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Metacognitive Perception and Learning Motivation as Predictors of 21st Century Skills in Science Among Junior High School Students

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Abstract — Low 21st-century skills is a growing concern in Science Education. The study determined the significance of forecasting 21st century skills in science using metacognitive perception and learning motivation as predictors. Using predictive design, simple random sampling, survey technique and multiple linear regression analysis were applied, with 230 total samples revealed that the predictors are significant in predicting the criterion variable, partly and partially affirms the theory of Self-regulated learning. Future research may explore other variables to account for the 26% variance in enhancing 21st century skills. Qualitative studies will be employed while school leaders may develop practices and strategies to strengthen 21st century skill in science education.

Keywords: Metacognitive perception, learning motivation, predictors of 21st century skills in science, junior high school students

I. INTRODUCTION

The Problem and its Scope

Low levels of 21st-century skills remain a persistent concern for learners worldwide. Although 21st-century skills are widely recognized as essential, many education systems fail to enhance 21st-century Skills (Mohammod et al., 2024). Empirical studies consistently show that a

significant proportion of students struggle with the essential 21st-century skills (Varghese & Musthafa, 2021).

In various countries, the struggle to meet benchmarks for 21st century skills in science increasingly evident. In Indonesia, research reveals that junior high school students continue to exhibit low levels of 21st century skills (Juwita Sari Rosdiana, 2024). Similarly, students in Malaysia, specifically in rural secondary schools, demonstrate low 21st century skills in science curriculum (Mohd et al., 2023). In Turkey, it was found that students possessed poor 21st century skills Science curriculum (Aksoy & Küçük Demir, 2023).

In the Philippine context, studies reveal that the uneven development of 21st-century competencies is also a pressing concern. For instance, one of the studies in Surigao del Sur, it was found that students exhibit inconsistencies in the broader spectrum of 21st-century skills as noted by Orzales and Mabalay (2024). Thus, the study of 21st-century skills remains vague, unclear and poorly develop.

Low levels of 21st-century skills have emerged as a critical challenge that threatens students' capacity to collaborate effectively, think critically, communicate clearly, and generate creative solutions in both academic and real-world contexts. Addressing this issue is significant as it affects learners' overall readiness for future careers, their ability to participate meaningfully in group tasks, and their potential to adapt and innovate in an increasingly competitive and fast-changing society. This research determined the significance of metacognitive perception and science learning motivation on 21st-century skills. Furthermore, this study contributes to the researcher by providing insights into how these variables can positively influence 21st century skills that enhance and improve academic readiness and performance among learners.

Significance of the Study

This study aims to quantitatively investigate how metacognitive perception and learning motivation predicts 21st-century skills in science among junior high school students. The findings of this research may guide the education system in the Philippines by providing evidence-based

insights on the relevance of the predictive variables in developing student 21st-century skills and promoting the United Nations' Sustainable Development Goal 4, which emphasizes quality education. Academic institutions can utilize the results as a foundational framework to understand and predict how the variables shape student 21st-century skills in science. Schools can implement more effective strategies to support and enhance student capacities. Moreover, this study can serve as a valuable reference for future research in shaping students' abilities and exploring innovative approaches to student 21st-century skills in science education.

Statement of the Problem

The study determined the significance of forecasting 21st century skills in science using metacognitive perception and learning motivation as predictors. Specifically, it aims to achieve the following objectives:

1. To describe the levels of metacognitive perception in terms of declarative knowledge, procedural knowledge, conceptual knowledge, planning, information management strategies, monitoring, debugging strategies and evaluation; Learning motivation in terms of self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment simulation; 21st-century skills in Science in terms of collaboration, critical thinking, creativity, communication;

2. To determine the significance of the correlation between Metacognitive Perception, and Learning Motivation, and the 21st Century Skills in Science.

3. To determine the significance of the strength of the model for 21st Century Skills in science as predicted by Metacognitive Perception and Learning Motivation.

