PILLAR OF PHYSICS EDUCATION
Vol. 18 (1), 2025, page.1-10
ISSN (Print) : 2337-9618
ISSN (Online) : 2684-8880

Analysis of Junior High School Students' Self-Efficacy towards Science: A Case Study

Dendy Verdiansyah[1], Nanang Winarno[2*], Saprudin[3]

[1]*PPG Prajabatan Bidang Studi IPA, Universitas Pendidikan Indonesia, Bandung, Indonesia*

[2]*Department of Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia*

[3]*Department of Physics Education, Universitas Khairun, Ternate, Indonesia*

*Corresponding author. Email:*nanang_winarno@upi.edu

ABSTRACT

In PISA 2025, formulated by the OECD in 2023, the science competence expected of students is to be able to recognize, construct, apply, and evaluate a phenomenon scientifically and use the scientific information in decision-making and subsequent actions. Many studies have revealed a decline in the level of interest in science. One of the causes of this is the lack of science self-efficacy. This study aims to analyze the self-efficacy of junior high school students toward science learning. The instrument used in this study is a questionnaire called the science self-efficacy Scale (SSES), which consists of four aspects: identification and recall, explaining and applying, questioning and debating, innovative design, and two open-ended questions. The participants of this study totalled 331 students, consisting of 200 females and 131 males. The data collected were analyzed with descriptive statistics. The results showed that the average self-efficacy of IPA was 3.14, which was included in the moderate category. The results of the average score of each aspect are in the aspect of identifying and remembering 3.29, in the aspect of explaining and applying 3.09, in the aspect of asking and arguing 3.08, and in the aspect of innovative design 3.04. Open-ended questions reveal that internal factors of learners and external factors of teachers and the learning environment influence self-efficacy in science. Therefore, the Kruskal-Wallis test results show that the Asymp.Sig. value is 0.002-0.037, so there is a significant difference in self-efficacy in science between grades 7, 8, and 9.

Keywords : Self-efficacy, Science Learning, Junior High School.

I. INTRODUCTION

Science is seen as one of the sources of solving global social or environmental problems such as resource management, climate change, health, energy sources, and other issues that put pressure on scientific development [1]. Many studies have revealed that there is a decrease in the level of interest and motivation towards science. One of the reasons for this is the lack of science self-efficacy, which is reflected in the monitoring of scientific learning of 200,000 primary and secondary school students published in 2020 and shows that only 20% of students are willing to engage in science [2], [3], [4]. Students with low science self-efficacy tend to be disinterested and give up on science tasks due to a lack of confidence and feeling less competent in completing science tasks, which impacts low academic achievement [5]. According to [6] Bandura (2006), self-efficacy is a description of a person's belief in their ability to perform a given task. Self-efficacy comprises cognitive processes, mastery, experience, social persuasion, and affective and physiological states. Research addressing science self-efficacy in secondary schools is lacking, and most research is conducted at the university level [7], [8], [9]. According to [10], the middle school period is key to fostering, measuring, and evaluating students' science self-efficacy.

In PISA 2025, formulated by the OECD in 2023, the science competence expected of students is to recognize, construct, apply, and evaluate a phenomenon scientifically and use the scientific information in decision-making and subsequent actions. Measuring self-efficacy is important to realize the expectations of these

Submitted: 2025-01-05 Accepted: 2025-03-20 Published: 2025-03-30

competencies because it describes the confidence of learners in completing science tasks that develop their scientific skills. In previous research, scientific interest and self-understanding predict a learner's science learning comfort and self-efficacy[11]. Much research on science self-efficacy has been conducted based on declining interest in a career in science. Commonly found variables include gender, its relationship with careers, changes in self-efficacy levels, understanding learner self-efficacy, and the impact of learning on science self-efficacy.

Self-efficacy can change over time. Research conducted by [8], [12], [13] revealed that changes in self-efficacy can be triggered through certain learning programs. Then, one of the studies investigating the relationship between learning and the level of self-efficacy toward science was conducted by [14], who revealed that PBL learning can increase self-efficacy toward science because it gives students autonomy when exploring phenomena. Then C.J. Ballen's research measured the impact of traditional versus active learning on academic performance and science self-efficacy. The results revealed that active learning can increase students' science self-efficacy and also have an impact on improving academic performance [2]. These findings are shows that guiding students in creating a learning product to visualize their learning significantly supports the perception of self-efficacy towards science [15]. However, other results were found in the research that active learning did not play a role in increasing self-efficacy but it was observed that students experienced very high anxiety, which made their level of self-efficacy low [16]. Another study that discussed self-efficacy was to determine the factors that influence the self-efficacy of learning science at both the teacher and student levels in Taiwan. The results revealed that the science resilience of teachers and students plays an important role in the structure of science learning self-efficacy so that teachers are expected to create learning programs that can increase science self-efficacy [17].

