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Students' Perception of Science and Technology in Science Learning: A Gender Comparative Study

Atila Ledia Putri[1*], Ogi Danika Pranata[2], Emayulia Sastria[3]

[1,3]Biology Education, State Islamic Institute of Kerinci, Jambi, Indonesia
[2]Physics Education, State Islamic Institute of Kerinci, Jambi, Indonesia
*E-mail: atilaledia02@gmail.com

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Abstract: Teachers face a dilemma. On the one hand, science and technology significantly benefit students, providing greater opportunities for future generations. On the other hand, students' interest in science and technology continues to decrease. The rapid advance of science and technology also widens inequities and enhances gender differences. Understanding students' perceptions of technology in learning, especially science, and their daily lives is necessary. The research employs both descriptive and comparative methods as its primary methodologies. The descriptive method provides an overview of students' perceptions of science and technology. The comparative method helps uncover differences in students' perceptions based on gender. The study encompasses 200 participants from a junior high school in Kerinci. This research utilized the "My Opinions about Science and Technology" questionnaire. The questionnaire was translated into Indonesian and formatted into an online survey using Google Forms. It comprises 16 research statements about science and technology designed to collect essential data, employing a 4-point scale response. The Independent Samples T-test, facilitated by SPSS, compared male and female perceptions of science and technology. The descriptive statistics reveal that the average student perception is 3.06. Based on the level of each student, no students are categorized as having a low level of perception of science and technology. Based on gender, female students exhibit an average perception of 3.02, and males display an average of 3.11. Based on the mean or average values, it can be concluded that there is a difference in the average perception between female and male students, with male students showing a higher perception of science and technology than female students. The independent samples t-test results confirm that the average perception of females regarding science and technology is lower than that of males, with a mean difference of -0.093 on a 4-point scale. The disparity in perception based on gender was found to be statistically significant. Male students have a higher percentage of high-level perception compared to female students. Males exhibit high perceptions regarding the development of scientific theories, the impact of science and technology on environmental problems, and the potential for science and technology to improve life, create more interesting jobs and help eradicate poverty and famine. The theoretical and practical implications of these results are discussed.

Keywords: Gender; Learning; Science and Technology; Student's Perception

Introduction

Science and technology are crucial aspects of life in all countries, irrespective of culture and levels of material development [1]. The OECD also emphasizes that curricula should ensure equity while innovating; all students, not just a select few, must benefit from social, economic, and technological changes [2]. Therefore, the integration of science and technology is highly essential in the field of education, facilitating all human activities.

The primary scope for this integration is in science learning in schools, providing numerous benefits to all parties involved, especially teachers and students. For teachers, technological activities are prime candidates for an integrated approach to teaching, serving as hubs for discussions resembling those traditionally associated with the arts, technological design, mathematics, science, language arts, and more [3]. Technology can assist teachers in designing the learning process, developing worksheets for students [4], creating learning media, using videos and simulations, open sources [5], and even integrating it into exams [6].

The widespread integration of technology in the teaching and learning environment has become a common practice. However, on the other hand, the rapid pace of technological developments presents a challenge for education. [2]. A framework for integration and adaptation is needed to leverage technology's potential fully. Professional teaching can be enhanced by improving knowledge and skills in technology, pedagogy, content, and their integration [7]. This integration, commonly known as TPACK (Technological, Pedagogical, and Content Knowledge) [8], [9], should guide learning processes at various levels of education.

True education is not solely about what and how teachers teach but also about how students learn [10]. Therefore, the main focus of education is on student learning. Education, especially in schools, should emphasize the process of student learning and prepare them for unprecedented technologies that have not yet been invented [2]. The learning process in schools should foster and equip learners with agency and responsibilities in their learning, a sense of purpose, and the competencies they need to shape their own lives and contribute to the lives of others.

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This preparation can occur in the learning process at school (elementary, junior, and senior high school), where technological integration could be promoted to help students in their learning and problem-solving. Furthermore, technology also can assist students in their daily lives and address their problems.

