JPPIPA 9(Special Issue) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Factors Affecting Junior High School Students' 4C Skills: An Empirical Study

Dwi Anggraini Harita Putri[1*], Usmeldi[2]

[1] Magister of Physics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Indonesia.
[2] Electrical Engineering Department, Faculty of Engineering, Universitas Negeri Padang, Padang, Indonesia.

Received: October 22, 2023
Revised: November 29, 2023
Accepted: December 25, 2023
Published: December 31, 2023

Corresponding Author:
Dwi Anggraini Harita Putri
dwianggrainihp@gmail.com

DOI: 10.29303/jppipa.v9iSpecialIssue.5793

Abstract: The purpose of this research is to find out factors that can affecting Junior High School Students' 4C Skills such as self-efficacy, learning motivation, liveliness, mathematical literacy, and scientific literacy can significantly influence students' 4C skills. This study is quantitative research using a survey method. In addition, the effect of each construct on the 4C skills is estimated through the Partial Least Square Structural Equation Model (PLS-SEM). The research results show that self-efficacy, scientific literacy, learning motivation and activeness have a significant effect on 4C skills. Mathematical literacy does not have a significant effect on 4C skills, but scientific literacy has a mediating effect on the relationship between mathematical literacy and 4C skills. Therefore, it is expected that students will further improve their skills in realizing the demands of globalization.

Keywords: Factors Affecting; Junior High School; Students' 4C Skills

Introduction

The industrial revolution 4.0 and the rapid development of technology have an impact on the provision of education in the 21st century, making life full of challenges and competition. Challenges in the 21st century are that humans are required to master technology more and have innovative and characteristic skills (Mardhiyah et al., 2021; Mukaromah, 2020). These changes aim to improve the quality of life of modern society by creating human resources with skills in various fields, including education (Pratiwi et al., 2019; Hasibuan & Prastowo, 2019; Sole & Anggraeni, 2018).

In the world of education, the challenge of the 21st century is to educate students to have various abilities to compete in filling the job market (Malik et al., 2019). 21st century learning requires students to be more active in learning than teachers, and to have learning abilities and various skills (Pratama et al., 2022; Tanti et al., 2020). The 21st century challenge capabilities include thinking, working, and living skills in the surrounding environment which combine cognitive, affective, and psychomotor skills and can use ICT (Yulkifli et al., 2019; Meilani et al., 2020). These 21st century skills are often referred to as 4C skills, namely critical thinking, creative thinking, communication, and collaboration (Meilani et al., 2020; Pramudita et al., 2021).

In fact, the 4C skills of students are still in the low category and need to be improved (Anggreni & Yohandri, 2022; Darmuki et al., 2022; Syahputra et al., 2022). This agrees with the TIMMS and PISA results showing that the ability to think both mathematically and scientifically as well as problem-solving in Indonesia is still relatively low (Abdiyani et al., 2019; Siregar, 2023). Based on TIMSS 2015, the ranking of Indonesian students shows that the mathematics results are ranked 44 out of 49 countries with a score of 397 and science is ranked 45 out of 48 countries with a score of 397, while the 2018 PISA ranking of Indonesian students shows that the results for mathematical literacy are ranked 72 out of 78 countries with a score of 379 and scientific literacy is ranked 70 out of 78 countries with a score of 396 (IEA, 2016; OECD, 2019). 4C competence can be achieved through an effective, continuous learning process that involves the active participation of students (Ropii et al., 2019).

How to Cite:
Putri, D.A.H., & Usmeldi, U. (2023). Factors Affecting Junior High School Students' 4C Skills: An Empirical Study. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 1089–1101. https://doi.org/10.29303/jppipa.v9iSpecialIssue.5793

To achieve skilled learners in 4C, many factors need to be met. Based on research of Akmam et al., (2019), states that the factors that can affect students' 4C skills are learning motivation, interest in learning, curiosity, self-confidence, self-efficacy, persistence, emotional understanding, strategies used by educators, literacy both reading, mathematics or science, activeness, study time and work on questions, and learning resources used (Adair & Jaeger, 2015; Fernández-García & Fonseca-Mora, 2022; Ismail et al., 2022; Nahar et al., 2022; Zahranie et al., 2020; Indrawati et al., 2019). If these factors are implemented properly, it will produce students who are ready and skilled in 4C to face the demands of 21st century educational skills. Much research has been conducted to analyze the relationship between self-efficacy, mathematical literacy, scientific literacy, motivation and student activity towards 4C skills, but there is no research design that produces theoretical relationships and provides a complete picture of the relationship between these variables.

The purpose of this empirical research is to find out how self-efficacy, learning motivation, activeness, mathematical literacy, and scientific literacy can significantly influence students' 4C skills. The theoretical model to determine the constructs that affect students' 4C skills is the partial least squares structural equation model (PLS-SEM). In this model, there are 15 proposed hypotheses. The results of this study can be used for further research to determine other variables that affect students' 4C skills.

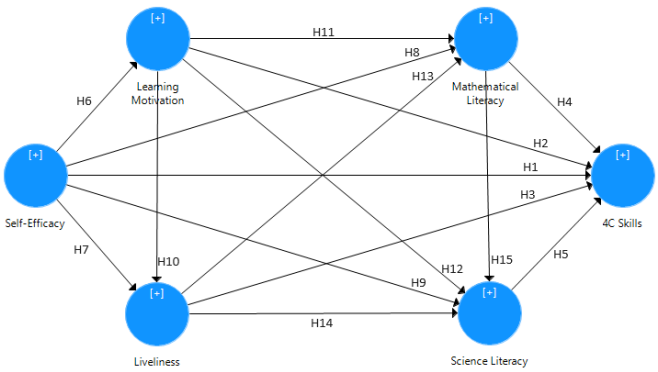

Figure 1. The proposed theoretical model.

H1 : Self-efficacy has a significant effect on student 4C skills
H2 : Learning motivation has a significant effect on student 4C skills
H3 : Liveliness has a significant effect on student 4C skills
H4 : Mathematical literacy has a significant effect on student 4C skills
H5 : Scientific literacy has a significant effect on student 4C skills
H6 : Self-efficacy has a significant effect on student learning motivation
H7 : Self-efficacy has a significant effect on student liveliness
H8 : Self-efficacy has a significant effect on student mathematical literacy
H9 : Self-efficacy has a significant effect on student scientific literacy
H10 : Learning motivation has a significant effect on student liveliness
H11 : Learning motivation has a significant effect on student mathematical literacy
H12 : Learning motivation has a significant effect on student scientific literacy
H13 : Student liveliness has a significant effect on student mathematical literacy
H14 : Student liveliness has a significant effect on student scientific literacy
H15 : Mathematical literacy has a significant effect on student scientific literacy

Method

This study uses a survey method that aims to describe a model that measures the 4C skills with 5 exogenous variables: self-efficacy, learning motivation, liveliness, mathematical literacy, and scientific literacy. Research flow can be seen in Figure 2. Students' 4C skills are measured through a survey designed in February 2023. There are 26 indicators from the survey and test results using a 1-4 likert scale adapted in previous research. The indicators are divided into six variables; self-efficacy, learning motivation, liveliness, mathematical literacy, scientific literacy, and 4C skills (Table 1).