Previous research on self-efficacy has been conducted at the high school level as in [18], which estimated the gender gap in self-efficacy. Other studies conducted by [17], [19], [20], [21] investigated the factors that influence self-efficacy in high school students. Meanwhile, research on self-efficacy at the junior high school level was conducted by [12] to examine changes in science self-efficacy in students, while [22] confirmed science self-efficacy and academic performance of students and investigated differences according to gender. Then, research by [23] explored the relationship between science learning and self-efficacy.

In addition, research on science learning self-efficacy was conducted in Indonesia at the high school student level. In another study conducted descriptive research on the level of self-efficacy using a student self-efficacy questionnaire consisting of 5 aspects, which include conceptual understanding, higher-order cognitive skills, practical work, everyday application, and science communication to find out how high school students' self-efficacy in physics material [24]. At the same time, [25] investigated the effect of the discovery learning model on student self-efficacy. However, we have not found a survey study that analyzes junior high school students' self-efficacy towards science based on grade level (grades 7, 8 and 9) [25]. This study will use a survey method using a self-efficacy questionnaire developed by [10]. The questionnaire consists of 24 questions divided into four aspects: identifying and remembering, explaining and applying, questioning and arguing, and innovative design [10]. So that in this study, there are two research questions, namely:

1. How is students' self-efficacy in science at junior high school?

2. Is there a significant difference in students' self-efficacy in grades 7, 8, and 9?.

II. METHOD

A. Research Design

This research uses a survey method. The survey method aims to collect information through a series of questions given to participants to obtain data representing the population under study [26]. The information collected through the questionnaire is then used to describe the specified variables [27]. This study was conducted using a self-efficacy questionnaire distributed online via Google Forms to participants so that they could be filled in anytime and anywhere. Learners are given instructions to answer the questionnaire honestly and truthfully according to the conditions experienced by students.

B. Participants

The participants in this study consisted of 331 junior high school students in grades 7,8,9 from 231 grade 7, 78 grade 8, and 40 grade 9, with 131 male and 200 female students aged 11-16 years old. They were spread across 8 different schools in 4 different cities: Bandung, Karawang, Cianjur, and Bangka. The sample population of student participants can be seen in Table 1.

Table 1. Sample population of student participants

Grade	Number	Percent (%)
7	213	64,4
8	78	23,6
9	40	12,1
Total	331	100

Then, data on the characteristics of respondents in gender, age, class, and education were obtained through a questionnaire via Google form, which was then searched for frequencies as follows as in the gender frequency table in Table 2 and age frequency in Table 3

Table 2. Frequency Gender

		Frequency	Percent
Valid	Male	131	39,58
	Female	200	60,42
	Total		100,0

Table 3. Age Frequency

		Frequency	Percent
Valid	11	3	,9
	12	91	27,5
	13	151	45,6
	14	59	17,8
	15	20	6,0
	16	7	2,1
	Total		100,0

C. Research Instruments

The research instrument used in this study is the Science Self-Efficacy Questionnaire called the Science Self-Efficacy Scale (SSES), which consists of two parts. The first part is questions related to Full Name, Class, Gender, Age, School origin, and Province. The second part includes questions about self-efficacy consisting of 24 questions covering 4 aspects of self-efficacy namely 1) Identifying and Remember, 2) Explaining and Applying, 3) Questioning and Arguing, and 4) Innovative Design. The Science Self-Efficacy Scale (SSES) was developed by [10]. In general, items have an acceptable fit if their MNSQ values are within the range of 0.6 to 1.4 and all items are within the acceptable range.

D. Data Analysis

The questionnaire in this study had a scale for each statement that included five possible responses (I can't do this at all, I can't do this, Maybe I can do this, I can do this, I can do this easily). The version of the Self-Efficacy towards science scale used included ratings for items in each aspect, including the first aspect of Identifying and Remembering in questions Q1 - Q7, the second aspect of Explaining and Applying in questions Q8 - Q15, the third aspect of Questioning and Arguing in questions Q16 - Q20 and the fourth aspect of Innovative Design in questions Q21 - Q24. Data were analyzed using SPSS ver 20 by calculating the average of all scores (1.00-1.50 very low, 1.51-2.50 low, 2.51-3.50 medium, 3.51-4.50 high, 4.51-5.00 very high) [28]. In data analysis with SPSS ver 20, the sig value of 0.05 is considered the significance level in interpreting the results. First, the normality of the data distribution was checked, and the data were organized. The data did not have a normal distribution according to the group; therefore, a non-parametric test, namely the Kruskal-Wallis Test, was carried out for data analysis. The Kruskal-Wallis test was used to test the data to determine whether there was a significant difference in the mean self-efficacy scores towards science based on grade levels 7, 8, and 9.