Hypotheses

The following were tested at a 0.05 level of significance:

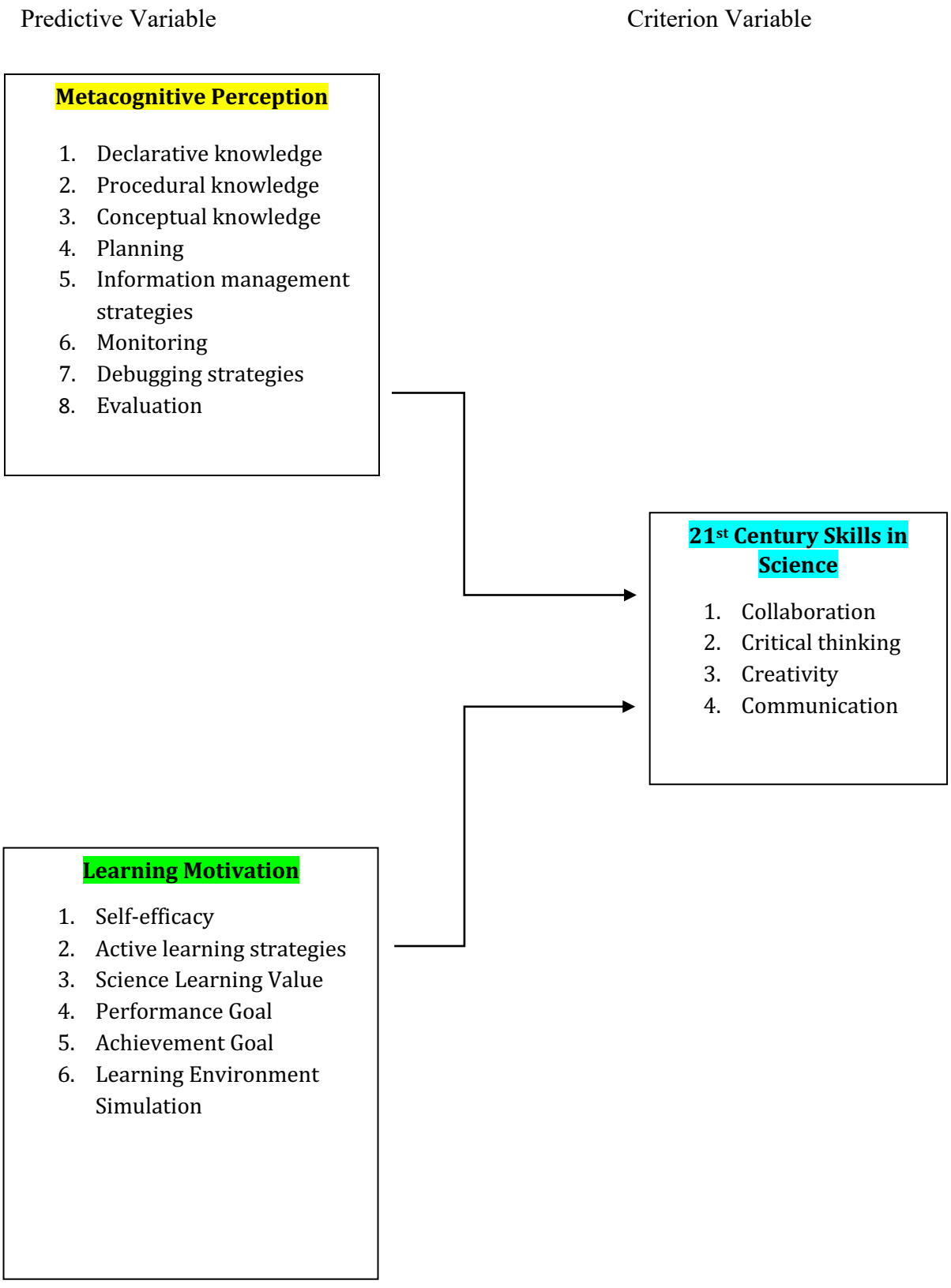
H_{01}: Metacognitive Perception and Learning Motivation do not significantly correlate with 21st Century Skills in Science

H_{02}: The model to predict 21st Century Skills in Science, using Metacognitive Perception and Learning Motivation as predictors, is not significant

Theoretical and Conceptual Framework

This study is anchored on Zimmerman Self-Regulated Learning theory (1980) which asserts that learners are active participants in their individual learning by evaluating their cognitive, motivation and behavior factor.

