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WEB Oriented Constructivist Learning to Increase Students' Self Regulation and Academic Achievement

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ABSTRACT

Constructivist learning emphasizes the active role of learners in constructing knowledge through experience, social interaction, and reflection. However, students often encounter difficulties in meeting the prerequisite knowledge required for effective learning. This study aims to examine the effect of web oriented constructivist learning on improving students' self regulation skills and academic achievement in Biology, particularly in biodiversity topics. The research employed an experimental method with a One Group Pretest-Posttest Design involving 38 students from class X-MIA 6 at a senior high school in Bandung Regency. Data were collected using questionnaires and test instruments, then analyzed through gain calculation and multiple linear regression. The results indicated a moderate increase in both self regulation skills and academic achievement based on the gain index. Furthermore, the correlation analysis revealed that the constructivist approach and self regulation skills collectively had a significant positive impact on students' academic achievement. These findings suggest that integrating a web oriented constructivist approach can effectively enhance self regulation skills and learning outcomes in Biology education.

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Introduction

In the 21st century, higher education increasingly emphasizes the development of essential skills to prepare future generations (Karaca-Atik et al., 2023). Within this learning paradigm, the Delors Report (1996) outlined four pillars of education, one of which highlights the importance of academic achievement and self-regulation skills (Banerjee & Mahato, 2022). Self-regulation is a crucial prerequisite for academic success, as students with strong self-regulation skills are more likely to stay motivated, persist in their studies, and achieve better learning outcomes (Hidajat, 2023). These skills help students recognize the significance of motivation, enthusiasm, and academic performance in shaping their future careers (Herring, 2018). Moreover, self-regulation levels serve as indicators of academic achievement—higher levels correlate with better performance, while lower levels suggest a need for further guidance (Zimmerman, 1996 in Lee et al., 2023). As a core component of constructivist learning, self-regulation empowers students to take ownership of their learning process, fostering independence and responsibility (García-Ros et al., 2023).

Despite its importance, self-regulation remains a challenge in many educational contexts. According to the 2022 PISA international study, which assessed 14,000 ninth- and tenth-grade students across various countries, Indonesia ranked 71st out of 81 countries in reading, 70th in mathematics, and 69th in science (PISA, 2022). These findings highlight the relatively low academic achievement of Indonesian students on a global scale. Research has identified self-regulation as a key factor influencing academic performance, with strong correlations between self-regulation skills and learning outcomes. Additionally, in terms of science concept comprehension, 35% of Indonesian students remain at the 1A competency level, while another 17% are classified even lower (Taipei & Authority, 2022). These statistics suggest that difficulties in understanding scientific concepts exist not only at the international level but may also have national and local implications.

To explore this issue in a specific educational setting, a preliminary study was conducted at SMAN 1 Bandung Regency. Although specific data on students' self-regulation skills at this school are not yet available, some students were found to have scores below the passing grade in science subjects, particularly Biology. This suggests that factors affecting academic achievement—including self-regulation—need to be examined further in the context of learning at this school. Given these challenges, developing self-regulation skills is crucial, as it plays a fundamental role in academic success.

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Self-regulation is especially important when students encounter complex scientific concepts, such as biodiversity (Nückles et al., 2020). The United Nations Conference on Environment and Development (1992) emphasized the strong connection between biodiversity and daily life (Petković et al., 2018). Biodiversity is not just about the variety of living organisms but also includes aspects such as species abundance, composition, spatial distribution, and functional groups (Bermudez & Lindemann-Matthies, 2020). Given the broad scope of biodiversity, students must develop awareness, responsibility, motivation, and a strong enthusiasm for learning. These elements are closely linked to self-regulation skills, and an appropriate learning approach is essential for fostering them (Brenner, 2022).

A learning approach refers to how individuals process and manage information, guiding their learning strategies (Gilakjani, 2012). One widely recognized approach in modern education is constructivism, which encourages students to actively engage in the learning process. A constructivist approach can be an effective method to enhance students' self-regulation skills and academic achievement in biodiversity education. By promoting interactive learning, constructivism fosters collaboration, problem-solving, and deeper understanding of scientific concepts (Barger et al., 2018). This approach also allows students to work on projects aligned with their interests, requiring strong self-regulation skills and encouraging active problem-solving (Bransen et al., 2022).