III. RESULTS AND DISCUSSION

1. How is self-efficacy in science among junior high school students?

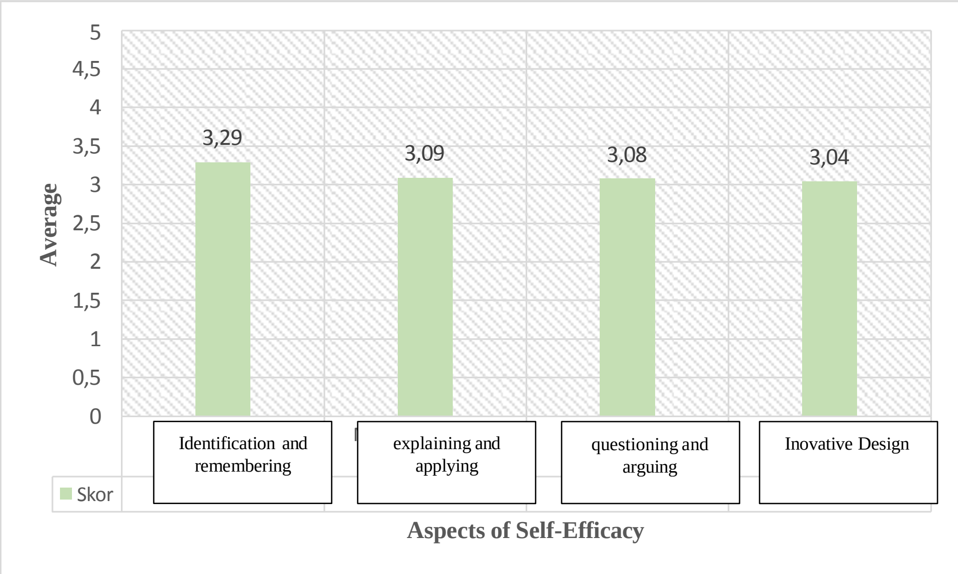

Fig. 1. Average score of Self-efficacy in Four Aspects

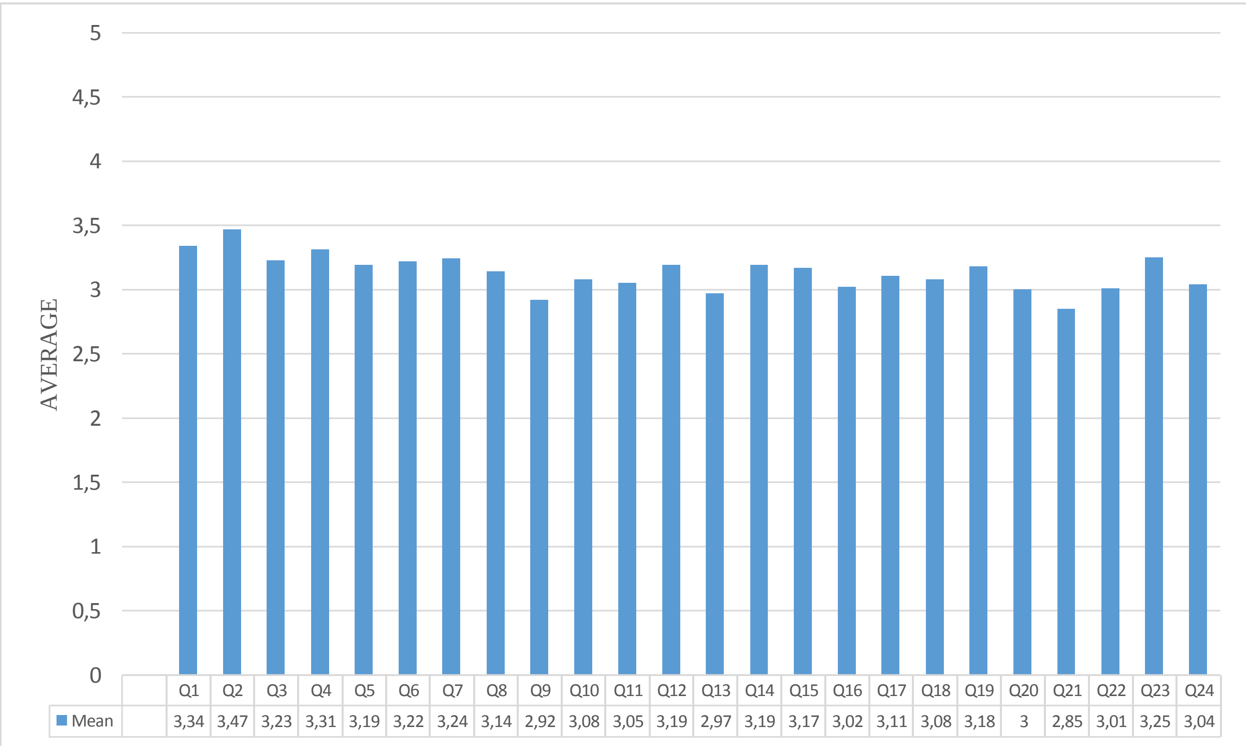

Fig. 2. Average score of Self-Efficacy per Item

Based on the SSES questionnaire survey of students' self-efficacy towards science learning in junior high schools, it can be seen in chart 1 that the identification and recall aspects have the highest average score compared to other aspects, namely 3.29, and the innovative design aspect has the lowest average of 3.04. Chart 2 contains the overall SSES score from each question item with an average of 3.14, meaning that self-efficacy towards science is in the moderate category (2.51-3.50). According to [10], the higher the level of the task given, the higher the self-efficacy as shown in Figure 3.

Fig. 3. Theory of Science Self-efficacy scale

The identification and recall aspects are at level 1, meaning learners are more confident in remembering and identifying concepts. According to [29], one aspect of efficacy is magnitude, which is a dimension of efficacy related to the level of task difficulty. Individuals will tend to prefer tasks that are difficult and in accordance with their abilities. In addition, there are also aspects of generality related to the belief in completing the task thoroughly and well..

Open-ended questions applied in this study are student' opinions about what makes them confident or less confident when learning science.

Question 1: What makes you confident when learning science?
Student 1: "The teacher who guides makes it easy for me to learn about science easily, and maybe some things I know about the material being taught make it easier for me to understand."
Student 2: "I am sure that I can understand or even re-explain about science learning that is most widely used in everyday life in my own language. Learning science by directly practising, testing, and modelling it will make me more active and can increase my confidence."