Table 1. Experimental Design (Bandura et al., 1999; Greenstein, 2012; Nofrion, 2018; OECD, 2016; Rikawati & Sitinjak, 2020; Treffinger et al., 2002; Uno, 2014)

Construct	Item	Indicators
Self-efficacy	SE1	Belief in something untried
	SE2	Faced with a difficult task
	SE3	Consistent on task
	SE4	Readiness for the situation
	SE5	Endurance and persistence in facing the task
	SE6	Previous successful experience
Learning motivation	LM1	There is desire and desire to succeed
	LM2	There is a drive and need for learning
	LM3	There are hopes and aspirations for the future
	LM4	There is an appreciation for learning
	LM5	There are interesting activities for learning
	LM6	There is a conducive learning situation
Liveliness	L1	Enthusiastic in participating in learning
	L2	Dare to ask during the learning process
	L3	Dare to answer the questions asked

Construct	Item	Indicators
	L4	Dare to convey the results of their understanding in front of the class
	ML1	Formulate real problems in problem-solving
Mathematical literacy	ML2	Using mathematics in problem-solving
	ML3	Interpret solutions in problem-solving
Scientific literacy	CL1	Science context
	CL2	Science content
	CL3	Process science
	C1	Critical thinking skills
4c skills	C2	Creative thinking skills
	C3	Collaboration skills
	C4	Communication skills

The survey was validated by the lecturers at master of Physics Education, physics department, Universitas Negeri Padang. The sample in this study was all students at three SMP Negeri in Padang with different accreditation A, B, and C considerations totaling 260 students. The data obtained in this study are from questionnaires and tests. Questionnaires were distributed via google forms while tests were distributed directly to students. Respondent identification can be seen in Table 2.

Table 2. Respondent Characteristic

Respondent characteristic		Frequency	Percentage (%)
Gender	Female	137	52.69
	Male	123	47.31
	Total	260	100.00
School name	Junior High School 8 Padang	138	53.08
	Junior High School 41 padang	69	26.54
	Junior High School 42 padang	53	20.38
Total		260	100.00

Table 2 shows that the number of female respondents is greater than that of males. Then, based on schools, the majority of respondents came from Junior High School 8 Padang. The second largest number of respondents came from Junior High School 42 Padang, and the last was Junior High School 41 Padang. Data are processed using SmartPLS SEM because the sample size is relatively small, or ten times as many indicators used (Hair et al., 2017; Hair et al., 2023).

To investigate the proposed hypothesis in a theoretical model, partial least squares structural equations have been used. The most significant impact on students' 4C skills will come from the results of PLS-SEM, which made predictions about construction. The PLS-SEM consists of two parts that can be seen in Table 3, which make up the estimation process (Cepeda-Carrion et al., 2019; Ghozali, 2008; J. F. Hair et al., 2017).

Table 3. Estimation Process in PLS-SEM

Measurement Model Evaluation	Structural Model Evaluation
Consistency reliability: Cronbach's alpha (α) and consistency reliability (CR) of 0.7	R square: model predictions are weak (0.25), moderate (0.5), and strong (0.75).
Convergent validity: outer loading 0.7 and average variance extracted (AVE) 0.5.	Path coefficient: If p-value < 0.05 the hypothesis is accepted and significant.
Discriminant validity: heterotrait-monotrait ratio (HTMT) < 0.9	Q square: has a predictive model relevance if Q square > 0, weak (0), moderate (0.25), and large (0.5).
	Effect size (f^2): the effect of exogenous to endogenous constructs if f^2 0.02, 0.15, and 0.35 have small, medium, and large effects.

Figure 2. Research Design

Result and Discussion

Measurement Model Evaluation: Smart PLS-SEM

All constructs of the developed model meet the criteria of internal consistency, convergent validation (Table 4), and discriminant (Table 5). The final theoretical model is shown in Figure 3.

Based on Figure 3 shows that that all indicators have an α value ≥ 0.7, meaning that the indicators can measure what they want to measure in each variable. Or it could be said that each indicator in the instrument is valid and can be used. There are 4 path coefficient values out of 15 relationships that are negative. The negative sign on the path coefficient value means that the relationship formed is in the opposite direction

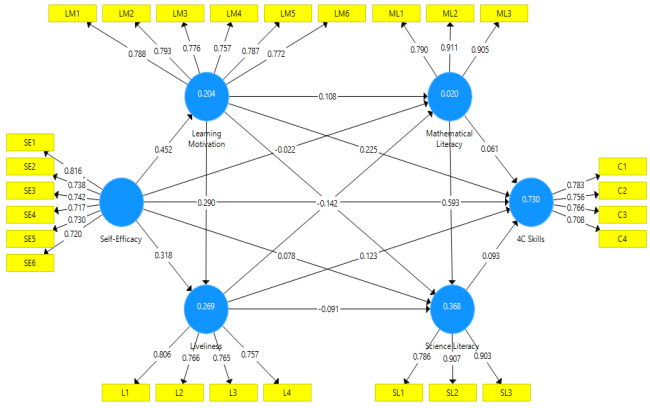

Figure 3. Structural Model Result

Table 4. Consistency Reliability and Covergent Validity

Construct	Item	Consistency reliability		Convergent validity	
		Cronbach alpha α ≥ 0.7	Composite reliability CR ≥ 0.7	Outer loadings ≥ 0.7	AVE ≥ 0.5
Self-efficacy	SE1	0.83	0.88	0.81	0.55
	SE2			0.73	
	SE3			0.74	
	SE4			0.71	
	SE5			0.73	
	SE6			0.72	
Learning motivation	LM1	0.87	0.90	0.78	0.60
	LM2			0.79	
	LM3			0.77	
	LM4			0.75	
	LM5			0.78	
	LM6			0.77	
Liveliness	L1	0.77	0.85	0.80	0.59
	L2			0.76	
	L3			0.76	
	L4			0.75	
Mathematical literacy	ML1	0.84	0.90	0.79	0.75
	ML2			0.91	
	ML3			0.90	
Scientific literacy	SL1	0.83	0.90	0.78	0.75
	SL2			0.90	
	SL3			0.90	
4C	C1	0.75	0.84	0.78	0.56
	C2			0.75	
	C3			0.76	
	C4			0.70	

Table 5. Heterotrait-monotrait ratio (HTMT)

	4C skills	Learning motivation	Liveliness	Mathematical literacy	Science literacy
Learning motivation	0.67				
Liveliness	0.66	0.49			
Mathematical literacy	0.17	0.11	0.14		
Science literacy	0.18	0.14	0.17	0.68	
Self-efficacy	0.66	0.50	0.54	0.15	0.15

Structural Model Evaluation: Smart PLS-SEM

The results of the path coefficient are shown in Table 6 and Figure 3. It shows that self-efficacy (SE) has the most influence on students' 4C skills. In addition, all other exogenous variables also affect students' 4C skills except for mathematical literacy variables. Four out of ten relationships between exogenous variables result in no influence between these exogenous variables.