Piaget's theory of constructivism suggests that learning becomes more dynamic when students are at the center of the learning process (Nyamekye et al., 2023). One way to support this approach is by integrating technology-based learning, which facilitates independent learning, enhances self-regulation skills, and improves academic performance. In the Industrial Revolution 4.0 era, the rapid development of technology has transformed education, providing access to vast learning resources and interactive tools (Schmid et al., 2023). Technology-integrated learning, particularly web-based learning, enables students to bridge knowledge gaps and adopt student-centered learning strategies (Ndebele & Mbodila, 2022).

Previous studies have examined various aspects of self-regulation, constructivist learning, and technology in education. Research has demonstrated that self-regulation skills positively impact online and blended learning, leading to improved academic performance across different subjects (Xu et al., 2022). Other studies have confirmed the effectiveness of constructivist learning in secondary education (Ugwuozor, 2020) and highlighted the role of technology in e-learning (Yaw Obeng & Coleman, 2020). However, most existing research has explored these factors in isolation, without investigating their combined impact. There is limited research on how self-regulation, constructivist learning, web-based learning, and academic achievement interact—particularly in the context of biodiversity education at the high school level.

Therefore, this study aims to examine whether a web-based constructivist approach can enhance self-regulation skills and, in turn, improve students' academic achievement in biodiversity learning. Specifically, this research investigates the relationships among these variables and evaluates their relative contributions to academic success. The findings are expected to provide new insights and innovative strategies for improving science education through technology-enhanced, student-centered learning approaches.

Methods

This study employed a Pre-Experimental Method with a One Group Pretest-Posttest Design to investigate the impact of a web-oriented constructivist approach on self-regulation skills and academic achievement in biodiversity learning. The population consisted of Class X students at SMAN 1 Bandung Regency, while the research sample included 38 students from one class. This class was selected based on the assumption that students with medium academic abilities have greater potential for improvement.

Data collection utilized non-test techniques, including a self-regulation skills questionnaire and a participant satisfaction questionnaire to evaluate students' perceptions of the web-based constructivist approach. Additionally, a test instrument was administered to assess students' mastery of biodiversity concepts. A mixed-method approach was applied for data analysis, combining quantitative and qualitative techniques through observations and measurement scales. The collected data were analyzed using gain score calculations to determine the magnitude of improvement and a Multiple Linear Regression Test to examine the relationships between variables. Statistical analysis was conducted using SPSS 26.0 for Windows.

Results and Discussions

The research on "Web-Oriented Constructivist Learning to Improve Students' Self-Regulation and Academic Achievement" gathered data on students' self-regulation skills, their satisfaction with the learning approach, and their understanding of biodiversity concepts. The following section compares the results of self-regulation skills and academic achievement scores.

Table 1. Comparison of Pretest and Posttest Self Regulation Results

Data Type	Mean	Minimum Score	Maximum Score
Pretest	66	40	79
Posttest	77	67	91

Table 2. Comparison of Pretest and Posttest Academic Achievement Results

Data Type	Mean	Minimum Score	Maximum Score
Pretest	41	20	63
Posttest	70	50	90

Table 1 shows an increase in the average score between the pretest and posttest by 11 points (from 66 to 77), while Table 2 indicates a 29-point increase (from 41 to 70). Based on the gain score calculations, both self-regulation and academic achievement fall into the moderate improvement category, with gain values of 0.34 and 0.49, respectively.

Figure 1 provides a clearer visualization of these results. In the self-regulation aspect, 1 student (3%) showed no improvement, 16 students (42%) experienced a low-level increase, and 21 students (55%) demonstrated a moderate-level increase. Meanwhile, for academic achievement, 9 students (24%) showed a low-level increase, 23 students (61%) achieved a moderate-level increase, and 6 students (15%) reached a high-level increase.