However, many teachers face a dilemma. On the one hand, the development of science and technology offers significant benefits for them and their students, providing greater opportunities for future generations. On the other hand, students' interest in science and technology continues to decrease [1]. This condition should be a major concern, especially for teachers. Teachers are expected to focus not only on cognitive aspects but also on students' mental, emotional, and motivational aspects [11]–[13], particularly those related to science and technology. What happens in schools related to science and technology will have a long-term impact on students [1]. Students who develop an interest in science and technology at school will likely pursue these interests later in life. Conversely, students who do not like science and technology at school may avoid it throughout their lives.

The rapid advance of science and technology may widen inequities, exacerbate social fragmentation, and accelerate resource depletion [2]. Gender differences in engagement in and interest in many areas of science have emerged in early childhood, developed over time, and ultimately reflected in advanced course selection in secondary education [14], [15]. Gender differences in science education generally reveal themselves in secondary education when students can choose their specialization [16]. So, it is important to identify the factors that contribute to the increase in the gender gap in learning from the early stages. Gender issues can also influence students' future interest in science and career choices [17].

As a first step, the teacher must explore and understand students' perceptions of science and technology in learning, especially in elementary and junior high school. Furthermore, comparing these perceptions based on gender is crucial to identifying patterns, differences, and disparities between male and female students in their interests, beliefs, and aspirations in science and technology. This allows for discovering more effective ways to stimulate students' interest in science and technology, helps create a better learning environment, and enhances students' overall potential to cope with ongoing science and technological advancements.

Research Methods

The research employs both descriptive and comparative methods as its primary methodologies. The descriptive method provides an overview of students' perceptions of science and technology in science learning, considering the overall student population and distinctions based on students' gender. The descriptive portrayal derived from this method is complemented by the comparative method, which helps uncover differences in students' perceptions based on gender.

The population of this study consists of all students from a junior high school in the Siulak District, Kerinci Regency. This research involves 200 participants selected through purposive sampling during the science course's first semester of the 2023/2024 academic year. The sample used in this study consists of 125 female students and 75 male students.

The study utilizes the "My Opinion about Science and Technology" questionnaire developed by Camilla Schreiner and Svein Sjøberg [1]. They have developed numerous questionnaires about the relevance of science (ROSE). For this study, we have chosen one that focuses on aspects crucial for how students engage with and relate to science and technology in their learning environment and everyday life.

The questionnaire was translated into Indonesian and formatted into an online survey using Google Forms. It consists of 16 research statements about science and technology that are designed to collect essential data, employing a 4-point scale ranging from 4 (strongly agree) and 3 (agree) to 2 (disagree) and 1 (strongly disagree).

After completing the data collection phase, the data from the Google Form responses was converted and organized using Microsoft Excel. Subsequently, data analysis was conducted using either the Independent Samples T-test or the Mann-Whitney U Test, facilitated by SPSS, to compare male and female perceptions of science and technology. The test selection was contingent upon the data's independence, normality, and variance.

Results and Discussion

The students' responses that have been collected were analyzed using descriptive statistics to understand their overall perception of science and technology in learning science based on gender. The analysis results are presented in Table 1.

Tabel 1. Descriptive Statistic

	N	Range	Min	Max	Mean		Std. Deviation	Variance	Skewness	
					Statistic	Std.Error			Statistic	Std.Error
All Students	200	1.63	2.31	3.94	3.06	0.02	0.30	0.09	0.33	0.17
Female	125	1.25	2.38	3.63	3.02	0.02	0.26	0.07	0.02	0.22
Male	75	1.63	2.31	3.94	3.11	0.04	0.35	0.12	0.32	0.28

The descriptive statistics in Table 1, specifically in the 'All Students' column, reveal that the average student perception is 3.06, with a standard deviation of 0.30 and a skewness of 0.33. Despite the variability in the data distribution for each student, students exhibit a high perception of science and technology overall. As educators, we must maintain and increase students' interest in science and technology, as this interest can significantly influence their future development. Students interested in science and technology are more likely to pursue careers in these fields,

whereas those not interested are likely to continue avoiding them in their daily lives.

When analyzing the data from a gender standpoint, the descriptive statistical analysis reveals that females have an average perception score of 3.02, with a standard deviation of 0.26 and a skewness of 0.02. On the other hand, males display an average perception of 3.11, with a standard deviation of 0.35 and a skewness of 0.32. Based on the mean or average values, it can be concluded that there is a difference in the average perception between female and male students, with male students showing a higher perception of science and technology than female students.