Table 6. Bootstrapped Results

Path Analysis	Path Coefficient	T Statistic	P-Value < 0.05	Hypothesis Result
SE → 4C	0.65	16.41	0.00	H1 accepted
LM → 4C	0.22	5.19	0.00	H2 accepted
L → 4C	0.12	3.20	0.00	H3 accepted
ML → 4C	0.06	1.19	0.23	H4 rejected
SL → 4C	0.09	2.02	0.04	H5 accepted
SE → LM	0.45	8.80	0.00	H6 accepted
SE → L	0.32	5.34	0.00	H7 accepted
SE → ML	-0.02	0.28	0.78	H8 rejected
SE → SL	0.08	1.22	0.22	H9 rejected
LM → L	0.29	4.47	0.00	H10 accepted
LM → ML	0.11	1.59	0.13	H11 rejected
LM → SL	-0.03	0.47	0.63	H12 rejected
L → ML	-0.14	2.15	0.03	H13 accepted
L → SL	-0.09	1.46	0.14	H14 rejected
ML → SL	0.59	15.46	0.00	H15 accepted

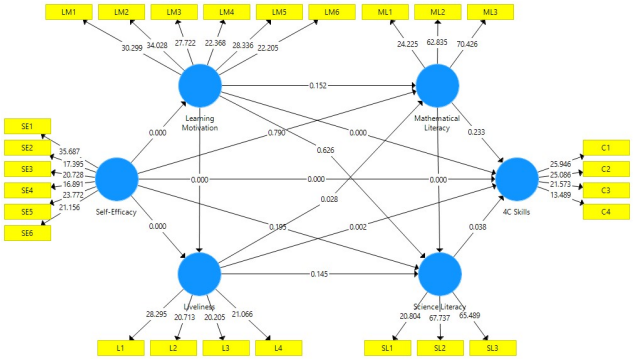

Figure 4. Bootstrapped Result

Table 7. R and Q square

Construct	R square	Category	Q square	Category
Learning motivation	0.20	Weak	0.11	Weak
Liveliness	0.27	Weak	0.15	Weak
Mathematical literacy	0.02	Weak	0.01	Weak
Scientific literacy	0.37	Weak	0.26	Moderate
4C	0.73	Moderate	0.40	Moderate

Figure 4, shows that there are 6 relationships that have a p-value > 0.05, meaning there is no significant influence between these variables. The model's predictive power from exogenous to endogenous constructs can be seen in Table 7. It shows that the 4C skill construct can be explained by the variables of self-efficacy, mathematical literacy, scientific literacy, learning motivation, and liveliness of 0.730 or 73.0%, while the remaining 27.0% is explained by other variables outside the research model. The construct of learning motivation can be explained by 20.4% by the self-efficacy variable, while the remaining 79.6% is explained by other variables outside the research model. The construct of liveliness can be explained by 26.9% by the variable self-efficacy and learning motivation, while the remaining 73.1% is explained by other variables outside the research model. The construct of mathematical literacy can be explained by 2.0% of self-efficacy, learning motivation, and liveliness while the remaining 98.0% is explained by other variables outside the research model. The scientific literacy construct can be explained by 36.8% of the variables of self-efficacy, learning motivation, liveliness, and mathematical literacy while the remaining 63.2% is explained by other variables outside the research model.

The significance of the prediction model (Q^2) for learning motivation (0.112) is weak, liveliness (0.150) is weak, mathematical literacy (0.008) is weak, scientific literacy (0.262) is moderate and 4C skills (0.396) is moderate. It can be concluded that the variables of learning motivation, liveliness, mathematical literacy, scientific literacy, and 4C skills have good observation values because Q > 0. The effect size is based on Table 8 which has the greatest effect is self-efficacy on 4C skills and which has the smallest effect is self-efficacy on mathematical literacy.

The Effect of Self-Efficacy on 4C Skills

H1 is accepted (t = 16.41 > 1.96, p-value < 0.05). This means that self-efficacy has a significant effect on 4C skills. This is in line with previous research which stated that self-efficacy can influence critical thinking skills, creative thinking, communication, and collaboration which are dimensions of the 4C skills (Amirian et al., 2023; Du et al., 2019; Parimita et al., 2020; Wardani et al., 2023; Yulikhah et al., 2019). Self-efficacy is students' belief in themselves which can help students in communicating with their environment. Self-efficacy can influence a student's problem solving (Nur et al., 2023). A person who has high self-efficacy will diligently try to master the learning task compared to students who have low self-efficacy. The higher the self-efficacy of students, the higher the confidence to meet the demands of learning (Agnah et al., 2019). It will have an effect on the ability to think critically, too if students possess high levels of self-efficacy (Umam et al., 2023).

Table 8. F square

Path Analysis	f^2	Category
SE → 4C	1	Large
LM → 4C	0.14	Small
L → 4C	0.04	Small
ML → 4C	0.01	Small
SL → 4C	0.02	Small
SE → LM	0.26	Moderate
SE → L	0.11	Small
SE → ML	0.00	Small
SE → SL	0.01	Small
LM → L	0.09	Small
LM → ML	0.01	Small
LM → SL	0.00	Small
L → ML	0.02	Small
L → SL	0.01	Small
ML → SL	0.55	Large

The Effect of Learning Motivation on 4C Skills

H2 is accepted (t = 5.19 > 1.96, p-value < 0.05). This means that learning motivation has a significant effect on 4C skills (Loes, 2022; Musa, 2019; Sudrajat & Disman, 2021). Motivation is an encouragement that directs students to achieve learning goals that are inside and outside themselves so that they can defend themselves to achieve certain goals. Motivation to learn is one of the important factors in the success of learning (Sari et al., 2021). The higher the learning motivation of students, the higher the 4C skills (Fajari et al., 2020). Bandura states that there is a significant relationship between critical thinking and metacognitive variables, such as

motivation and self-efficacy beliefs. Motivation activates the cognitive resources and conative attitudes that enable individuals to face the challenges inherent in the creative process (Agnoli et al., 2018).

The Effect of Liveliness on 4C Skills

H3 is accepted (t = 3.20 > 1.96, p-value < 0.05). This means that liveliness has a positive effect on 4C skills. Student liveliness is one of the basic elements that are important for the success of the learning process (Asti & Andriyani, 2022). Active students can be formed if teachers improve student involvement through increasing student perceptions. Active learning will bring students to be even better while participating in the learning process which includes cognitive, affective, and psychomotor aspects (Hariandi & Cahyani, 2018).

The Effect of Mathematical Literacy on 4C Skills

H4 is rejected (t = 1.19 < 1.96, p-value > 0.05). This means that mathematical literacy does not significant affect 4C skills. This result is different from previous research which stated that there was a significant influence of mathematical literacy on critical thinking skills, which is one of the indicators of 4C skills (Pambudi et al., 2020). There are external factors that can influence students' 4C skills other than mathematical literacy. Mathematical literacy is an individual's ability to use mathematical concepts, procedures, facts, and mathematical tools to formulate, use, explain, interpret, and predict phenomena in various contexts and situations. Mathematical literacy activity is an activity or activity in formulating, compiling, and interpreting mathematics as the main ability in learning mathematics.

The Effect of Scientific Literacy on 4C Skills

H5 is accepted (t = 2.02 > 1.96, p-value < 0.05). This means that Scientific literacy has a significant effect on 4C skills (Ridzal & Haswan, 2023). Scientific literacy is a need and goal of learning in the 21st century and industrial revolution 4.0 (Izzah, 2023; Nilyani et al., 2023). The importance of thinking and acting skills is highlighted in science literacy. The results of research conducted by Glaze (2018) state that improving scientific literacy skills is not only influenced by the ability to memorize and apply science concepts in class, but is influenced by depth of thinking, understanding of the scientific process of knowledge so that students can find their own concepts by exploring their knowledge, things. This can happen if a person is able to think critically about the knowledge he is dealing with. The weak influence between critical thinking skills and scientific literacy is thought to be caused by students' low interest in reading (Primasari et al., 2020).