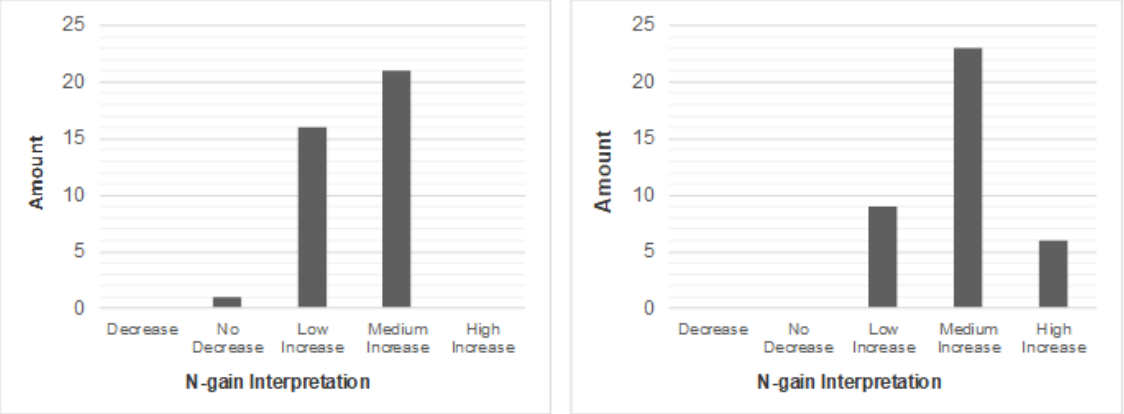

Figure 1. Gain Self Regulation Index Category Graph (left side) and Academic Achievement Gain Index Category (right side)

Meanwhile, a recapitulation of research data regarding the self regulation profile before and after the implementation of the learning approach for each indicator developed can be seen in the table below:

Table 3. Recapitulation of Self Regulation Indicators

Self Regulation Indicators	Number of Responses/ Indicator		Mean Score/ Indicator	
	Before	After	Before	After
Becoming Aware of Your Own Thoughts	446	534	12	14
Plan Effectively	540	593	14	16
Be Aware of and Use Information Sources	529	614	14	16
Sensitive to Feedback	498	585	13	15
Evaluating the Effectiveness of Actions	478	617	13	16
TOTAL	**2491**	**2943**	**66**	**77**

The table shows that before the learning process, the total number of responses reached 2,491 out of a possible 3,800, with an average score of 66 out of 100. After learning, the total responses increased to 2,943 out of 3,800, with an average score of 77 out of 100. These results indicate a positive change in students' self-regulation skills. Meanwhile, the recapitulation of students' academic achievement levels can be seen in Figure 2.

Figure 2. Graph of Criteria for Students' Academic Performance Levels

The graph above illustrates that before implementing the learning approach, students' academic achievement was categorized as adequate or not good. However, after the implementation, their achievement improved, with some students reaching the "good" category and even a few achieving "very good" results. This confirms an overall increase in academic achievement scores. To further analyze the extent of the relationship between variables, a multiple linear regression test was conducted. The independent variables in this study were the constructivist learning approach and self-regulation skills, which were examined for their potential influence on the dependent variable—academic achievement scores. However, before performing the multiple linear regression test, the data analysis process began with testing classical regression assumptions, as explained below.

Normality Test

In multiple linear regression, the normality test uses a Probability Plot and histogram as seen in the following image:

In the picture, it can be seen that the plotting data shows that the distribution of points follows/is close to the diagonal line and the curve forms a bell with a normal curve, so that the data shows a normal distribution and meets the normality assumption.

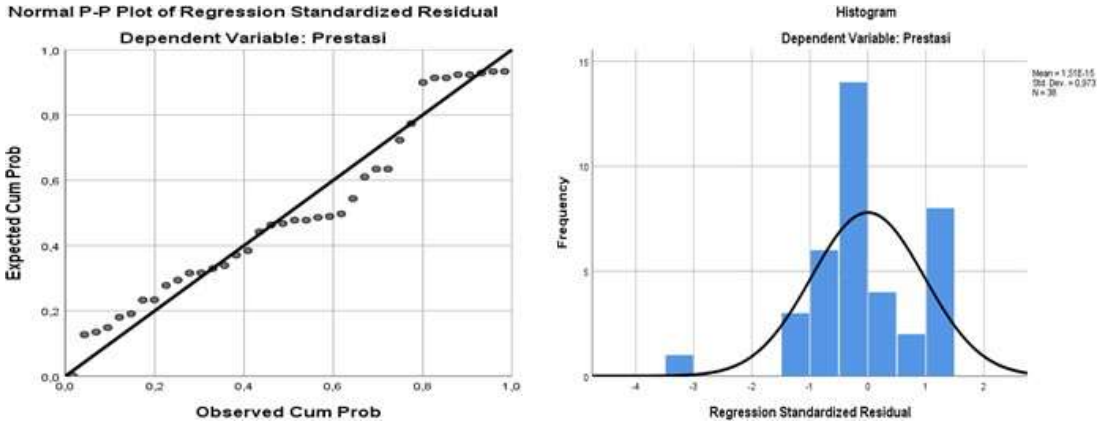

Figure 3. Chart of Normality

Multicollinearity Test

Multicollinearity analysis was carried out by considering the Tolerance and VIF (Variance Inflating Factor) values in the self regulation skills data as well as the constructivism approach. The Tolerance value is 0.774 (greater than the reference value of 0.10), while the VIF value reaches 1.292 (smaller than the reference value of 10). From these results, it can be concluded that there are no symptoms of multicollinearity in the regression model, in other words the classical assumptions are met.