Student 1 shows external factors, namely that he becomes confident in learning science because of the teacher's guidance, which makes him more confident and easy to understand. Student 2 shows internal factors; he believes in his ability to complete a certain task through learning experiences that increase his confidence.

This is in accordance with [29] statement that self-efficacy is formed by cognitive processes and interactions between experience, mastery, social persuasion and physiological and affective states [10]

SSES is divided into four aspects: identification and recall, explaining and applying, questioning and arguing, and innovative design. Descriptive statistics of SSES scores on identification and recall aspects based on the SSES questionnaire survey are listed in Table 3.

Table 3. Descriptive statistics of SSES scores on aspects of identification and remembering

	N	Minimum	Maximum	Mean	Std. Deviation
IM1	331	1	5	3,34	,801
IM2	331	1	5	3,47	,752
IM3	331	1	5	3,23	,769
IM4	331	1	5	3,31	,745
IM5	331	1	5	3,19	,798
IM6	331	1	5	3,22	,772
IM7	331	1	5	3,24	,756
Valid N (listwise)	331			Avg 3,29	

Table 3 shows the mean and standard deviation of science self-efficacy of junior high school students in the aspects of identification and recall. Table 5 shows that the average score obtained in this aspect is 3.29, and the points Q1, Q2, and Q4 are above average. These results indicate that students' science self-efficacy level is moderate, especially when recognizing information from text, images, graphs, and tables, observing a phenomenon, and recognizing basic relationships between things and concepts already known. Then, points Q3, Q5, Q6, and Q7 are below average. This shows that students, in terms of memorizing concepts, principles, formulas, or equations and accurately describing observed information, identifying similarities, and classifying science concepts, are not as confident in recognizing and observing information. Then, the descriptive statistics of SSES scores on the aspects of explaining and applying are listed in Table 4.

