Teachers' Attitudes to Use of Advanced Technological Tools as Teaching and Learning Aids: From an Inter-Generational Perspective," *The European Educational Researcher*, vol. 4, no. 3, pp. 329–354, Nov. 2021, doi: 10.31757/euer.434.

[9] K. Kitts, "The Paradox of Middle School Attitudes Toward Science Versus Science As A Career," *Journal of Geoscience Education*, vol. 57, no. 2, pp. 159–164, 2009.

[10] A. Baram-Tsabari and A. Yarden, "Quantifying The Gender Gap in Science Interests," *International Journal of Science and Mathematics Education*, vol. 9, no. 3, pp. 523–550, Jun. 2011, doi: 10.1007/s10763-010-9194-7.

[11] M. Uğraş, "The Effects of STEM Activities on STEM Attitudes, Scientific Creativity and Motivation Beliefs of the Students and Their Views on STEM Education," *International Online Journal of Educational Sciences*, vol. 10, no. 5, 2018, doi: 10.15345/iojes.2018.05.012.

[12] R. B. Toma and I. M. Greca, "The Effect of Integrative STEM Instruction on Elementary Students' Attitudes toward Science," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 14, no. 4, pp. 1383–1395, Jan. 2018, doi: 10.29333/ejmste/83676.

[13] S.-N. Zhou, H. Zeng, S.-R. Xu, L.-C. Chen, and H. Xiao, "Exploring changes in primary students' attitudes towards science, technology, engineering and mathematics (STEM) across genders and grade levels," *Journal of Baltic Science Education*, vol. 18, no. 3, pp. 466–480, Jun. 2019, doi: 10.33225/jbse/19.18.466.

[14] J. DeWitt, L. Archer, and J. Osborne, "Science-related Aspirations Across the Primary–Secondary Divide: Evidence from two surveys in England," *International Journal of Science Education*, vol. 36, no. 10, pp. 1609–1629, Jul. 2014, doi: 10.1080/09500693.2013.871659.

[15] M. Ali, J. Surif, N. M. Zaid, C. A. Talib, A. H. Abdullah, and N. H. Ibrahim, "The Effectiveness of a Mentor-Mentee Program on Malaysian School Students' Interest in STEM," in *Proceedings of 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering, TALE 2018*, 2019, pp. 855–860, doi: 10.1109/TALE.2018.8615161.

[16] M. M. McMahon, T. T. Showers, and A. A. C. P. Schools, "Partnering for Success in the 21st Century," in *Advancing the STEM Agenda: Quality Improvement Supports STEM: Selected Papers from the 2011 Advancing the STEM Agenda in Education, the Workplace and Society Conference at the University of Wisconsin-Stout*, 2012, p. 29.

[17] S. Yerdelen, N. Kahraman, and Y. Taş, "Low socioeconomic status students' STEM career interest in relation to gender, grade level, and stem attitude," *Journal of Turkish Science Education*, vol. 13, no. Special issue, pp. 59–74, 2016, doi: 10.12973/tused.10171a.

[18] E. Wiebe, A. Unfried, and M. Faber, "The Relationship of STEM Attitudes and Career Interest," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 14, no. 10, Jun. 2018, doi: 10.29333/ejmste/92286.

[19] A. Zilberman and L. Ice, "Why computer occupations are behind strong STEM employment growth in the 2019–29 decade," *Beyond the Numbers: Employment & Unemployment*, vol. 10, no. 1 (U.S. Bureau of Labor Statistics), pp. 1–9, 2021, [Online]. Available: https://www.bls.gov/opub/btn/volume-10/why-computer-occupations-are-behind-strong-stem-employment-growth.htm.

[20] R. S. Harris and C. Hodges, "STEM Education in Rural Schools: Implications of Untapped Potential," *National Youth at Risk Journal*, vol. 3, no. 1, pp. 1–12, Dec. 2018, doi: 10.20429/nyarj.2018.030102.