In order to determine the significance of these differences, it is necessary to conduct a comparison test, such as the Independent Samples T-test or the Mann-Whitney U Test. The Independent Samples T-test can be used if the assumptions are met: datasets are independent, and data is normally distributed. Since we are comparing gender, the scores of female students are not systematically related to the scores of male students. In other words, the datasets are independent. Next, the normality of the data can be determined based on the results of descriptive statistics, particularly skewness. All datasets are normally distributed as the skewness values fall from -1.00 to 1.00 [18].

With the assumptions met, an independent samples t-test was conducted to ascertain the statistical significance of the observed differences in perceptions based on students' gender at one of the junior high schools in the Siulak sub-district, Kerinci district. The comparative analysis of the data through the independent samples t-test was carried out using SPSS software, and the results are presented in Table 2.

Table 2. Results of Independent Samples T-Test

	Levene's Test For Equality of Variances		t-test for Equality of Means						
	F	Sig	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	8.926	0.003	-2.15	198	0.033	-0.093	0.044	-0.179	-0.008
Equal variances are not assumed.			-2.00	122.95	0.048	-0.093	0.047	-0.186	-0.001

The data in the 'Levene's Test For Equality of Variances' column reveals a significant value of 0.003 ($\rho < 0.05$). This outcome suggests that the variances of both data groups (female and male) are not homogeneous, meaning equal variances cannot be assumed. Consequently, the comparison test results will be interpreted based on the data in the bottom row (equal variances not assumed) in Table 2.

The test results suggest that the average perception of females regarding science and technology is lower compared to males, with a mean difference of -0.093 on a 4-point scale. The disparity in perception based on gender was statistically significant ($\rho = 0.048$). Additionally, for visual confirmation, Figure 1 illustrates the distribution of perceptions between female and male students, and Figure 2 shows the percentage of the level or category of perception for male and female students.

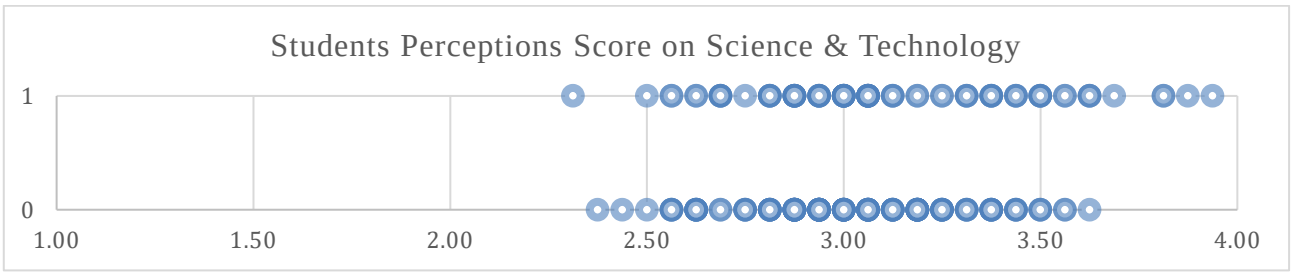
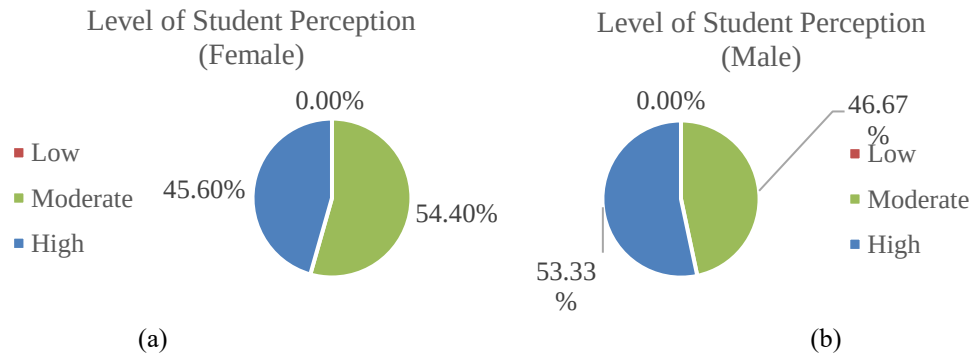