Table 4. Descriptive statistics of SSES scores on the aspects of explaining and applying

	N	Minimum	Maximum	Mean	Std. Deviation
MM1	331	1	5	3,14	,824
MM2	331	1	5	2,92	,854
MM3	331	1	5	3,08	,851
MM4	331	1	5	3,05	,813
MM5	331	1	5	3,19	,762
MM6	331	1	5	2,97	,810
MM7	331	1	5	3,19	,714
MM8	331	1	5	3,17	,809
Valid N (listwise)	331			Avg 3,08	

Table 4 shows the mean and standard deviation of science self-efficacy of junior high school students in the aspects of explaining and applying. Table 6 shows the results, showing that the average score obtained in this aspect is 3.08, and it can be seen that points Q8, Q12, Q14, and Q15 are above average. These results indicate that students' science self-efficacy level is moderate, especially when using scientific principles to explain phenomena, understand and interpret existing models, predict new knowledge based on relationships between concepts, and using scientific principles to make simple judgments. This means that based on the results at points Q9, Q10, Q11, and Q13, students are not confident enough to calculate and compare unknown variables according to data, interpret objectives, explain examples, and predict experimental phenomena based on scientific principles. This is in line with [29], the experience of mastering something strongly influences self-efficacy because the experience of success can increase the expectation of self-ability. Descriptive statistics of SSES scores on the aspects of asking and arguing are listed in Table 5.

Table 5. Descriptive statistics of SSES scores on questioning and arguing aspects

	N	Minimum	Maximum	Mean	Std. Deviation
BB1	331	1	5	3,02	,770
BB2	331	1	5	3,11	,784
BB3	331	1	5	3,08	,786
BB4	331	1	5	3,18	,735
BB5	331	1	5	3,00	,765
Valid N (listwise)	331			Avg 3,08	

Table 5 shows the mean and standard deviation of junior high school students' science self-efficacy in the aspect of asking and arguing. Table 7 shows the results, showing that the average score obtained in this aspect is 3.08, and it can be seen that points Q17 and Q19 are above average. These results indicate that the level of science self-efficacy of students is at a moderate level, especially at the point of obtaining evidence from facts, proving hypotheses based on evidence, and carrying out a complete and systematic investigation to solve problems. Then, at points Q16, Q18, and Q20, scores equal to or below the average are obtained. It shows that students are not more confident in evaluating and explaining various differences in assumptions, selecting and integrating appropriate tools for scientific explanation, proposing one or more series of research programs, and designing. According to [29], one of the factors of self-efficacy is strength, which refers to the behavior needed to complete the task at hand when needed. Whether or not strong belief in one's abilities will affect one's efforts to face difficulty completing a task. Descriptive statistics of SSES scores on innovative design aspects are listed in Table 6.

Table 6. Descriptive statistics of SSES scores on innovative design aspects

	N	Minimum	Maximum	Mean	Std. Deviation
DI1	331	1	5	2,85	,791
DI2	331	1	5	3,01	,833
DI3	331	1	5	3,25	,794
DI4	331	1	5	3,04	,754
Valid N (listwise)	331			Avg 3,04	

Table 6 shows the mean and standard deviation of junior high school students' science self-efficacy in the innovative design aspect. Table 6 shows that the average score obtained in this aspect is 3.04, which can be seen only at point Q23, which is above the average. These results indicate that the level of science self-efficacy of students is at a moderate level, especially in identifying problems in everyday life and using science to design solutions. Then, at other points, namely Q21, Q22, and Q24, they get a score equal to or below the average. This shows that learners are less confident in terms of designing science and technology programs by considering the pros and cons, identifying defects in science equipment and using practical designs to fix them, and designing and completing appropriate technology products. Since mastery experience is the most prominent source of self-efficacy as it relates to the self-interpretation of previous performance [29], [30] Therefore, point Q23 has a higher score in relation to daily life experiences.

2. Is there a significant difference in self-efficacy among 7th, 8th, and 9th grade students?

For the second research question, the researcher investigated whether there is a significant difference in self-efficacy towards learning science between grade 7, grade 8, and grade 9 in junior high school using descriptive statistical analysis and the Kruskal-Wallis test. Table 7 shows self-efficacy towards learning science in junior high school based on the mean and standard deviation scores.