The Effect of Self-Efficacy on Learning Motivation

H6 is accepted (t = 8.80 > 1.96, p-value < 0.05). This means that self-efficacy has a significant effect on learning motivation. These results are in line with several studies that state that self-efficacy has a positive and significant effect on learning motivation (Farihah & Rakasiwi, 2020; L. S. Rahayu & Dian, 2022; Wahyuddin, 2022). Self-efficacy is the ability to organize and carry out part of the activities needed to achieve the desired goals. Self-efficacy has a high effect on motivation, effort, choice, and persistence that leads to achieving academic goals (Maraghi et al., 2018). Self-efficacy can provide the basis for human motivation, well-being, and personal achievement and influence the success of the learning process and academic achievement of students (Ibnah & Rosidin, 2018; Yuliyanto et al., 2019). Someone who has high self-efficacy means that person has a plan to deal with the desired goal.

The Effect of Self-Efficacy on Liveliness

H7 is accepted (t = 5.34 > 1.96, p-value < 0.05). This means that self-efficacy has a significant effect on liveliness. These results are in line with studies that state that self-efficacy has a positive and significant effect on learning liveliness (Ridwan et al., 2019). The activeness of students in the learning process is a very important thing to note to obtain optimal goals in the learning process (Prasetya & Harjanto, 2020). To have high liveliness, one must also have high self-efficacy. Self-efficacy can influence a number of individual stress and anxiety experiences such as when individuals engage themselves in an activity. Self-efficacy also influences the choice of activities, goals, and efforts as well as the continuation of actions to achieve certain goals despite obstacles, difficulties, and despair in classroom activities.

The Effect of Self-Efficacy on Mathematical Literacy

H8 is rejected (t = 0.28 < 1.96, p-value > 0.05). This means that self-efficacy does not significant affect mathematical literacy. There are external factors that can influence students' mathematical literacy more than self-efficacy. Mathematical literacy is the ability to understand and utilize the basics of mathematics in everyday life. Mathematical literacy allows individuals to know the function or application of mathematics in everyday life and apply it to make the right decisions as citizens who contribute to development, have empathy and the ability to reflect. One of the personal factors that can cause students' low mathematical literacy is students' self-efficacy (Ananda & Wandini, 2022). Self-efficacy seeks to understand the function of self-control when adjusting thoughts, providing motivation, and supporting oneself, as well as adjusting in the realm of emotional and psychological management. Students who have high self-efficacy can solve a problem with

enthusiasm, tenacity, and courage. Even though someone has good abilities, if he does not have high self-efficacy, good learning results will be difficult to achieve (Andriani et al., 2023).

The Effect of Self-Efficacy on Scientific Literacy

H9 is rejected (t = 1.22 < 1.96, p-value > 0.05). This means that self-efficacy has no significant effect on scientific literacy and there are many external factors that influence scientific literacy. This is different from previous research which states that self-efficacy influences students' scientific literacy (Ozgen, 2013). A high level of self-efficacy will help a person create a feeling of calm when facing difficult problems or activities. Students with high self-efficacy will say that they are able to learn the material given in class and have confidence that they can work well. to improve students' scientific literacy, we need to pay attention to student self-efficacy (Wiarsana, 2020). The existence of differences in background, culture, and conditions of the samples when the research was carried out may also be a factor that causes the hypothesis to be rejected. Another thing that might cause the hypothesis to be rejected is because there are many other factors outside the research model that can have a significant influence on scientific literacy.

The Effect of Learning Motivation on Liveliness

H10 is accepted (t = 4.47 > 1.96, p-value < 0.05). This means that learning motivation has a significant effect on liveliness. In line with previous research which states that learning motivation affects the liveliness of students (Aristya & Darminto, 2019). Student activity in learning is all physical and non-physical activities of students in the process of optimal teaching and learning activities so as to create a conducive classroom atmosphere. Learning motivation and liveliness in the learning process are very important to achieve good learning outcomes (Tegeh et al., 2019). Student active participation is very influential in the process of thinking, emotional, and social development. Some of the efforts that teachers can make in developing student learning activeness in learning are by increasing student interest, arousing student motivation, and using media in learning. Student involvement in learning, makes children actively involved in the learning process.

The Effect of Learning Motivation on Mathematical Literacy

H11 is rejected (t = 1.59 < 1.96, p-value > 0.05). This means that learning motivation does not a significant effect on mathematical literacy. There are external factors that can influence students' mathematical literacy more than learning motivation. Learning motivation is one aspect that can affect students' mathematical communication skills (Aqilah et al., 2021). Learning motivation is one of the most important things to improve mathematical literacy skills. With a student's learning motivation, it will make students more critical in dealing with a problem (Amelia et al., 2023).

The Effect of Learning Motivation on Scientific Literacy

H12 is rejected (t = 0.47 < 1.96, p-value > 0.05). This means that learning motivation does not significant affect scientific literacy. This is in line with other research (Mayasari, 2023) and different from the results of previous research which stated that there was an influence of learning motivation on students' scientific literacy (Jufrida et al., 2019; Syah et al., 2020). This can happen because of the different characteristics of the respondents from previous research and also many other external factors that can affect scientific literacy such as the selection of textbooks, misconceptions, learning that is not contextual, and students' reading abilities (Fuadi et al., 2020). Scientific literacy is a person's ability to apply his knowledge to identify questions, construct new knowledge, provide scientific explanations, draw conclusions based on scientific evidence, and the ability to develop a reflective mindset so that he is able to participate in overcoming issues and ideas related to science.

The Effect of Liveliness on Mathematical Literacy

H13 is accepted (t = 2.15 > 1.96, p-value < 0.05). This means that liveliness affects mathematical literacy and has a significant effect. Mathematical literacy skills help someone to understand the role or use of mathematics in everyday life and use it to make the right decisions. To increase students' mathematical literacy, students are required to be active in learning. The quality of learning will be improved and students' results will be influenced by the existence of proactive activities (Fricticarani & Maksum, 2020). Student liveliness in the learning process can stimulate and develop their talents, students can also practice critical thinking, and can solve problems in everyday life.

The Effect of Liveliness on Scientific Literacy

H14 is rejected (t = 1.46 < 1.96, p-value > 0.05). This means that liveliness does not a significant effect on scientific literacy. This could possibly occur due to differences in background, culture and condition of the samples when the research was carried out. However, mathematical literacy has a mediating effect on the influence of activeness and scientific literacy. These results indicate that mathematical literacy strengthens the relationship between activeness and scientific literacy. In this case, it is concluded that students' scientific literacy depends on scientific literacy which is influenced by mathematical literacy. Literacy skills are very important for various human activities, such as communicating with other people and knowing various information about the occurrence of an event

(Hadiprayitno et al., 2021; Mellyzar et al., 2022; Mulyana & Desnita, 2023). Active participation of students in the learning process will lead to a higher degree of teacher and student interaction, which can be very beneficial for developing knowledge and skills leading to increased achievement (Rahayu et al., 2018; Yasiro et al., 2021).