Figure 1. Students Perceptions Score on Science & Technology: Female (0) and Male Students (1)



(a) (b)

Figure 2. Level of Student Perception: (a) Female and (b). Male Students

The findings of this study suggest that male students have a higher perception of science and technology than female students. Male students tend to have higher scores, as shown in Figure 1. This finding may be due to different learning participation levels between male and female students. Male students are more frequently involved in activities to improve skills, specifically in the curricular subject of computer science. On the other hand, female students are more often engaged in activities aiming to involve participants with various scientific topics [19]. Male students showed higher self-concepts in chemistry and physics [20]. Based on participation, there are large gender gaps in the three STEM (Science, Technology, Engineering, and Mathematics) domains: math, physics, and chemistry [21]. Then, male students outperformed female participants in science competitions, such as science Olympiads [15]. Male students tend to accept learning as a challenge, like the existence and development of science and technology.

Then, it was confirmed by the level of student perception, as shown in Figure 2. Although no students are categorized as having a low level of perception of science and technology, male students (52.33%) have a higher percentage of high perception than female students (45.60%). Other studies also found differences in perceptions between male and female students, where male students had higher perceptions [14] and interest in science and technology [15] than female science students. Based on learning activity, male students are more likely to cover physics, chemistry, mathematics, and computer science, while female students are more likely to cover biology, humanities, literature, and arts [19]. Based on that explanation, it can be observed that some of the reasons male students tend to have higher perceptions than female students regarding science and technology. The difference may be caused by their career perspective [17] related to science and technology.

Therefore, it is important to explore gender differences during adolescence (high school). Gender studies in childhood and adulthood are influenced by gender phenomena in adolescence [22]. A more detailed exploration of perceptions of science and technology from different gender perspectives is depicted by the distribution of student responses for each statement, as shown in Table 3.

Table 3. Distribution of Student Responses for Each Statement

Ideas about Science and Technology	Gender	Student Responses (%)				Average	Difference
		1	2	3	4		
1. Science and technology are important for society	F	0.80	0.80	48.00	50.40	3.48	0.07
	M	2.67	0.00	50.67	46.67	3.41	
2. Science and technology are crucial for the health sector, contributing to drug development	F	1.60	5.60	66.40	26.40	3.18	-0.08
	M	1.33	4.00	62.67	32.00	3.25	
3. With science and technology, there will be greater opportunities for future generations	F	2.40	0.80	54.40	42.40	3.37	-0.02
	M	1.33	2.67	52.00	44.00	3.39	
4. Science and technology make our lives healthier, easier, and more comfortable	F	1.60	5.60	61.60	31.20	3.22	-0.14
	M	0.00	6.67	50.67	42.67	3.36	
5. New technology will create more interesting jobs	F	0.80	8.00	63.20	28.00	3.18	-0.12
	M	0.00	6.67	56.00	37.33	3.31	
6. The benefits of science outweigh the negative impacts	F	3.20	12.80	64.00	20.00	3.01	-0.10
	M	4.00	9.33	58.67	28.00	3.11	
7. Science and technology can help eradicate poverty and famine worldwide	F	12.00	24.00	47.20	16.80	2.69	-0.11
	M	6.67	28.00	44.00	21.33	2.80	
8. Science and technology can contribute to solving almost all problems	F	4.00	20.00	64.80	11.20	2.83	-0.07
	M	4.00	24.00	49.33	22.67	2.91	
9. Science and technology can be utilized to assist underprivileged people	F	2.40	17.60	53.60	26.40	3.04	-0.08
	M	1.33	14.67	54.67	29.33	3.12	
10. Science and technology can potentially trigger environmental problems	F	21.60	52.00	20.80	5.60	2.10	-0.22
	M	22.67	34.67	30.67	12.00	2.32	
11. A country needs science and technology for development	F	0.00	1.60	50.40	48.00	3.46	-0.08
	M	0.00	2.67	40.00	57.33	3.55	
	F	1.60	5.60	60.00	32.80	3.24	-0.05