Table 7. Descriptive Statistics of SSES scores based on values

Grade	**N**	**(*Mean*)**	**SD**
7	213	3,14	0,77
8	78	3,20	0,77
9	40	2,90	0,80
Average		3,08	0,78

This shows that the sample consisted of 231 grade 7 students, 78 grade 8 students, and 40 grade 9 students. The highest average score was found in grade 8, which amounted to 3.20 and the total average of the three grade levels was 3.08. The data in Table 7 shows that each grade level's average self-efficacy score differs. This follows previous research revealed that self-efficacy can change and changes can be triggered through certain learning programs [8], [12], [13]. Considering the current curriculum in Indonesia, the higher the grade level, the more complex the subject matter and tasks received by students become one factor that influences changes in self-efficacy of science learning in junior high school. The results of the Kruskal-Wallis Test of participants' SSES scores based on class are listed in Table 8 below.

Table 8. Kruskal-Wallis Test Results (Mean Rank) participants' SSES scores by class

	Grade	N	Mean Rank
IM	7	213	168,66
	8	78	176,96
	9	40	130,44
	Total	331	
MM	7	213	167,77
	8	78	184,42
	9	40	120,69
	Total	331	
BB	7	213	171,17
	8	78	174,55
	9	40	121,80
	Total	331	
DI	7	213	165,06
	8	78	183,54
	9	40	136,79
	Total	331	

Table 8 shows the mean rank results for each grade in each aspect. It can be seen that grade 8 obtained the highest mean rank in each aspect, while grade 9 obtained lower scores in all aspects. Then, the results of the Kruskal-Wallis Test (significant differences) of participants' SSES scores by class are listed in Table 9.

Table 9. Kruskal-Wallis Test Results (Significant Difference) SSES scores of participants by grade

	IM	MM	DI
Chi-Square	6,798	12,040	6,607
df	2	2	2
Asymp. Sig.	,033	,002	,037

Table 9 shows the results of the Kruskal-Wallis test that the Asymp.Sig. value is 0.002-0.037, so there is a significant difference in self-efficacy for science between grades 7, 8, and 9. In the first year of schooling, students have confidence in themselves but tend to be more doubtful about their abilities in the following years of education [31]. This is in accordance with previous research conducted at the high school level, which shows a more obvious increase in self-efficacy in science from grade 10 to grade 11, while from grade 11 to 12 shows a more obvious decrease in self-efficacy [10]. The difficulty level of science tasks influences self-efficacy in science and shows the obstacles or challenges students face to achieve success [6]. According to [32], the difficulty of science tasks is influenced by cognitive processes. Therefore, the low scores obtained by grade 9 can be influenced by the difficulty of the tasks received at their level.

To further explain why there can be differences in self-efficacy, an open question was applied to this study: the learners' opinion about what makes them confident (confident) or less confident when learning science.

Question 2: What makes you less confident (not confident) when learning science?
Student 1: "I find it difficult to understand science materials and questions."
Student 2: "I don't understand formulas"
Student 3: "I am confused and hesitant in doing exam questions"

Based on the answers to these open questions, most 9th-grade students have more difficulty in learning science. In addition, according to [10], the reason for this significant difference in self-efficacy for science may be the influence of the curriculum and the experience of students with different curricula. The Indonesian curriculum used by grades 7 and 8 is currently the independent curriculum, while grade 9 still uses the previous curriculum, namely the 2013 curriculum. The independent curriculum emphasizes learner engagement and allows learners to experience inquiry through creative thinking and critical thinking to strengthen their attention to learning. This experience is one of the important sources of self-efficacy [29]. In addition, learning inquiry and critical thinking encourage the development of self-efficacy in science, which has provided much empirical evidence in previous studies [19].

IV. CONCLUSION

The total average of the four aspects of science self-efficacy is 3.14, which means it is in the moderate category. Self-efficacy towards science learning shows that class 8 has the highest IPA self-efficacy with an average of 3.20, followed by class 7 at 3.14 and class 9 at 2.90. There is a significant difference in the value of self-efficacy toward science in grades 7, 8, and 9. This can be seen from the results of the highest mean rank obtained by grade 8, which is quite far from the mean rank obtained by grade 9. Significant differences in self-efficacy towards science occur due to differences in science learning experiences at each grade level. The middle school period is the point and key to fostering, measuring, and evaluating students' self-efficacy towards science learning. Therefore, in future studies, researchers should increase the number and range of samples so that the self-efficacy of science in Indonesia is more highlighted and observed. They should also look for solutions that can increase self-efficacy for science in junior high school.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to Mr. Nanang Winarno for his invaluable support and contribution to the successful implementation of this research/article. His generosity, insights, and commitment have played a crucial role in making this work possible. I deeply appreciate his unwavering dedication, which significantly enhanced the quality and depth of this study.