The Effect of Mathematical Literacy on Scientific Literacy

H15 is accepted ($t = 15.46 > 1.96$, p-value < 0.05). This means that mathematical literacy has a significant effect on scientific literacy. Learning mathematics can encourage students to build a concept which is the basis for solving problems. Someone who has numeracy literacy skills will be able to recognize or understand which mathematical ideas can be used to solve a problem in the daily life they face (Putri et al., 2021). Science learning cannot be separated from numbers and mathematical calculations. To have good scientific literacy skills, someone also needs to have good mathematical literacy skills. Mathematical literacy can influence science learning because mathematical literacy can improve students' ability to make decisions or predict using numbers and symbols in the form of graphs, charts, tables and strengthen the ability to solve problems in everyday life and then analyze them in various forms (Isa et al., 2023; Khakima et al., 2021).

Conclusion

The findings from the PLS-SEM analysis show that the 4C skills are significantly influenced by self-efficacy, learning motivation, liveliness, and scientific literacy. The variable that most influence 4C skills is self-efficacy. Thus, students will be ready to face the demands of the Industrial Revolution 4.0 by thinking critically, developing creative ideas, being able to communicate and work together or collaborate, and learning actively and interactively. The limitation of this research is that it was only conducted in three Junior High Schools Negeri in Padang City, Indonesia. This research also only analyzes five factor variables on 4C skills. Therefore, many other factors can influence the 4C skills beyond the factors in this study.

Acknowledgments

The author thanks the parties, and students from SMPN 8 Padang, SMPN 41 Padang, and SMPN 42 Padang for their assistance in this research. In addition, the author also thanks the lecturers at Padang University who have guided me in compiling this article. The author appreciates the various forms of assistance that have been given to the author to help complete this article.

Author Contributions

Conseptualization idea by D. A. H. P. and U. U. Prepared the research design by D. A. H. P. and U. U. Designed the instrument and drafted the article by AM. Methodology and validation by U. U. Investigation by D. A. H. P. Analyzed the data by D. A. H. P. Resources by D. A. H. P. and U. U. Review and editing by D. A. H. P. and U. U. All authors have read and agreed to published version of the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

No Conflicts of interest.

References

Abdiyani, S. S., Khabibah, S., & Rahmawati, N. D. (2019). Profil Kemampuan Pemecahan Masalah Matematika Siswa SMP Negeri 1 Jogoroto Berdasarkan Langkah-langkah Polya Ditinjau dari Adversity Quotient. *Al-Khwarizmi: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam*, *7*(2), 123–134. https://doi.org/10.24256/jpmipa.v7i2.774

Adair, D., & Jaeger, M. (2015). Cultivation of critical thinking in undergraduate engineering education. *Proceedings of the 43rd SEFI Annual Conference 2015 - Diversity in Engineering Education: An Opportunity to Face the New Trends of Engineering*, SEFI 2015, June. Retrieved from https://research.nu.edu.kz/en/publications/cultivation-of-critical-thinking-in-undergraduate-engineering-edu

Agnah, S. M., Rusdi, R., & Herlanti, Y. (2019). Pengaruh Metode Peta Argumen dan Efikasi Diri terhadap Kemampuan Berpikir Kritis. *Edusains*, *10*(2), 217–225. https://doi.org/10.15408/es.v10i2.7596

Agnoli, S., Runco, M. A., Kirsch, C., & Corazza, G. E. (2018). The Role Of Motivation In The Prediction Of Creative Achievement Inside And Outside Of School Environment. *Thinking Skills and Creativity*, *28*(December 2017), 167–176. https://doi.org/10.1016/j.tsc.2018.05.005

Akmam, A., Anshari, R., Jalinus, N., & Amran, A. (2019). Factors Influencing The Critical And Creative Thinking Skills Of College Students In Computational Physics Courses. *Journal of Physics: Conference Series*, *1317*(1). https://doi.org/10.1088/1742-6596/1317/1/012172

Amelia, I., Pujiastuti, H., Fathurrohman, M., Santosa, C. A. H. F., & Fatah, A. (2023). Systematic Literatur Review: Kemampuan Literasi Matematis Ditinjau dari Motivasi Belajar Matematika. *JIIP - Jurnal Ilmiah Ilmu Pendidikan*, *6*(2), 811–818. https://doi.org/10.54371/jiip.v6i2.1281

Amirian, S. M. R., Ghaniabadi, S., Heydarnejad, T., & Abbasi, S. (2023). The Contribution Of Critical Thinking And Self-Efficacy Beliefs To Teaching Style Preferences In Higher Education. *Journal of Applied Research in Higher Education*, *15*(3), 745–761. https://doi.org/10.1108/JARHE-11-2021-0441

Ananda, E. R., & Wandini, R. R. (2022). Analisis Kemampuan Literasi Matematika Siswa Ditinjau dari Self Efficacy Siswa. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *6*(5), 5113–5126. https://doi.org/10.31004/obsesi.v6i5.2659

Andriani, R., Muhibbudin, Khairil, Safrida, & Pada, A. U. T. (2023). Effect of Implementation of Chat Room-Based Blended Learning on Self-Efficacy and Student Learning Outcomes on Human Movement System Material. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 4535–4543. https://doi.org/10.29303/jppipa.v9i6.3850

Anggreni, Y. D., & Yohandri, Y. (2022). Pengembangan E-book Berbasis Discovery Learning Terintegrasi Keterampilan 4C Untuk Pembelajaran Fisika SMA. *Jurnal Eksakta Pendidikan (Jep)*, *6*(2), 117–127. https://doi.org/10.24036/jep/vol6-iss2/695

Aqilah, Z., Roza, Y., & Maimunah, M. (2021). The Effect Of Student Learning Motivation on MTS Students' Mathematic Communication Ability. *Daya Matematis: Jurnal Inovasi Pendidikan Matematika*, *9*(3), 190. https://doi.org/10.26858/jdm.v9i3.24632

Aristya, N., & Darminto, E. (2019). Faktor-Faktor yang Memengaruhi Keaktifan Belajar Peserta Didik. *Jurnal Bimbingan Konseling UNESA*, *10*(2), 76–81. Retrieved from https://ejournal.unesa.ac.id/index.php/jurnal-bk-unesa/article/view/30472/27781

Asti, P. N. W., & Andriyani. (2022). Peningkatan Kemampuan Berpikir Kritis dan Keaktifan Belajar Materi Statistika Melalui Model Problem Based Learning Berpendekatan STEAM. *Formosa Journal of Sustainable Research*, *1*(2), 133–152. https://doi.org/10.55927/fjsr.v1i2.713

Bandura, A., Freeman, W. H., & Lightsey, R. (1999). Self-Efficacy: The Exercise of Control. In *Journal of Cognitive Psychotherapy* (Vol. 13, Issue 2, pp. 158–166). https://doi.org/10.1891/0889-8391.13.2.158

Cepeda-Carrion, G., Cegarra-Navarro, J. G., & Cillo, V. (2019). Tips to use partial least squares structural equation modelling (PLS-SEM) in knowledge management. *Journal of Knowledge Management*, *23*(1), 67–89. https://doi.org/10.1108/JKM-05-2018-0322

