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The Relationship Between the Implementation of 4C with Biology Learning Outcomes and Soft Skills of High School Students in Jayapura City

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Abstract: This study highlights the 21st century global education policy, namely learning that emphasizes 4 important aspects, namely: Critical thinking, Communication, Collaboration, and Creativity, hereinafter abbreviated as 4 C. This study aims to determine the relationship between the application of four 21st century critical skills—critical thinking, communication, collaboration, and creativity (4C)—into biology learning and the impact or relationship to learning outcomes and Soft Skills of high school students in Jayapura City. The results showed that students in the "Sekolah Penggerak" had a higher level of mastery of the 4C and soft skills, such as adaptability, time management, empathy, ethical awareness, self-motivation, and initiative, compared to students in the "Regular School." Although there was a significant correlation between 4C skills and soft skills, no substantial relationship was found between 4C skills and academic outcomes directly. This suggests that the learning approach applied in the "Sekolah Penggerak," which is more interactive and collaborative, is more effective in supporting the development of soft skills than academic achievement. These findings highlight the importance of integrating 4C and soft skills development into the secondary education curriculum to prepare students for future challenges. Recommendations from this study encourage educators and policymakers to implement learning methods that support students' interpersonal skills and independence in all types of schools.

Keywords: High school students; Implementation of 4C; Learning outcomes; Soft skills

Introduction

State Advances in technology and society lead to increasing demands for students in biology learning to develop modern skills (Hafiza et al., 2022). Modern skills integrate critical thinking, problem-solving, teamwork, and efficient communication into high school biology learning, thereby enhancing students' academic achievement (Kamalov et al., 2023; Dwivedi et al., 2023). In addition, students can develop important soft skills needed for success in the 21st century. Integration of the 4Cs (critical thinking, problem-solving, collaboration, effective communication) is essential to preparing students to thrive in an increasingly complex and interconnected world. By integrating the 4Cs into high school biology instruction, students not only improve their academic performance but also develop important soft skills needed for success in the 21st century. Integration of the 4Cs into high school biology instruction makes students better prepared to face the challenges of the 21st century and excel in improving their academics (Uka, 2013; Kain et al., 2024).

The development of education that continues to grow in Indonesia, especially in Papua Province, more

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specifically Jayapura City, shows that the integration of 4C— Critical Thinking, Communication, Collaboration, and Creativity —in teaching is an inevitable necessity to prepare students to face the challenges of the 21st century. However, in reality, there is a gap in the ability of high school biology teachers to apply these four components effectively in their teaching (González-Pérez & Ramírez-Montoya, 2022; Furman Shaharabani & Yarden, 2019; Langelaan et al., 2024). In many schools, biology teachers face various obstacles that limit their ability to integrate the 4C approach into the curriculum and teaching practices. One of the main gaps is the lack of adequate professional training (Hyseni Duraku et al., 2022; Rikala et al., 2024; Admiraal et al., 2023). Teachers often do not receive enough training on how to develop and implement teaching methods that support critical thinking, creativity, collaboration, and effective communication (Herlinawati et al., 2024; Thornhill-Miller et al., 2023; Darling-Hammond et al., 2020). As a result, many teachers return to traditional methods, such as lectures and memorization, which do not support the development of 4C skills (Ye & Xu, 2023; Luthfi et al., 2023).

The combination of these factors creates an environment where innovative and 21st-century skills-oriented teaching is often seen as a difficult challenge to overcome, rather than an integral part of teaching practice. To address this gap, there needs to be a concerted effort among education stakeholders to provide better training for teachers, allocate more adequate resources, and design curricula that are more flexible and responsive to modern teaching and learning needs (Branchaw et al., 2020; Dange & Siddaraju, 2020; Ormancı et al., 2020; Amir et al., 2022). This study aims to determine the relationship between the application of four critical 21st-century skills—critical thinking, communication, collaboration, and creativity (4C)—into biology learning and its impact or relationship to learning outcomes and Soft Skills of high school students in Jayapura City.

Method

Place and Time of Research

Research will be conducted at SMA Negeri 3 Jayapura, SMA Negeri 1 Jayapura, SMA Teruna Bhakti, and SMA PGRI (Negeri 7 Jayapura), for 2 months from July - August 2024.

Population and Sample

The population in this study was all There are 26 high schools in Jayapura City (7 public schools and 19 private schools) (Dapodik Kemenristek Dikti Even Semester 2023/2024). School determination is determined purposively, namely determining the main criteria are Leading State Schools (Upper School) namely SMA Negeri 3 Jayapura, Regular State Schools (Middle School) namely SMA Negeri 1 Jayapura and Private Schools namely SMA Teruna Bhakti and SMA PGRI (SMA Negeri 7 Jayapura). Number of respondents: Teachers from each school are 2 people. The number of students is the same as the total number of class XI study groups.