Furthermore, I extend my heartfelt thanks to the research funders and all other parties who contributed their resources, expertise, and time to this endeavor. Your support has been instrumental in facilitating this work, and I am truly grateful for your collaboration.

Thank you once again for your support and belief in this project..

REFERENCES

[1] B. Thomas and J. J. Watters, “Perspectives on Australian, Indian and Malaysian approaches to STEM education,” *Int. J. Educ. Dev.*, vol. 45, pp. 42–53, Nov. 2015, doi: 10.1016/j.ijedudev.2015.08.002.

[2] C. J. Ballen, C. Wieman, S. Salehi, J. B. Searle, and K. R. Zamudio, “Enhancing diversity in undergraduate science: self-efficacy drives performance gains with active learning,” *CBE Life Sci. Educ.*, vol. 16, no. 4, Dec. 2017, doi: 10.1187/cbe.16-12-0344.

[3] R. L. Lamb, D. Vallett, and L. Annetta, "Development of a short-form measure of science and technology self-efficacy using rasch analysis," *J. Sci. Educ. Technol.*, vol. 23, no. 5, pp. 641–657, Oct. 2014, doi: 10.1007/s10956-014-9491-y.

[4] K. A. Blotnicky, T. Franz-Odendaal, F. French, and P. Joy, "A study of the correlation between STEM career knowledge, mathematics self-efficacy, career interests, and career activities on the likelihood of pursuing a STEM career among middle school students," *Int. J. STEM Educ.*, vol. 5, no. 1, 2018, doi: 10.1186/s40594-018-0118-3.

[5] J. A. Baldwin, D. Ebert-May, and D. J. Burns, "The Development of a College Biology Self-Efficacy Instrument for Nonmajors."

[6] "Self Efficacy Belief of Adolescent".

[7] L. V. Charleston and R. Leon, "Constructing self-efficacy in STEM graduate education," *J. Multicult. Educ.*, vol. 10, no. 2, pp. 152–166, Jun. 2016, doi: 10.1108/JME-12-2015-0048.

[8] L. Ainscough *et al.*, "Changes in biology self-efficacy during a first-year university course," *CBE Life Sci. Educ.*, vol. 15, no. 2, Jun. 2016, doi: 10.1187/cbe.15-04-0092.

[9] R. D. Robnett, M. M. Chemers, and E. L. Zurbriggen, "Longitudinal associations among undergraduates' research experience, self-efficacy, and identity," *J. Res. Sci. Teach.*, vol. 52, no. 6, pp. 847–867, Aug. 2015, doi: 10.1002/tea.21221.

[10] X. Hu, Y. Jiang, and H. Bi, "Measuring science self-efficacy with a focus on the perceived competence dimension: using mixed methods to develop an instrument and explore changes through cross-sectional and longitudinal analyses in high school," *Int. J. STEM Educ.*, vol. 9, no. 1, 2022, doi: 10.1186/s40594-022-00363-x.

[11] Y. Y. Lu, T. J. Smith, Z. R. Hong, H. shyang Lin, and W. Y. Hsu, "Exploring the relationships of citizens' scientific interest and self-understanding to their learning enjoyment and self-efficacy in science," 2023. doi: 10.1007/s12144-022-02785-w.

[12] B. W. Bergey, D. J. Ketelhut, S. Liang, U. Natarajan, and M. Karakus, "Scientific Inquiry Self-Efficacy and Computer Game Self-Efficacy as Predictors and Outcomes of Middle School Boys' and Girls' Performance in a Science Assessment in a Virtual Environment," 2015. doi: 10.1007/s10956-015-9558-4.

[13] V. W. Vongkulluksn, A. M. Matewos, G. M. Sinatra, and J. A. Marsh, "Motivational factors in makerspaces: a mixed methods study of elementary school students' situational interest, self-efficacy, and achievement emotions," 2018. doi: 10.1186/s40594-018-0129-0.

[14] L. M. Mataka and M. G. Kowalske, "The influence of PBL on students' self-efficacy beliefs in chemistry," *Chem. Educ. Res. Pract.*, vol. 16, no. 4, pp. 929–938, 2015, doi: 10.1039/c5rp00099h.

[15] H. Semilarski, R. Soobard, J. Holbrook, and M. Rannikmäe, "Expanding disciplinary and interdisciplinary core idea maps by students to promote perceived self-efficacy in learning science," 2022. doi: 10.1186/s40594-022-00374-8.