Darmuki, A., Hariyadi, A., & Hidayati, N. A. (2022). Pembelajaran PBL Kolaborasi PjBL untuk Meningkatkan Keterampilan 4C pada Mata Kuliah Pragmatik. *Jurnal Penelitian Dalam Bidang Pendidikan Dan Pengajaran*, *16*(1), 21–27. http://dx.doi.org/10.26877/mpp.v16i1.12050

Du, J., Fan, X., Xu, J., Wang, C., Sun, L., & Liu, F. (2019). Predictors for students' self-efficacy in online collaborative groupwork. *Educational Technology Research and Development*, *67*(4), 767–791. https://doi.org/10.1007/s11423-018-9631-9

Fajari, L. E. W., Sarwanto, & Chumdari. (2020). Student critical thinking skills and learning motivation in elementary students. *Journal of Physics: Conference Series*, *1440*(1). https://doi.org/10.1088/1742-6596/1440/1/012104

Farihah, U., & Rakasiwi, P. (2020). The effect of self efficacy on students' motivation and learning outcome of class 8 in build flat side space material. *Journal of Physics: Conference Series*, *1563*(1). https://doi.org/10.1088/1742-6596/1563/1/012069

Fernández-García, A., & Fonseca-Mora, M. C. (2022). EFL learners' speaking proficiency and its connection to emotional understanding, willingness to communicate and musical experience. *Language Teaching Research*, *26*(1), 124–140. https://doi.org/10.1177/1362168819891868

Fricticarani, A., & Maksum, H. (2020). Improving Student Activity and Learning Outcomes by Applying the Jigsaw Type Learning Model in PPHP Skills Study. *Journal of Education Research and Evaluation*, *4*(4), 296. https://doi.org/10.23887/jere.v4i4.30240

Fuadi, H., Robbia, A. Z., Jamaluddin, & Jufri, A. W. (2020). Analisis Faktor Penyebab Rendahnya Kemampuan Literasi Sains Peserta Didik. *Jurnal Ilmiah Profesi Pendidikan*, *5*(2), 108–116. https://doi.org/https://doi.org/10.29303/jipp.v5i2.122

Ghozali, I. (2008). *Structural Equation Modeling: Metode Alternatif dengan Partial Least Square (PLS)*. Semarang: Universitas Diponegoro.

Greenstein, L. M. (2012). *Assessing 21st Century Skills: A Guide to Evaluating Mastery and AuthenticLearning*. Corwin.

Hadi, S., & Novaliyosi. (2019). TIMSS INDONESIA (Trends in International Mathematics and Science Study). *Prosiding Seminar Nasional & Call For Papers*, 108–108. https://doi.org/10.1007/978-94-6209-497-0_97

Hadiprayitno, G., Kusmiyati, K., Lestari, A., Lukitasari, M., & Sukri, A. (2021). Blended Learning Station-Rotation Model: Does it Impact on Preservice Teachers' Scientific Literacy? *Jurnal Penelitian Pendidikan IPA*, *7*(3), 317–324. https://doi.org/10.29303/jppipa.v7i3.676

Hair, J. F., Hult, G. T., Ringle, C., & Sarstedt, M. (2017). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Los Angeles: SAGE Publications.

Hair, J. F. J., Hult, G. T. M., Ringle, C. M., Danks, M. S. N. P., & Ray, S. (2023). Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook. In *Structural Equation Modeling: A Multidisciplinary Journal*, 30(1). https://doi.org/10.1080/10705511.2022.2108813

Hariandi, A., & Cahyani, A. (2018). Meningkatkan

Keaktifan Belajar Siswa Menggunakan Pendekatan Inkuiri Di Sekolah Dasar. *Jurnal Gentala Pendidikan Dasar*, *3*(2), 353–371.

Hasibuan, A. T., & Prastowo, A. (2019). Konsep Pendidikan Abad 21: Kepemimpinan Dan Pengembangan Sumber Daya Manusia Sd/Mi. *MAGISTRA: Media Pengembangan Ilmu Pendidikan Dasar Dan Keislaman*, *10*(1), 26–50. https://doi.org/10.31942/mgs.v10i1.2714

Ibnah, I., & Rosidin, U. (2018). The Effectiveness of Applying STEM Approach to Self-Efficacy and Student Learning Outcomes for Teaching Newton's Law. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *4*(1), 11–18. https://doi.org/10.21009/1.04102

IEA. (2016). *TIMSS 2015 International Results in Mathematics and Science*. Boston: TIMSS & PIRLS International Study Center. Retrieved from https://timssandpirls.bc.edu/timss2015/international-results/timss-2015/

Indrawati, Fiqi, A., & Wardono. (2019). Pengaruh Self Efficacy Terhadap Kemampuan Literasi Matematika Dan Pembentukan Kemampuan 4C. *Prisma, Prosiding Seminar Nasional Matematika*, *2*, 247–267. Retrieved from https://journal.unnes.ac.id/sju/index.php/prisma/article/download/29307/12926/

Isa, V. N., Pramulia, F., Juita, R., Syahira, F., Harliyani, W., & Metriani, L. P. (2023). Meningkatkan Kemampuan Literasi Numerasi Siswa pada Pembelajaran IPA Melalui Metode Problem Solving di Sekolah Dasar. *TSAQOFAH: Jurnal Penelitian Guru Indonesia*, *3*(1), 50–58. https://doi.org/10.58578/tsaqofah.v3i1

Ismail, I., Ali, H., & Anwar Us, K. (2022). Factors Affecting Critical and Holistic Thinking in Islamic Education in Indonesia: Self-Concept, System, Tradition, Culture. (Literature Review of Islamic Education Management). *Dinasti International Journal of Management Science*, *3*(3), 407–437. https://doi.org/10.31933/dijms.v3i3.1088

Izzah, N. (2023). The Effectiveness of Tornado Physics Enrichment Book to Increase Science Literacy of High School Students. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7740–7748. https://doi.org/10.29303/jppipa.v9i9.5076

Jufrida, Basuki, F. R., Pangestu, M. D., & Prasetya, N. A. D. (2019). Analisis Faktor yang Mempengaruhi Hasil Belajar IPA dan Literasi Sains di SMP Negeri 1 Muaro Jambi. *Edu Fisika: Jurnal Pendidikan Fisika*, *4*(2), 31–38. Retrieved from https://online-journal.unja.ac.id/EDP/article/view/6188

Khakima, L. N., Zahra, S. F. A., Marlina, L., & Abdullah, Z. (2021). Penerapan Literasi Numerasi dalam Pembelajaran Siswa MI/SD. *Prosiding Seminar Nasional PGMI*, *1*(1), 775–791. Retrieved from http://proceeding.iainpekalongan.ac.id/index.php/semai-775-

Loes, C. N. (2022). The Effect of Collaborative Learning on Academic Motivation. *Teaching and Learning Inquiry*, *10*. https://doi.org/10.20343/teachlearninqu.10.4

Malik, A., Novita, Y., & Nuryantini, A. Y. (2019). Enhancing Critical Thinking Skills of Students Related to Temperature and Heat Topics Through Problem Solving- Laboratory Model. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *5*(1), 9–20. https://doi.org/10.21009/1.05102