[21] Google and GALLUP, "Computer Science Learning: Closing the Gap Rural and Small-Town School Districts," *2015-2016 Google-Gallup Study of Computer Science in U.S. K-12 Schools (Issue Brief No. 4)*, vol. 2017, no. August, pp. 1–5, 2017, [Online]. Available: http://services.google.com/fh/files/misc/computer-science-learning-closing-the-gap-rural-small-town-brief.pdf.

[22] F. K. Sarfo, A. M. Amartei, K. I. Adentwi, and C. Brefo, "Technology and gender equity: Rural and urban students' attitudes towards information and communication technology," *Journal of Media and Communication Studies*, vol. 3, no. 6, pp. 221–230, 2011, [Online]. Available: http://www.academicjournals.org/jmcs.

[23] S. E. Graham and L. E. Provost, "Mathematics Achievement in Kindergarten Is Lower for Rural and Urban Children and the Achievement Gap Widens by Eighth Grade," *Carsey Institute*, vol. 52, no. 52, pp. 1–8, 2012, [Online]. Available: https://files.eric.ed.gov/fulltext/ED535962.pdf.

[24] Central Bureau of Statistics Boyolali Regency, *Boyolali Regency in Numbers in 2019*. Central Bureau of Statistics, Boyolali Regency (in Indonesian), 2019. [Online]. Available: https://boyolalikab.bps.go.id/publication/2019/08/16/99acc6e0b0e4f02e5018b1ab/kabupaten-boyolali-dalam-angka-2019.html

[25] R. P. Dewi, C. Muryani, and S. Sarwono, "Change of Land Supporting Capacity of Boyolali Regency in 2003 - 2012," (in Indonesian), *Jurnal GeoEco*, vol. 1, no. 1, pp. 1–31, 2015, [Online]. Available: https://jurnal.uns.ac.id/GeoEco/article/view/8894.

[26] J. W. Creswell, *Research Design: Qualitative, Quantitative and Mixed Method Approach*. Singapore: Sage Publication, 2014.

[27] M. Faber, A. Unfried, E. N. Wiebe, J. Corn, L. T. W. Townsend, and T. L. Collins, "Student attitudes toward STEM: The development of upper elementary school and middle/high school student surveys," *2013 ASEE Annual Conference & Exposition*, 2013, doi: 10.18260/1-2--22479.

[28] K. S. Taber, "The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education," *Research in Science Education*, vol. 48, no. 6, pp. 1273–1296, Dec. 2018, doi: 10.1007/s11165-016-9602-2.

[29] S. Azwar, *Research Method*. Yogyakarta: Pustaka Belajar (in Indonesian), 2012.

[30] R. Perdana, A.-N. Apriani, R. Richardo, E. Rochaendi, and C. Kusuma, "Elementary students' attitudes towards STEM and 21st-century skills," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 10, no. 3, pp. 1080–1088, Sep. 2021, doi: 10.11591/ijere.v10i3.21389.

[31] N. Suprapto, "Students' attitudes towards STEM education: Voices from Indonesian junior high schools," *Journal of Turkish Science Education*, vol. 13, no. Special issue, pp. 75–87, 2016, doi: 10.12973/tused.10172a.

[32] National Research Council, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. National Academies Press, 2012.

[33] N. R. Siregar, "Students' Perception on Math Subject: Preliminary Study of Game-Loving students," (in Indonesian), *Prosiding Temu Ilmiah X Ikatan Psikologi Perkembangan Indonesia*, 2017, pp. 224–232, [Online]. Available: https://jurnal.unissula.ac.id/index.php/ippi/article/view/2193.

[34] R. N. Hafni, T. Herman, E. Nurlaelah, and L. Mustikasari, "The importance of science, technology, engineering, and mathematics (STEM) education to enhance students' critical thinking skill in facing the industry 4.0," *Journal of Physics: Conference Series*, vol. 1521, no. 4, p. 042040, Mar. 2020, doi: 10.1088/1742-6596/1521/4/042040.

[35] A. V. Maltese and R. H. Tai, "Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students," *Science Education*, vol. 95, no. 5, pp. 877–907, Sep. 2011, doi: 10.1002/sce.20441.