[16] V. K. Kolil, S. Muthupalani, and K. Achuthan, "Virtual experimental platforms in chemistry laboratory education and its impact on experimental self-efficacy," *Int. J. Educ. Technol. High. Educ.*, vol. 17, no. 1, Dec. 2020, doi: 10.1186/s41239-020-00204-3.

[17] Y. L. Wang and C. C. Tsai, "Taiwanese students' science learning self-efficacy and teacher and student science hardiness: a multilevel model approach," *Eur. J. Psychol. Educ.*, vol. 31, no. 4, pp. 537–555, Oct. 2016, doi: 10.1007/s10212-015-0285-2.

[18] R. C. H. Chan, "A social cognitive perspective on gender disparities in self-efficacy, interest, and aspirations in science, technology, engineering, and mathematics (STEM): the influence of cultural and gender norms," 2022. doi: 10.1186/s40594-022-00352-0.

[19] M. Jansen, R. Scherer, and U. Schroeders, "Students' self-concept and self-efficacy in the sciences: Differential relations to antecedents and educational outcomes," *Contemp. Educ. Psychol.*, vol. 41, pp. 13–24, Apr. 2015, doi: 10.1016/j.cedpsych.2014.11.002.

[20] R. A. M. Ambiel and A. P. P. Noronha, "Professional choice self-efficacy: Predicting traits and personality profiles in high school students," *Psicol. Reflex. e Crit.*, vol. 29, no. 1, 2016, doi: 10.1186/s41155-016-0021-0.

[21] T. J. Lin and C. C. Tsai, "Differentiating the Sources of Taiwanese High School Students' Multidimensional Science Learning Self-Efficacy: An Examination of Gender Differences," 2018. doi: 10.1007/s11165-016-9579-x.

[22] J. Webb-Williams, "Science Self-Efficacy in the Primary Classroom: Using Mixed Methods to Investigate Sources of Self-Efficacy," *Res. Sci. Educ.*, vol. 48, no. 5, pp. 939–961, Oct. 2018, doi: 10.1007/s11165-016-9592-0.

[23] H. N. J. Ho, J. C. Liang, and C. C. Tsai, "The Interrelationship Among High School Students' Conceptions of Learning Science, Self-Regulated Learning Science, and Science Learning Self-

Efficacy," 2022. doi: 10.1007/s10763-021-10205-x.
[24] P. Mutiara Meidayanti, A. Hidayat, and P. Mutiara Meidayanti Pendidikan Fisika, "Analisis Efikasi Diri Siswa pada Pembelajaran Sains Berdasarkan Kuesioner yang Dikembangkan Lin dan Tsai," 2019. [Online]. Available: http://journal.um.ac.id/index.php/jptpp/
[25] E. R. Jurnal Penelitian Pendidikan ; Siregar, R. Asyhar, and Z. Zurweni, "Pengaruh Model Discovery Learning dan Efikasi Diri Terhadap Ketermpilan Literasi Sains Siswa," *J. Penelit. Pendidikan, Psikol. dan Kesehat. (J-P3K*, vol. 4, no. 1, pp. 10–16, 2023, doi: 10.51849/j-p3k.v4i1.196.
[26] "survey method".
[27] "pdf-james-h-mcmillan-sally-schumacher-research-in-education-evidence-based-inquiry-pearson-2013_compress".
[28] T. Manakul, A. Somabut, and K. Tuamsuk, "Smart teaching abilities of junior high school teachers in Thailand," *Cogent Educ.*, vol. 10, no. 1, 2023, doi: 10.1080/2331186X.2023.2186009.
[29] "Bandura, A. (1997). Self-efficacy The exercise of control. New York W.H. Freeman".
[30] F. Pajares, S. L. Britner, and G. Valiante, "Relation between Achievement Goals and Self-Beliefs of Middle School Students in Writing and Science," *Contemp. Educ. Psychol.*, vol. 25, no. 4, pp. 406–422, 2000, doi: 10.1006/ceps.1999.1027.
[31] C. Freedman-Doan, A. Wigfield, J. S. Eccles, P. Blumenfeld, A. Arbreton, and R. D. Harold, "What Am I Best At? Grade and Gender Differences in Children's Beliefs About Ability Improvement," *J. Appl. Dev. Psychol.*, vol. 21, no. 4, pp. 379–402, 2000.
[32] H. Rindermann, "The g-factor of international cognitive ability comparisons: The homogeneity of results in PISA, TIMSS, PIRLS and IQ-tests across nations," *Eur. J. Pers.*, vol. 21, no. 5, pp. 667–706, Aug. 2007, doi: 10.1002/per.634.