Research Instruments

Quantitative instruments in the form of questionnaires and qualitative instruments in the form of interview guidelines and observation sheets.

Method of collecting data

Data collection for the first objective in this study, using two approaches, namely quantitative (survey and learning outcome test) and qualitative (interview and observation). Data collection for the second objective on the profile of students' *soft skills* in Jayapura City, qualitative data collected through interviews and observations will be analyzed using Thematic Analysis and Coding: The coding process will be carried out to organize data into relevant categories and facilitate further analysis. Qualitative data is tabulated, inputted, and processed using Qualitative Data Processing *Software,* namely *Watase-Uake.*

Data analysis

For quantitative data analysis, the following statistical methods will be used: Descriptive Statistics: The use of descriptive statistics to present basic data such as the mean, median, mode, and standard deviation of test and survey scores; Correlation Analysis: Using Pearson correlation analysis to determine the relationship between the implementation of 4C and biology learning outcomes and *soft skills*; Multiple Regression Analysis: to determine how much influence the implementation of 4C has on biology learning outcomes and *soft skills development*.

Results and Discussion

The first hypothesis test (Table 1) shows a weak but significant correlation between the 4C skill variables— Critical Thinking, Communication, Collaboration, and Creativity—and the development of soft skills in students. Based on the results of the Product Moment Correlation Test, the Pearson correlation coefficient between the 4C variables and soft skills is 0.197 with a significance level of 0.045 ($p < 0.05$). This indicates that there is a relationship between the two variables, although the strength of the relationship is low or very weak.

Table 1. Product Moment Correlation Test

		Correlations		
		x	y1	y2
x	Pearson Correlation	1	.197 *	-.185
	Sig. (2-tailed)		.045	.060
	N	104	104	104
y1	Pearson Correlation	.197 *	1	-.096
	Sig. (2-tailed)	.045		.334
	N	104	104	104
y2	Pearson Correlation	-.185	-.096	1
	Sig. (2-tailed)	.060	.334	
	N	104	104	104

*. Correlation is significant at the 0.05 level (2-tailed)

This weak correlation implies that although 4C skills play a role in the development of soft *skills*, the level of influence is limited. This finding is in line with the research of Azmi et al. (2024), which states that the application of 4C skills in an educational context does contribute to the development of soft *skills*. However, to achieve a more substantial impact, additional methods or factors may be needed. Furthermore, Hikmah et al. (2023), emphasized that the integration of 4C in project-based learning can improve creativity and critical thinking skills, which are important components of soft *skills*. However, its direct influence on the development of soft *skills* may vary depending on the educational context in which it is applied.

The second hypothesis test, shown in Figure 3, examines the simultaneous relationship between 4C skills (Critical Thinking, Communication, Collaboration, and Creativity), soft *skills*, and learning outcomes using Way Multivariate Analysis (MANOVA). This approach is suitable for measuring the effect of one independent variable (4C skills) on several dependent variables (soft *skills* and learning outcomes). Based on the results of the MANOVA test, the analysis shows that there is no significant simultaneous relationship between 4C skills and the combined variables of soft *skills* and learning outcomes, with the Wilks' Lambda value indicating a significance value greater than 0.05 (p = 1.000) .

These results indicate that 4C skills, when implemented as a whole, may not directly impact soft *skills* and learning outcomes simultaneously. This may be due to external factors such as the educational environment and social support from peers, which greatly affect student motivation and participation (Chen et al., 2023; Hendrawati & Wuryandani, 2023). In situations where the learning environment is less supportive, the positive influence of 4C skills on learning outcomes may be hampered even though innovative learning methods have been implemented. The following is a detailed comparison of each 4C component between Sekolah Penggerak and Sekolah Reguler, based on their respective percentages:

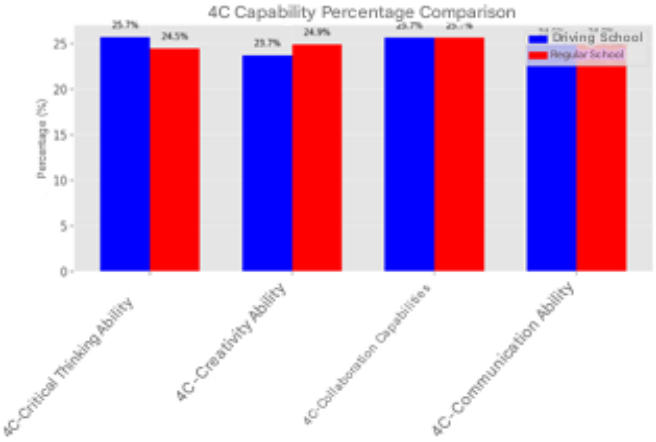

Figure 1. Comparison of students' 4C abilities between schools

Critical thinking, Sekolah Penggerak has a slightly higher percentage (25.74%) allocated to critical thinking compared to Sekolah Regular, which has 24.48%. This difference suggests that Sekolah Penggerak may invest more in developing students' analytical skills and their ability to critically evaluate information. Creativity, Regular Schools allocate a higher percentage (24.92%) compared to 23.70% for the Mover Schools. This difference indicates that Regular Schools may place more emphasis on developing imaginative and innovative thinking among their students. Activities in Regular Schools may include art projects, creative writing, or open-ended assignments that allow students to express their ideas freely.

Collaboration, Both the Driving Schools and Regular Schools have almost identical percentages for Collaboration, at 25.67% and 25.68% respectively. This similarity suggests that both types of schools prioritize teamwork and cooperative learning to a similar degree. Communication, similarly, for Communication, Regular Schools are slightly ahead with 24.92%, compared to 24.88% for the Driving Schools. This small difference suggests that Regular Schools may have a slightly higher focus on verbal and written expression. On these additional skills metrics, Mover Schools generally score higher than Regular Schools, reflecting a curriculum that emphasizes holistic skill development. Some key observations include:

Adaptability and Time Management

Sekolah Penggerak places greater emphasis on developing students' adaptability and time management skills, demonstrating a curriculum that prepares students for the demands of a rapidly changing modern environment.

Empathy & Ethical Awareness

Penggerak Schools place more emphasis on social and ethical values, preparing students to become

empathetic and ethically responsible individuals. Regular Schools also value these skills, albeit to a lesser extent.

Self-Motivation & Initiative

Driving Schools encourage students to be proactive and have an internal drive, whereas Regular Schools may rely more on structured guidance. Overall, the Mover Schools appear to instill a broader range of personal and social skills, preparing students to navigate a variety of situations, manage their responsibilities, and act with empathy and ethical consideration. Regular Schools, while still supporting these skills, might do better by integrating more opportunities for students to build these competencies.

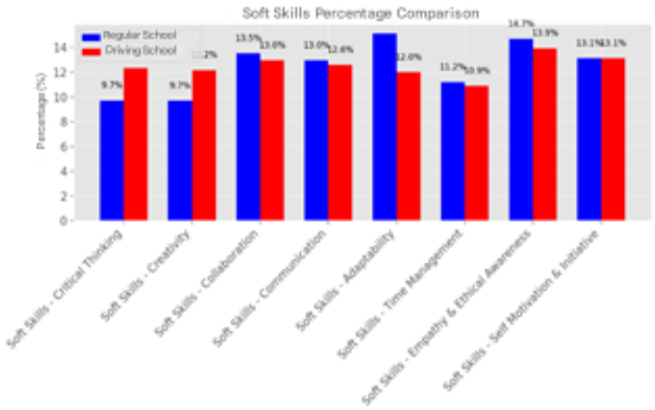

Figure 2. Comparison of soft skills components of driving schools and regular schools

The graph above shows the trend of soft skills performance between "Moving Schools" and "Regular Schools" based on the total score for each soft skill. Each dot represents the score for soft skills such as Critical Thinking, Creativity, Collaboration, and others. From this graph, you can see how the performance of each skill compares between the two types of schools and how it differs across the various skills. Research by Lavado-Anguera et al. (2024), Li et al. (2023), emphasized that adaptability in students is significantly increased through experiential learning approaches, such as project-based learning and simulations. These methods allow students to face unexpected situations and adapt to new challenges, which may explain the higher adaptability scores in "Moving Schools." In addition, the supportive environment provided by teachers and peers plays an important role in developing adaptability (McLean et al., 2023; Colognesi et al., 2020). Such support structures appear to be more prominent in "Moving Schools," which may contribute to the superior adaptability demonstrated by students there.

The variation in 4C skills between "Sekolah Penggerak" and "Sekolah Reguler" is in line with the findings of Arifin et al. (2020) which highlighted the influence of learning styles, such as field-dependent and Field Independent styles, on critical thinking and problem-solving skills. Field Independent style students tend to excel in analytical and problem-solving skills, which appear to be better accommodated by "Sekolah Penggerak" through activities that support Critical Thinking skills and more intense collaboration. This suggests that the "Sekolah Penggerak" curriculum may be designed to support students in processing information independently and critically, with activities such as debates and analytical tasks that stimulate their critical thinking skills. In contrast, students in "Sekolah Reguler" focus more on Creativity and Communication, which suit the needs of Field Dependent style students who are better at expressive and verbal-based tasks (Saugi et al., 2023).