[36] Widya, R. Rifandi, and Y. L. Rahmi, "STEM education to fulfil the 21 st century demand: a literature review," *Journal of Physics: Conference Series*, vol. 1317, no. 1, p. 012208, Oct. 2019, doi: 10.1088/1742-6596/1317/1/012208.

[37] S. Chachashvili-Bolotin, M. Milner-Bolotin, and S. Lissitsa, "Examination of factors predicting secondary students' interest in tertiary STEM education," *International Journal of Science Education*, vol. 38, no. 3, pp. 366–390, Feb. 2016, doi: 10.1080/09500693.2016.1143137.

[38] B. Peterson, G. Bornemann, C. Lydon, and K. West, "Rural Students in Washington State: STEM as a Strategy for Building Rigor, Postsecondary Aspirations, and Relevant Career Opportunities," *Peabody Journal of Education*, vol. 90, no. 2, pp. 280–293, Mar. 2015, doi: 10.1080/0161956X.2015.1022397.

[39] L. E. Grimes, M. A. Arrastía-Chisholm, and S. B. Bright, "How Can They Know What They Don't Know? The Beliefs and Experiences of Rural School Counselors about STEM Career Advising," *Theory & Practice in Rural Education*, vol. 9, no. 1, pp. 74–90, May 2019, doi: 10.3776/tpre.2019.v9n1p74-90.

[40] A. Astalini, D. Darmaji, D. A. Kurniawan, S. Sumaryanti, R. Perdana, and S. Susbiyanto, "Description Of Relationship Between Students Interests And Attitudes In Physical Subject In Indonesia," *Journal of Educational Science and Technology (EST)*, vol. 5, no. 3, pp. 202–211, Nov. 2019, doi: 10.26858/est.v5i3.9309.

[41] A. Astalini, D. A. Kurniawan, D. Darmaji, and L. Anggraini, "Comparison of Students Attitudes in Science Subjects In Urban And Rural Areas," *Journal of Educational Science and Technology (EST)*, vol. 6, no. 2, pp. 126–136, Jun. 2020, doi: 10.26858/est.v6i2.12057.

[42] A. B. Diekman, E. R. Brown, A. M. Johnston, and E. K. Clark, "Seeking Congruity Between Goals and Roles: A New Look at Why Women Opt Out of Science, Technology, Engineering, and Mathematics Careers," *Psychological Science*, vol. 21, no. 8, pp. 1051–1057, 2010, doi: 10.1177/0956797610377342.

[43] M. V. Bøe, E. K. Henriksen, T. Lyons, and C. Schreiner, "Participation in science and technology: Young people's achievement-related choices in late-modern societies," *Studies in Science Education*, vol. 47, no. 1, pp. 37–72, 2011, doi: 10.1080/03057267.2011.549621.

BIOGRAPHIES OF AUTHORS

Arifin Septiyanto is a general practitioner who graduated from bachelor's degree in science education, Universitas Sebelas Maret, Surakarta, Indonesia. He is currently student at science education department, Graduate School, Indonesian Education University, Bandung, Indonesia. His research interest includes science education, STEM education, and integrated science. He is also LPDP scholarship awardee for his master's degree. He can be contacted at email: arifinseptiyanto3@gmail.com.

Dwi Oetomo completed his master's degree of microbiology in Institut Pertanian Bogor, Bogor, Indonesia. He is currently teaching in Universitas Sebelas Maret as a lecturer. His research interest biology education, microbiology, science education, cell biology. He is currently also interested in biology and science education especially in teaching and learning. He can be contacted at email: dwioetomo@staff.uns.ac.id.

Nurma Yunita Indriyanti is an associate professor in the Science Education Department, Universitas Sebelas Maret, Indonesia. The research interests are innovation in science learning, STEM learning, and blended learning design. She got her Ph.D. in Education from the University of Muenster Germany in 2016. She can be contacted at email: nurma.indriyanti@staff.uns.ac.id.