Heteroskedasticity Test

This test uses the scatterplot graph in Figure 4. From this image, it can be seen that there is no clearly defined pattern, because the points are scattered above and below zero on the Y axis. Thus, it can be concluded that there are no signs of sign of heteroscedasticity, explaining that the classical assumption test is also fulfilled.

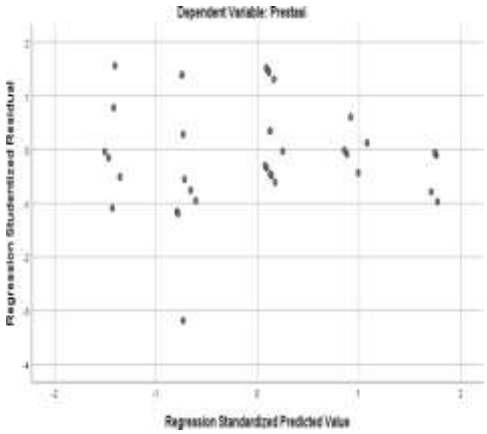

Figure 4. Scatterplots Chart

Uji Autokorelasi

This test applies a run test with Asymp values. Sig. (2-tailed) of 0.411, which shows the results are greater than the reference significance of 0.05. Therefore, it can be concluded that there are no signs of autocorrelation so that it meets the classical assumptions.

Hypothesis Testing

After all the classical assumption tests are met, the data analysis continues to the multiple linear regression test to test the hypothesis. The types of testing carried out include:

1. Parsial t Test

Partial t test is an evaluation of the effect of individual variables X on variable Y. This is based on the decision "if the significance value is smaller than the reference value of 0.05, then the independent variable (X) has a partial influence on the dependent variable (Y)". The following are the results of the partial test analysis seen in the coefficient table:

Table 4. Parsial t Test

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Tolerance**	**VIF**
(Constant)	-65.135	10.204		-6.383	.000		
Constructivist	1.532	.099	.921	15.468	.000	.774	1.292
Self Regulation	.142	.144	.059	.987	.330	.774	1.292

Dependent Variable: Prestasi

Source: *SPSS 26 for windows*

Based on the test analysis results listed in the coefficient table, a significance value for the constructivist approach was obtained of 0.000, indicating that the independent variable (constructivist approach) partially influences the dependent variable (academic achievement). Meanwhile, the significance value of self regulation skills shows 0.330, indicating that the independent variable (self regulation) partially has no influence on the dependent variable (academic achievement). The form of the regression equation is as follows:

$$Y = a + b_1X_1 + b_2X_2$$

Figure 5. Regression equation

From this equation a formula can be drawn that the value of Y = 30.619 + 0.002 + 0.610. The regression coefficient for the constructivism approach (X_1) is b1 = 1.532. This coefficient is positive, indicating that if the constructivist approach increases by 1 unit, then academic achievement (Y) is also estimated to increase by around 1.532 units. The regression coefficient for self regulation skills (X_2) is b2 = 0.142. A positive coefficient also indicates that if self regulation skills increase by 1 unit, then academic achievement will also increase by around 0.142 units.

2. Simultan F Test

The Simultaneous F Test is a test of the overall impact of variables X on variable Y. The results of this test are in the Anova table, where if the Sig value is > 0.05, then Ho is accepted, while if the Sig value is < 0.05 then Ho is rejected.

Table 5. Simultan F Test

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	481.,969	2	2406.985	164.589	.000[b]
	Residual	511.846	35	14.624		
	Total	5325.816	37			

a. Dependent Variable: Prestasi

b. Predictors: (Constant), Self Regulation, Constructivist

Source : *SPSS 26 for windows*

The table shows that the significance value obtained in this study is 0.000 (calculated sig < reference sig 0.05), indicating that the null hypothesis (Ho) is rejected. This leads to the conclusion that there is a significant relationship between self-regulation skills and the constructivist learning approach. In other words, self-regulation and the constructivist approach collectively impact academic achievement. To further evaluate the extent of the influence of the independent variables on the dependent variable, both partially and simultaneously, complete details can be found in the following Model Summary table.