In the context of this study, metacognitive perception which has an indicator of declarative knowledge, procedural knowledge, conceptual knowledge, planning, information management strategies, monitoring, debugging strategies and evaluation (Harrison et al., 2018) represents cognitive factors. In addition, learning motivation with indicators of self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment simulation (Tuan et al., 2005) stands for motivation factor. Moreover, 21st-century skills which has indicators of collaboration, critical thinking, creativity, and communication (Kelley et al., 2019) denoting that learners are active participants in their individual learning as reflected in the theory. Furthermore, behavior factor was delimited in the theory. Hence, the study partially aligned to the theory.



II. METHODOLODY

The research design, locale of the study, the sample and sampling, data gathering technique, data analysis, and the ethical considerations were included in this chapter.

Research Design

This study employed a predictive research design, utilizing statistical models and historical data to generate projections that complement traditional explanatory research (Sghir et al., 2022). This design is uniquely suited to this research as it evaluates whether metacognitive perception and learning motivation serve as significant predictors of 21st-century science skills. Furthermore, this methodology allows for the visualization of trends and the development of evidence-based interventions within educational and social science contexts (Khalil & Ebner, 2023). By prioritizing prediction over simple description, this approach effectively identifies latent patterns within large datasets, provides prospective insights, and enhances the accuracy of strategic decision-making (Shmueli et al., 2023).

Locale of the Study

The study was conducted in the public junior high schools of Don Marcelino District, Division of Davao Occidental, which was under the regulation of the Department of Education in Region XI, Philippines. The locale was chosen because of its large and diverse student population, which allows for a more comprehensive understanding and strong emphasis on student 21st century competencies. Moreover, the schools were recognized for their commitment to quality education providing an ideal setting to validate the how metacognitive perception and learning motivation predicts to student 21st century skills in science curriculum.

Sample and Sampling Technique

This study includes a total of 230 Grade 10 students from public junior high school in Davao Occidental, which aligns with the recommended sample size suggested by Julious (2023). The inclusion criteria for selecting respondents are those students officially enrolled in the research locale for the school year 2025–2026. This ensures that the respondents are active members of the academic community during the period of data collection. Conversely, the exclusion criteria were those students who were not officially enrolled in the institution and those who expressed an unwillingness to participate, upholding the ethical standard of voluntary consent. The researcher employed simple random sampling, a probability sampling method in which each member of the population has an equal chance of being selected (Thomas, 2023). Furthermore, using Yamane's formula, a minimum of 230 respondents will be required from the total population.

Data Gathering Technique

In this study, survey was used as data-gathering technique. A survey is a research method that collects data from respondents through structured questionnaires to identify trends, relationships, and differences among variables (Goodfellow, 2023). The questionnaires used in this study were adapted and modified to align with the respondents' background and the objectives of the study.

The Metacognitive Perception Questionnaire adapted from (Harrison et al., 2018), comprised 50 items and yielded a Cronbach's alpha of 72%, interpreted as good reliability. The Learning Motivation Questionnaire was adapted from Tuan et al. (2005), consisting of 28 items and achieved a reliability coefficient of 94%, indicating excellent reliability. Lastly, the 21st Century Skills Questionnaire adapted from Kelley et al. (2019) consisting of 22 items with a Cronbach's alpha of 92%, denoting high reliability. The overall instrument, composed of 100 items, obtained a Cronbach's alpha of 86%, which indicates excellent internal consistency and reliability.

Data Analysis Technique

Descriptive data analysis is a statistical method used to summarize and describe data using measures such as mean and standard deviation (Lim, 2025). In this study, descriptive statistics were used to determine the levels of metacognitive perception, learning motivation, and 21st century using a 4-point Likert scale. Correlation analysis was employed to determine the strength and direction of correlation between variables. It is applied when examining associations without inferring causation, and is useful for identifying patterns, quantifying relationships, and supporting prediction (Wisniewski & Brannan, 2024). This study specifically utilized the Pearson Product-Moment Correlation to determine the relationships among the variables. Furthermore, multiple regression analysis was used to determine and predict the relationship between a dependent variable and one or more independent variables, to identify influencing factors and forecast outcomes, with advantages such as prediction, explanation of relationships, and informed decision-making (Kamel & Abonazel, 2023). The unstandardized beta coefficient was used as the statistical treatment for interpreting the regression results.