12. Science and technology provide significant benefits for developing countries	M	1.33	2.67	61.33	34.67	3.29	
13. Scientists follow the scientific method, which guides them to the right answers	F	0.80	4.80	73.60	20.80	3.14	0.01
	M	2.67	5.33	68.00	24.00	3.13	
14. We should trust what scientists say	F	4.80	35.20	54.40	5.60	2.61	0.03
	M	12.00	30.67	45.33	12.00	2.57	
15. Scientists are neutral and objective	F	4.80	8.80	73.60	12.80	2.94	-0.10
	M	2.67	9.33	69.33	18.67	3.04	
16. Scientific theories continuously develop and change over time	F	3.20	25.60	60.00	11.20	2.79	-0.45
	M	1.33	1.33	69.33	28.00	3.24	

* Bold text indicates higher average scores between Male (M) and Female (F)

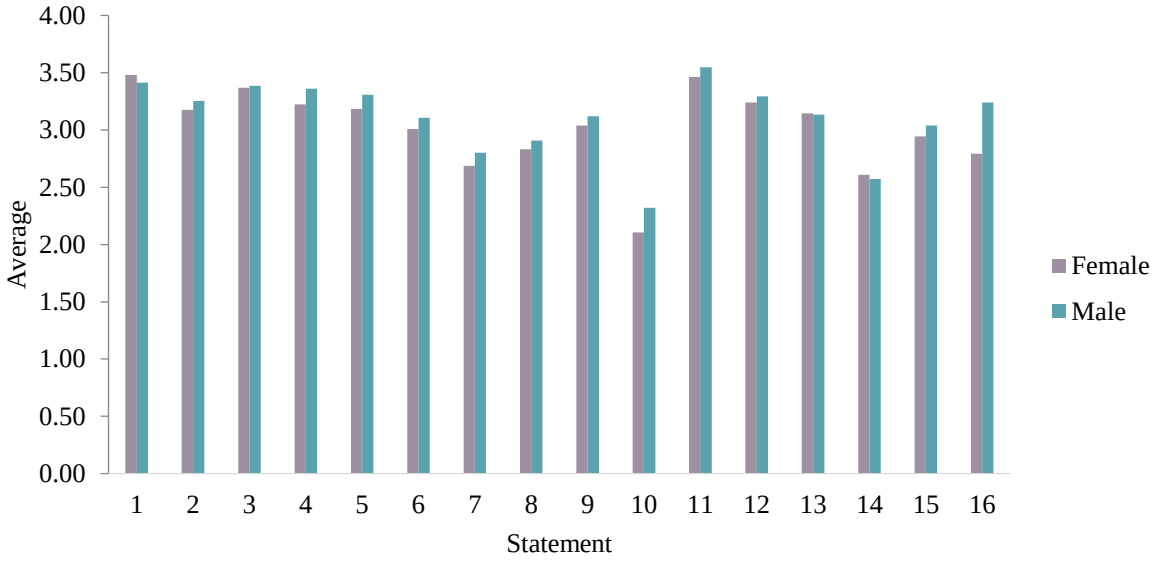


Figure 3. Average Student Perceptions for Each Statement

Out of all the statements provided, only three statements showed higher perception scores for female students than male students, which are statements 1, 13, and 14. A comparison between the average perceptions of female and male students for each statement can be visually distinguished through a diagram, as depicted in Figure 3. The overall difference is small, 0.11 in total on a 4-point scale. The biggest difference is number 1 (0.07), which addresses the importance of knowledge and technology for society. Previous research provides supporting evidence that helping others and improving society is a main motivator for females to enter science in general [14], [23].

Then, number 14 contains a statement about always trusting what scientists say (0.03). Other relevant studies also confirm this result. Female students were more interested than male students in the people-oriented aspects [14], like scientists and other people/society-oriented jobs. Lastly, number 13 elaborates on scientists or experts following the scientific method, which always leads them to the correct answers (0.01). Students must have first-hand experiences with the empirical methods of science to gain a comprehensive understanding of the nature of science [24]. We found no difference in perception scores between males and females on the scientific method. Both male and female perceptions are categorized as moderate. For numbers 1 and 14, males' and females' average scores and perception of science and technology are categorized as high.