Maraghi, M., Abdolreza Mortazavi-Tabatabaei, S., Ahmady, S., & Hosseini, M. (2018). The Relation Of Educational Self-Efficacy And Motivation Among Medical Education Students. *Journal of Advances in Medical Education (JAMED)*, *1*(2), 1–5. Retrieved from https://jamed.ir/article-1-31-en.pdf

Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, M. R. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. *Lectura: Jurnal Pendidikan*, *12*(1), 29–40. https://doi.org/10.31849/lectura.v12i1.5813

Mayasari, A. (2023). Factors Affecting Junior High School Students' Scientific Literacy : An Empirical Study. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 8341–8350. https://doi.org/10.29303/jppipa.v9i10.5377

Meilani, D., Aiman, U., Guru, P., Dasar, S., & Kupang, U. M. (2020). Indonesian Journal of Primary Education Implementasi Pembelajaran Abad 21 terhadap Hasil Belajar IPA Peserta Didik dengan Pengendalian Motivasi Belajar. *Indonesian Journal of Primary Education*, *4*(1), 19–24. Retrieved from https://ejournal.upi.edu/index.php/IJPE/article/view/24419

Mellyzar, M., Alvina, S., & Zahara, S. R. (2022). Influence of POGIL and MFI Models on Science Literacy and Science Process Skills for Junior High School. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 2201–2209. https://doi.org/10.29303/jppipa.v8i4.2121

Mukaromah, E. (2020). Pemanfaatan Teknologi Informasi dan Komunikasi dalam Meningkatkan Gairah Belajar Siswa. *Indonesian Journal of Education Management and Administration Review*, *4*(1), 179–185. Retrieved from http://www.yourdictionary.com/library/reference/word-definitions/definition-of-technology.html.

Mulyana, V., & Desnita, D. (2023). Empirical Validity and Reliability of the Scientific Literacy Assessment Instrument Based on the Tornado Physics Enrichment Book. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 3961–3967. https://doi.org/10.29303/jppipa.v9i5.3290

Musa, H. M. (2019). The Effect of Motivation in Improving Students' Speaking Skill Performance in

Secondary School. *Journal of the College of Basic Education*, *1*, 105–136. Retrieved from https://www.iasj.net/iasj/download/6da82b211da016a1

Nahar, S., Suhendri, Zailani, & Hardivizon. (2022). Improving Students' Collaboration Thinking Skill under the Implementation of the Quantum Teaching Model. *International Journal of Instruction*, *15*(3), 451–464. https://doi.org/10.29333/iji.2022.15325a

Nilyani, K., Asrizal, A., & Usmeldi, U. (2023). Effect of STEM Integrated Science Learning on Scientific Literacy and Critical Thinking Skills of Students: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 65–72. https://doi.org/10.29303/jppipa.v9i6.2614

Nofrion. (2018). *Komunikasi Pendidikan: Penerapan Teori dan Konsep Komunikasi dalam Pembelajaran*. Jakarta: Prenadamedia Group.

Nur, Y. D. S., Fitri, A., Latifatusadiah, T., Dewi, S. M., & Febriansyah, F. (2023). Effect of the Flipped Classroom Model on Self Efficacy Student in Limited Face Learning. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6278–6283. https://doi.org/10.29303/jppipa.v9i8.4340

OECD. (2016). *Assesing Scientific, Reading, and Mathematical Literacy*. A Framework for PISA 2016: OECD Publishing.

OECD. (2019). PISA 2018 Results. In *Paris: PISA-OECD Publishing: Vol. I*. Paris: PISA-OECD Publishing. https://doi.org/10.1787/g222d18af-en

Ozgen, K. (2013). Self-Efficacy Beliefs In Mathematical Literacy And Connections Between Mathematics And Real World: The Case Of High School Students. *Journal of International Education Research (JIER)*, *9*(4), 305–316. https://doi.org/10.19030/jier.v9i4.8082

Pambudi, R. E., Soekirno, S., & Prihastari, E. B. (2020). Pengaruh Aktivitas Literasi Matematika Terhadap Kemampuan Berpikir Kritis Pada Kelas Iv. *Jurnal Sinektik*, *3*(1), 75. https://doi.org/10.33061/js.v3i1.3764

Parimita, W., Purwana, D., Fadillah, N., & Fatimah, S. Z. (2020). The Effect of Self-Efficacy and Communication Skills on Employee Performance and Work Engagement at Online Transportation Companies. *International Journal of Innovation, Creativity and Change*, *13*(1), 1376–1388. Retrieved from http://jurnal.unsyiah.ac.id/AGC-BEST/article/view/16845

Pramudita, I. F. E., Praherdhiono, H., & Adi, E. P. (2021). Studi Keterampilan Abad 21 Mahasiswa Dalam Memilih Peminatan. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *4*(3), 251–259. https://doi.org/10.17977/um038v4i32021p251

Prasetya, T. A., & Harjanto, C. T. (2020). Improving Learning Activities and Learning Outcomes Using the Discovery Learning Method. *VANOS Journal Of Mechanical Engineering Education*, *5*(1), 59–66. Retrieved from http://jurnal.untirta.ac.id/index.php/vanos

Pratama, R. A., Pratiwi, I. M., Saputra, M. A., & Sumargono. (2022). Integration of STEM education in history learning. *International Journal of Evaluation and Research in Education*, *11*(1), 313–320. https://doi.org/10.11591/ijere.v11i1.22064

Pratiwi, S. N., Cari, C., & Aminah, N. S. (2019). Pembelajaran IPA Abad 21 dengan Literasi Sains Siswa. *Jurnal Materi Dan Pembelajaran Fisika (JMPF)*, *9*(1), 34–42. https://doi.org/10.20961/jmpf.v9i1.31612

Primasari, R., Miarsyah, M., & Rusdi, R. (2020). Science literacy, critical thinking skill, and motivation: A correlational study. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *6*(2), 273–282. https://doi.org/10.22219/jpbi.v6i2.11124

Putri, M., Inayah, F., & Hadiany, D. A. (2021). Analisis Kemampuan Literasi Numerasi Siswa Smp Ditinjau dari Kemandirian Belajar Matematika. *Prosiding Seminar Nasional Pendidikan Matematika (SNPM) III, Univeristas Swadaya Gunung Jati (UGJ)*, *3*, 196–207. Retrieved from http://fkip-unswagati.ac.id/ejournal/index.php/snpm/article/viewFile/953/453

Rahayu, A. B., Hadi, S., Istyadji, M., Zaini, M., Sholahuddin, A., & Fahmi. (2018). Development of Guided Inquiry Based Learning Devices to Improve Student Learning Outcomes in Science Materials in Middle School. *European Journal of Alternative Education Studies*, *3*(2), 107–117. https://doi.org/10.5281/zenodo.2261027

Rahayu, L. S., & Dian, R. D. (2022). The Correlation Between Self-Efficacy and Learning Motivation in 11th Grade of Senior High School. *Academia Open*, *7*, 1–12. https://doi.org/10.21070/acopen.7.2022.4547

Ridwan, E., Wahyuni, I., & Mayasari, R. (2019). Hubungan Kesiapan Belajar dan Self Efficacy Dengan Keaktifan Belajar Siswa di SMP Negeri 5 Kendari. *Zawiyah: Jurnal Pemikiran Islam*, *5*(2), 261–287. https://dx.doi.org/10.31332/zjpi.v5i2.1535

Ridzal, D. A., & Haswan, H. (2023). Analysis of the correlation between science literacy and critical thinking of grade eight students in the circulatory system. *Jurnal Pijar Mipa*, *18*(1), 1–5. https://doi.org/10.29303/jpm.v18i1.4469

Rikawati, K., & Sitinjak, D. (2020). Peningkatan Keaktifan Belajar Siswa dengan Penggunaan Metode Ceramah Interaktif. *Journal of Educational Chemistry (JEC)*, *2*(2), 40. https://doi.org/10.21580/jec.2020.2.2.6059

Ropii, N., Hardyanto, W., & Ellianawati, E. (2019).