The matrix presenting the scale, descriptive level, and corresponding interpretation for each study variable is provided, specifically used to describe metacognitive perception, learning motivation, and 21st century skills in science.

Scale	Level	Metacognitive Perception	Learning Motivation	21st Century Skills in Science
3.26-4.00	Very High	Excellent	Very strong	Excellent
2.51-3.25	High	Good	Strong	Good
1.76-2.50	Low	Poor	Weak	Poor
1.00-1.75	Very Low	Very poor	Very Weak	Very poor

Standard Deviation Value Ranges and Interpretation

Range	Description	Interpretation
SD ≤ 0.50	High consistent responses	Strong and uniform perception
SD = 0.51 – 1.00	Moderate Consistent Responses	Acceptable consistency
SD = 1.01 – 1.50	Low consistent responses	Differing views or experiences
SD > 1.50	Very low consistent responses	High variability and lack of consensus

In this study, the significance of the correlation is tested at 0.05 confidence level. The following is the standard measure for the interpretation scale of *r*-value, the following scheme is used:

Computed r	**Descriptive Interpretation**
+/- 1.00	Very High Correlation
Between +/- 0.75 – +/- 0.99	High Correlation
Between +/- 0.51 – +/- 0.74	Moderately High Correlation
Between +/- 0.31 – +/- 0.50	Moderately Low Correlation
Between +/- 0.01 – +/- 0.30	Low Correlation
0.00	No Correlation

The standard measure for the interpretation to assess the extent of influence and the predictive strength of the independent variables on the criterion variable is as follows:

β Value Range	Predictive Strength
±0.00 – ±0.09	Very Weak
±0.10 – ±0.29	Weak
±0.30 – ±0.49	Moderate
±0.50 – ±0.69	Strong
±0.70 and above	Very Strong

Ethical Consideration

The study followed appropriate ethical standards to protect the respondents and ensure the accuracy and reliability of the results, while demonstrating utmost respect for the policies and authority of the Department of Education (DepEd) and school administrators. It complied with the guidelines of the Holy Cross of Davao College – Society for Moral Integrity and Legal Ethics (SMILE) and the Data Privacy Act of 2012, ensuring proper safeguarding of all collected information. Informed consent was obtained from all respondents, with clear explanation of the purpose of the study, procedures, and their right to voluntary participation and withdrawal at any time. Confidentiality and anonymity were strictly maintained by avoiding the collection of personally identifiable information, and all responses were handled with privacy, honesty, and objectivity. Permission to conduct the study was secured from the DepEd – Schools Division of Davao Occidental and concerned school authorities, with coordination from school heads to ensure smooth implementation. Ethical clearance was obtained prior to data collection and validated. Further, reliable instruments were used to ensure consistency and accuracy of data collected.

III. RESULTS

Included in this chapter were the descriptive, correlation, and regression tabular presentations, along with the corresponding analysis and interpretation of the statistical results. This chapter ended with a summary of findings.

Descriptive Results

Table 1 is descriptive table. It includes the variables of the study namely, Metacognitive Perception, Learning Motivation, and 21st Century Skills in Science. It also showed the number of respondents, mean, standard deviation (SD), and the descriptive levels for each variable.

TABLE 1
DESCRIPTIVE TABLE (N=230)

Variables	**SD**	Mean	Descriptive Level
Metacognitive Perception	***0.16***	***3.36***	***Very High***
Declarative Knowledge	0.29	3.48	Very High
Procedural Knowledge	0.53	3.23	High
Conceptual Knowledge	0.17	3.46	Very High
Planning	0.19	3.45	Very High
Information Management	0.12	3.34	Very High
Strategies			
Monitoring	0.16	3.40	Very High

Debugging Strategies	0.27	3.24	High
Evaluation	0.42	3.24	High
Science Learning Motivation	***0.34***	***3.03***	***High***
Self-efficacy	0.50	2.97	High
Active Learning Strategies	0.37	2.91	High
Science Learning Value	0.29	3.08	High
Performance Goal	0.29	3.05	High
Achievement Goal	0.37	3.05	High
Learning Environment Simulation	0.29	3.11	High
21st Century Skills	***0.27***	***2.96***	***High***
Collaboration	0.25	2.92	High
Critical Thinking	0.31	2.78	High
Creativity	0.30	3.05	High
Communication	0.32	3.08	High