Apart from numbers 1, 13, and 14, previously explained in the paragraph above, males' perceptions are higher than females for the other thirteen statements about science and technology. From number 1 to 16 detailed above, the discussion can be summarized as follows:

The biggest difference in average perception scores between males and females is 0.45 on a 4-point scale. This difference concerns scientific theories that are continuously developing and changing over time (idea number 16). This occurs because science always seeks better and more accurate truths. This process is integrated with technological advancement. Technology serves as a source of new scientific challenges [25]. This role of technology leads to the reinforcement and development of scientific theory. Then, scientific theory serves as the source of ideas for new technological possibilities. Our data shows that males highly perceive the development of scientific theories 3.24. On the other hand, females' perception of this has a much lower score, which is 2.79, and they are categorized as medium in their level of perception about the development of scientific theories. Ideas about the development of scientific theories related to science as content. The other study also found the same pattern: female students tended to find science

uninteresting and the scientific lifestyle (as perceived) unattractive [14].

The next biggest difference in average scores between males and females are ideas in numbers 10, 4, 5, and 7. Others are numbered with a difference of 0.10 or less. The aforementioned environmental issues (0.22) have the potential to enhance quality of life (0.14), generate more engaging employment opportunities (0.12), and contribute to the elimination of poverty and famine (0.11). Other studies also confirm that significantly more males than females perceived science as involving ease of understanding, the potential to help people experiencing poverty, destruction, and danger, creating societal problems, and better suitability for boys [26].

Although we have focused on gender differences, male and female students are similar in certain ways. They share a high perception of the same aspects of science and technology. The top three are ideas number 11 (3.50), number 1 (3.46), and number 3 (3.38). Both males and females agree that science and technology are important for developing countries, creating greater opportunities for future generations.

However, the interesting thing is the top four and accidentally, with the same number of ideas, ideas number 4. This idea is about how science and technology make our lives healthier, easier, and more comfortable. Although there are differences (0.14 points), both male and female students agree that science and technological development aims for a better life. This result aligns with an idea in the OECD report about the future of education and skills. The report discusses that innovation in science and technology, especially in biotechnology and artificial intelligence, raises fundamental questions about what it is to be human. It is time to create new economic, social, and institutional models that pursue better lives for all [2].

The results of this study provide empirical evidence and stimulate theoretical discussions about priorities and alternatives in science and technology education. Teachers can apply varied learning activities in science learning according to students' conditions and needs [27]. Teachers can also continue integrating technology-based planning, processes, and evaluation [6]. Apart from assisting teachers, integrating technology into learning also benefits students. Students become closer and more familiar with science and technology. Many technology-based learning resources can be utilized. One freely available learning resource for the science field is Physics Education Technology (PhET) simulations. PhET has the potential to transform education through technology integration [28], whether used in traditional classrooms, online learning, blended learning [29], or flipped classrooms [30]. Students can use interactive simulations and experience ease and comfort in a learning process integrated with technology.

Conclusion

The descriptive statistics reveal that the average student perception is 3.06. Female students exhibit an average perception of 3.02, and males display an average of 3.11. Based on the mean or average values, it can be concluded that there is a difference in the average perception between female and male students, with male students showing a higher perception of science and technology than female students. Then, based on the level of each student, no students were categorized as having a low level of perception of science and technology. Male students (52.33%) have a higher percentage of high perception levels than female students (45.60%).

The independent samples t-test results confirm that the average perception of females regarding science and technology is lower than that of males, with a mean difference of -0.093 on a 4-point scale. The disparity in perception based on gender was statistically significant ($\rho = 0.048$). Male students have a higher percentage of high-level perception compared to female students. Males exhibit high perceptions regarding the development of scientific theories, the impact of science and technology on environmental problems, and the potential for science and technology to improve life, create more interesting jobs and help eradicate poverty and famine.

Based on the findings, several potential avenues for future research could be explored. Gender-based disparities could be examined through an in-depth analysis of factors influencing perceptions of science and technology (socio-cultural factors, educational experiences, or other variables that may influence these perceptions). Longitudinal studies could also be conducted to track changes in students' perceptions of science and technology over time. This could help identify critical periods or interventions that might impact and potentially reduce gender-based disparities. Additionally, interventions aimed at improving science and technology perceptions, particularly for female students, could be implemented.

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