Guided Inquiry Scratch Increase Students' Critical Thinking Skills on the Linear Motion Concept: Can it be? *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *5*(1), 63–68. https://doi.org/10.21009/1.05107

Sari, R. M., Sumarmi, Astina, I. K., Utomo, D. H., & Ridhwan. (2021). Increasing Students Critical Thinking Skills and Learning Motivation Using Inquiry Mind Map. *International Journal of Emerging Technologies in Learning*, *16*(3), 4–19. https://doi.org/10.3991/ijet.v16i03.16515

Siregar, R. S. (2023). Analisis Kemampuan Literasi Matematika Dalam Menyelesaikan Soal Matematika PISA Pada Kelas VIII MTsN 2 Medan. *Jurnal Pembelajaran Dan Matematika Sigma (JPMS)*, *9*(2), 144–153. https://doi.org/https://doi.org/10.36987/jpms.v9i1.4699

Sole, F. B., & Anggraeni, D. M. (2018). Inovasi Pembelajaran Elektronik dan Tantangan Guru Abad 21. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *2*(1), 10. https://doi.org/10.36312/e-saintika.v2i1.79

Sudrajat, D. R., & Disman. (2021). The effect of learning motivation on students' critical thinking ability in Economics subject during the Covid-19 pandemic. *The International Conference of Universitas Pekalongan 2021*, 167–171. Retrieved from https://proceeding.unikal.ac.id/index.php/icunikal2021/article/view/638

Syah, R., Winarno, R. A. J., Kurniawan, I., Robani, M. Y., & Khomariah, N. N. (2020). Pengaruh Motivasi Belajar dan Pola Asuh Keluarga terhadap Kemampuan Literasi Sains. *Prosiding Seminar Nasional Sains*, *1*(1), 332–338. Retrieved from http://proceeding.unindra.ac.id/index.php/sinasis/article/view/4109

Syahputra, Y., Ardimen, A., Tanjung, R. F., Erwinda, L., Wulan, A. N., Fadhila, C., & Zulfikar, F. (2022). Pengembangan Instrumen Keterampilan Belajar dan Berinovasi (4C) Pada Pembelajaran IPA Siswa Kelas V SD. *PENDASI: Jurnal Pendidikan Dasar Indonesia*, *6*(1), 65–74. https://doi.org/10.31957/cjce.v1i2.2631

Tanti, Maison, Syefrinando, B., Daryanto, M., & Salma, H. (2020). Students' self-regulation and motivation in learning science. *International Journal of Evaluation and Research in Education*, *9*(4), 865–873. https://doi.org/10.11591/ijere.v9i4.20657

Tegeh, M., Pratiwi, N. L. A., & Simamora, A. H. (2019). Hubungan Antara Motivasi Belajar dan Keaktifan Belajar dengan Hasil Belajar IPA Siswa Kelas V SD. *Jurnal IKA*, *17*(2), 150–170. https://doi.org/10.23887/ika.v17i2.19850

Treffinger, D. J., Young, G. C., Selby, E. C., & Shepardson, C. (2002). *Assessing Creativity: A Guide for Educators.* National Research Center on the Gifted and Talented. Retrieved from https://eric.ed.gov/?id=ED505548

Umam, I. U., Nurlaelah, E., & Suhendra. (2023). Mathematical Critical Thinking Ability Based on Student's Self-Efficacy Using Phenomenological Study Approach. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(2), 2676–2687. https://doi.org/10.24127/ajpm.v12i2.6859

Uno, H. B. (2014). *Teori Motivasi dan Pengukurannya: Analisis di Bidang Pendidikan*. Jakarta: Bumi Aksara.

Utami, R. W., & Wutsqa, D. U. (2017). Analisis Kemampuan Pemecahan Masalah Matematika Dan Self-Efficacy Siswa SMP Negeri Di Kabupaten Ciamis. *Jurnal Riset Pendidikan Matematika*, *4*(2), 166. https://doi.org/10.21831/jrpm.v4i2.14897

Wahyuddin, W. (2022). The Influence of Self-efficacy and Self-regulation on Motivation and Learning Achievement. *Proceedings of the 3rd International Conference of Education and Science, ICES 2021,* 1-17. https://doi.org/10.4108/eai.17-11-2021.2318641

Wardani, A. D. P., Mufidah, A., Mufidah, R., & Aristiawan. (2023). The Effect of Self Efficacy on the Creative Thinking Ability Learners on Environmental Material. *Islamic Journal of Integrated Science Education (IJISE)*, *2*(2), 99–110. https://doi.org/10.30762/ijise.v2i2.1528

Wiarsana, I. G. S. (2020). Pengaruh Self Efficacy, Motivasi Berprestasi, Dan Study Habits Terhadap Literasi Sains Siswa. *Jurnal Pendidikan Sains (JPS)*, *8*(2), 110–120. http://jurnal.unimus.ac.id/index.php/JPKIMIA

Yasiro, L. R., Wulandari, F. E., & Fahmi, F. (2021). Analisis Kemampuan Berpikir Kreatif Siswa Dalam Menyelesaikan Soal Pada Materi Pemanasan Global Berdasarkan Prestasi Siswa. *Journal of Banua Science Education*, *1*(2), 69–72. https://doi.org/10.20527/jbse.v1i2.11

Yulikhah, S., Bukhori, B., & Murtadho, A. (2019). Self concept, self efficacy, and interpersonal communication effectiveness of student. *Psikohumaniora*, *4*(1), 65–76. https://doi.org/10.21580/pjpp.v4i1.3196

Yuliyanto, A., Turmudi, T., Agustin, M., Putri, H. E., & Muqodas, I. (2019). The Interaction Between Concrete-Pictorial-Abstract (CPA) Approach and Elementary Students' Self-Efficacy In Learning Mathematics. *Al Ibtida: Jurnal Pendidikan Guru MI*, *6*(2), 244. https://doi.org/10.24235/al.ibtida.snj.v6i2.5226

Yulkifli, Y., Ningrum, M. V., & Indrasari, W. (2019). The Validity of Student Worksheet Using Inquiry-Based Learning Model with Science Process Skill Approach for Physics Learning of High School. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *5*(2), 155–162. https://doi.org/10.21009/1.05210

Zahranie, M., Andayani, Y., & Loka, I. N. (2020). Hubungan Keaktifan Bertanya dengan Kecenderungan Berpikir Kritis Siswa Kelas XI IPA di SMA/MA Se-Kecamatan Narmada Tahun Ajaran 2019/2020. *Chemistry Education Practice*, *3*(1), 5. https://doi.org/10.29303/cep.v3i1.1426