Specifically, the table revealed that metacognitive perception variable obtained a mean of 3.36, which was described as very high. This suggested that students possessed excellent metacognitive perception. Further, while five indicators reached the very high level, three were rated as high. The corresponding standard deviation of 0.16 reflects high consistent and uniform responses among the respondents. Moreover, learning motivation variable, obtained a mean of 3.03, which was describes as high, indicating a strong student learning motivation. All its indicators were described as high. The standard deviation of 0.34 indicates high consistent

responses. Finally, 21st-century skills in science obtained a mean of 2.96, which was described as high, indicating that student 21st-century skills in science variable was good. All indicators of 21st-century skills in science were also described as high. The corresponding standard deviation of 0.27 reflects highly consistent responses across respondents.

The results show that metacognitive perception obtained a very high level while learning motivation and 21st century skills obtained both high levels, indicating very good conditions among students. The consistent response across variables demonstrates a very good 21st century sills in science.

Correlation Results

Table 2 presented the results of the correlation analysis among the two predictive variables with the criterion variable. The table detailed the r-values, p-values, and the resulting decision on the null hypotheses.

TABLE 2
CORRELATION TABLE (N=230)

Variables	***21ST Century Skills in Science***			
	r	**p-value**	**Decision on Ho**	**Interpretation**
Metacognitive Perception	0.85	0.000	Reject Ho	High positive, significant correlation
Learning Motivation	0.68	0.000	Reject Ho	Moderately high positive, significant correlation

Level of Significance: 0.05
Decision Rule: Reject H_0 if $p < 0.05$

Specifically, Table 2 showed the correlation between metacognitive perception and 21st century skills in science, with a p-value of 0.000, which was less than the 0.05 level of significance. Hence, the null hypothesis was rejected, indicating that the correlation between metacognitive perception and 21st-century skills was significant. The correlation yielded an r-value of 0.85, indicating a high positive correlation. This implies that when metacognitive perception increases, student 21st century skills will also increase. Similarly, the correlation between learning motivation and 21st century skills in science also obtained a p-value of 0.000, which was below the 0.05 level of significance. Hence, the null hypothesis was likewise rejected. It denoted a statistically significant correlation. The r-value of 0.68 reflected a moderately high positive correlation. This indicated that high level of learning motivation corresponds to high 21st century skills in science. Metacognitive perception and learning motivation shows significant positive correlation with 21st century skills in science, indicating that developing these variables greatly influenced the criterion variable.

Metacognitive Perception and learning motivation both show statistically significant positive correlation with 21st century skills, indicating that enhancement in these variables is associated with higher levels of 21st century skills in science.

Regression Results

Table 3 presents the regression table. Several columns are included in the table, namely, the predictors and criterion variables, B (Unstandardized Coefficient), Beta (Standardized Coefficient), t (t-value), p (p-value), and the Decision on the null hypothesis.

TABLE 3
REGRESSION TABLE (N=230)

	21st century skills in science (2CSS)						
	Unstandardized Coefficients		**Standardized Coefficients**				
Variables	**B**	**Std. Error**	**Beta**	**t**	**P value**	**Decision on H_0**	**Interpretation**
(Constant)	1.69	0.21	–	8.05	0.001	–	–
Metacognitive Perception (MP)	1.33	0.08	0.80	15.52	0.001	Reject	Positive Significant Influence
Learning Motivation (LM)	0.05	0.04	0.07	1.36	0.176	Failed to Reject	Not Significant

Model Summary:

R = 0.86 | R^2 = 0.74| F-value = 324| p = 0.000
Level of Significance: 0.05
Decision Rule: Reject H_0 if $p < 0.05$
Predictive Model: 2CSS = 1.33MP + 0.05LM + 1.69

Specifically, the table shows that the model for 21st century skills in science using the predictive variables, metacognitive perception and learning motivation, is 2CSS = 1.33MP + 0.05LM +1.69. The corresponding p-value of 0.001 is lower than the 0.05 level of significance. Hence, the null hypothesis was rejected. This indicates that the model to predict 21st century skills in science is statistically significant. The R-squared value of 0.74 shows that the strength (74%) of the model to explain 21st century skills in science is substantial. Although only metacognitive perception exerted a strong positive and statistically significant prediction, not the learning motivation.