The following is a comparative analysis of the Average Learning Outcomes between Driving Schools and Regular Schools based on the data:

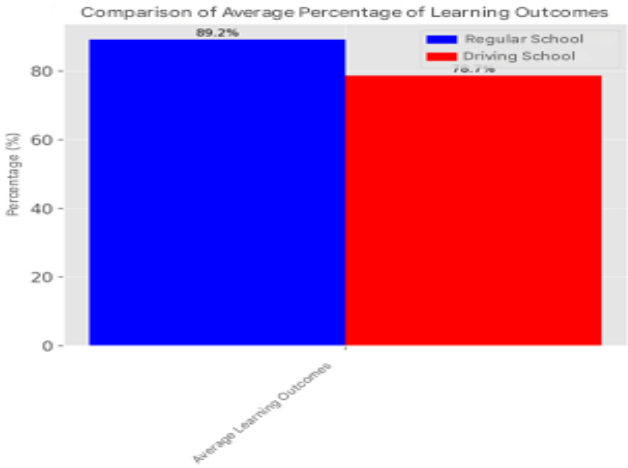

Figure 3. Comparison of average learning outcomes between pioneer schools and regular schools

The findings presented in Fig. 3 show the relationship between the 4C components (Critical Thinking, Creativity, Collaboration, Communication), soft skills, and student learning outcomes. These results are in line with the literature that emphasizes the positive impact of mastery of 4C skills and soft skills on academic achievement. As stated by Aben-Ahmed (2022), Kivunja (2015), Van Laar et al. (2020), the development of 4C skills serves as a foundation for broader soft skills, which support higher academic engagement and success. For example, critical thinking and creativity skills enable students to analyze information and generate innovative solutions, which enhances their problem-solving abilities in academic contexts (Utami et al., 2022).

These skills not only help students achieve better grades but also support their performance outside of the academic environment, which emphasizes the importance of integrating 4C development into the educational framework (Salybekova et al., 2023). Soft skills, such as communication and collaboration, play a vital role in academic success by creating a supportive learning environment. Research by Cao et al. (2023) and Mafarja et al. (2023), shows that students who have good communication skills can interact more effectively with teachers and peers, which ultimately improves their understanding of the subject matter and level of engagement in the learning process. In addition, collaborative skills enable students to work efficiently in teams, which has been shown to improve creativity and problem-solving abilities (Ruiz-Rojas et al., 2024).

Group activities and collaborative projects provide opportunities for students to apply their knowledge in real-world contexts, thereby improving their overall learning outcomes. These findings suggest that the 4Cs and soft skills reinforce each other and together contribute to better educational outcomes. Overall, the higher mean scores of learning outcomes in the Mover Schools indicate that students there may receive a higher quality education and more effective teaching methods compared to Regular Schools (Almoslamani, 2022; Kintu et al., 2017). To improve the mean scores of learning outcomes in Regular Schools, some steps that can be considered include introducing more innovative teaching methods, improving the quality of teacher training, and providing additional resources that support a dynamic and student-centered learning environment.

Conclusion

The conclusion of this study is as follows: There is a significant but weak correlation between 4C skills and soft skills, while the relationship between 4C skills and academic outcomes does not show a substantial correlation; The analysis also showed that students in "Sekolah Penggerak" had higher levels of mastery of the 4Cs and soft skills compared to students in "Sekolah Regular." Students from "Sekolah Penggerak" showed better levels of adaptability, self-motivation, and initiative, which were likely influenced by more innovative teaching methods and a supportive learning environment; The 4C framework plays a vital role in preparing students for future challenges by encouraging the development of essential soft *skills. However, the impact of 4C skills on academic outcomes* appears to be limited, possibly due to the influence of external factors such as social support and curriculum approaches. These findings are in line with increasing attention to holistic education, which encourages a balance between mastery of academic content and the development of interpersonal skills to prepare students for an increasingly complex and connected world.

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Author Contributions

Conceptualization, R. E. R.; methodology, P. J. K.; validation, A. R.; formal analysis, R. M.; investigation, D. R. J.; resources, R. E. R.; data curation, P. J. K.: writing—original draft preparation, A. R.; writing—review and editing, R. M.: visualization, R. E. R. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

This research was purely done collaboratively and there was no internal conflict.

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