Summary of Findings

Based on the statistical results, it specifically was found that:

1. Metacognitive Perception and learning motivation show a significant correlation with 21st century skills in science.

2. The model to predict 21st century skills in science with metacognitive perception and learning motivation as predictors is significant; although only the first predictor registers a significant predictive strength.

IV. DISCUSSIONS

In this chapter, the descriptive, correlational, and regression analysis results of the study.

Metacognitive Perception and 21st century skills in Science Correlation

The results revealed high positive correlation between metacognitive perception and 21st-century skills in science. This finding confirms the study of Checa-Romero and Gimenez-Lozano (2025), positing that metacognitive processes are fundamental to the development of 21st-century competencies, as they allow students to monitor and adjust their thinking during complex problem-solving tasks. Similarly, this current finding agrees with Popandopulo et al. (2023), who highlight that metacognitive skills serve as a primary driver for fostering the adaptability and critical thinking necessary for modern scientific literacy. When students possess high declarative and procedural knowledge, they are better equipped to manage information and evaluate their own collaborative efforts, directly enhancing their 21st-century performance.

Contrary, the recent finding denies the study of Zohar and Barzilai (2021), noting that even students perceive themselves as having high metacognitive awareness, the actual application of these skills can be hindered by traditional curricula that prioritize rote memorization over the active inquiry required for true 21st-century proficiency. This suggests that while the correlation is high in this study, the translation of perception into behavior may still be moderated by the specific pedagogical strategies employed in the classroom.

Learning Motivation and 21st century skills in Science Correlation

The results showed a moderately high positive correlation between learning motivation and 21st-century skills in science. This finding affirms the study of Akkaya (2024), reporting that that students with strong motivation in science specifically those with high self-efficacy and active learning strategies are more likely to engage in the collaborative and creative processes essential for 21st-century success. Similarly, this current finding agrees with Marin-Mantilla and Moscoso-Barrera (2025), who emphasized that when students value science learning for its practical utility, they are more intrinsically driven to develop the communication and critical thinking skills required to solve real-world problems.

Conversely, the present finding contrasts Ryan and Deci (2025), who argued that performance-based goals and extrinsic motivation may not support the development of 21st-century skills as effectively as intrinsic motivation. This explains that despite a significant correlation, the predictive power of motivation was lower than that of metacognitive perception in the regression model. If student motivation is heavily tied to performance goals, such as getting good grades rather than a genuine interest in scientific inquiry, the resulting 21st-century skills may remain inconsistent across different contexts.

21st century skills in science as Predicted by Metacognitive Perception and Learning Motivation

The regression analysis revealed that metacognitive perception and learning motivation significantly predicts 21st century skills in science. Further, this finding affirms Karataş and Arpaci (2021), reporting that metacognitive awareness are powerful predictors of students' readiness to handle the demands of modern education and competency-based tasks. Similarly, this current finding agrees with Schraw and Moshman (2022), who emphasized that students that can actively monitor and control their cognitive processes tend to demonstrate improved learning performance and transferable skills essential for complex learning.

The data revealed a notable discrepancy in which while the model was significant, only metacognitive perception emerged as a significant individual predictor, while science learning motivation did not. This may contradict some traditional views that place motivation as the primary driver of achievement. The current finding contradicts the study of Howard et al. (2022), suggesting that while motivation is existing metacognition drives the complex cognitive work required for 21st-century skills. This implies that metacognitive perception is the contributing predictor that could enhance 21st century skills in science.

V. CONCLUSION

Based on the findings, 21st century skills in science significantly forecasted by metacognitive perception and learning motivation as predictors. The significant predictive model suggests that 21st century skills in science arises from the combined strength of metacognitive perception and learning motivation. This conclusion partly affirmed the theory of Self-Regulated Learning, which asserts that learners are active participants in their individual learning by evaluating their cognitive, motivation and behavior factor.

VI. RECOMMENDATIONS

Based on the conclusions, the following are recommended:

1. Future research may explore other variables not covered in this study to account for the 26% of the variance in the strength of the model predicting 21st century skills in science.

2. Qualitative studies could also be conducted to identify emerging themes and sub-themes, which may guide the selection of these potential variables.

3. School leaders may develop practices and strategies to strengthen 21st century skills in science education.

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