Table 6. Simultan F Test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.951[a]	.904	.898	3.82416	2.521

a. Predictors: (Constant), Self_Regulation, Constructivist

b. Dependent Variable: Achievement

Source : *SPSS 26 for windows*

The coefficient of determination (R Square) in Multiple Linear Regression indicates "How much contribution/influence the variables X1 (self regulation skills) and X2 (constructivist approach) together have on variable Y (academic achievement)". The R square value in the table shows a figure of 0.904, which shows that self regulation skills and a web oriented constructivism approach together have an influence of 90.4% on increasing academic achievement on the concept of biodiversity. While the remaining 9.6% is influenced by other factors.

The results of the questionnaire analysis indicate that students' self-regulation skills were initially low before implementing the constructivist approach (see Table 1). However, after applying this approach as a solution in the study, there was a noticeable improvement in self-regulation skills. These skills play a crucial role in learning success and can be influenced by both internal and external factors (Divayana et al., 2021).

Internal factors relate to personal conditions, such as variations in students' learning endurance—some can study for hours without interruption, while others can only focus for a limited time (Halawa & Mulyanti, 2023). This is reflected in the questionnaire results for the indicator "becoming aware of one's own thoughts," which assesses students' planning and preparation. The indicator received the lowest average score (see Table 3), suggesting that not all students in class X-MIA 6 had established habits or preferences for preparing themselves before studying. These differences in learning endurance may contribute to the variation in self-regulation skills.

External factors, particularly the surrounding environment, also play a significant role in shaping self-regulation skills. This environment includes not only family and society but also the school setting, including the atmosphere and the way teaching and learning activities are conducted (Yandi et al., 2023). Interviews with biology teachers at SMAN 1 Bandung Regency revealed that the teaching approach used in the classroom had not been optimized, which could potentially affect students' learning success. Since the learning approach serves as the foundation for managing the learning process, its effectiveness is critical (Paputungan & Paputungan, 2023). The questionnaire data on the indicator "planning effectively, being aware of and utilizing information sources, and responding to feedback" showed a lower average score before implementing the constructivist approach compared to afterward (see Table 3).

Teacher-centered learning tends to discourage students from actively seeking information related to the subject matter (Asilevi et al., 2023). As a result, students become more passive, and classroom interactions—both between teachers and students and among students themselves—are limited (Haley et al., 2021). This aligns with the theory of Brook and Brooks (Homepage et al., 2023), which describes conventional classrooms as environments where students are passive recipients of knowledge while teachers act as the sole providers of information. Consequently, students have little motivation to explore concepts independently since all the material is delivered directly by the teacher. This is linked to students' low self-regulation skills, particularly in the "evaluating the effectiveness of actions" indicator. Brook and Brooks further argue that traditional learning methods encourage individual work rather than collaborative learning, which negatively impacts the "sensitivity to feedback" indicator. Without collaboration, students tend to work alone without engaging with their peers' perspectives. In contrast, group-based learning fosters creativity and collaboration, essential elements for developing self-regulation skills (Mulyono, 2018).

The improvement in self-regulation skills following the implementation of the web-oriented constructivist approach aligns with the theoretical framework emphasizing that this method places students at the center of the learning process. The constructivist approach is designed to maximize students' potential by actively involving them in learning (Ayse, 2018). Moreover, it aligns with the 2013 Curriculum and the Independent Curriculum, both of which

emphasize the student's central role in education (Muzakki, 2021; Tishana et al., 2023; Sumiati et al., 2024). One of the key advantages of this approach is that it allows students to develop and apply their own ideas while encouraging them to select and utilize learning strategies that best suit them (Ecevit & Özdemir, 2020). As a result, students become more prepared and motivated to plan their learning effectively, ultimately improving their self-regulation skills, particularly in the areas of "becoming aware of one's own thoughts" and "planning effectively."

The constructivist approach encourages students to construct knowledge through personal exploration and initiative (Marliat, 2023). When applied in the classroom, it enhances self-regulation skills, particularly in the area of "being aware of and utilizing information sources." This approach fosters active learning, prompting students to seek information from diverse sources, including digital platforms such as the internet and online learning tools. In today's digital era, educators must integrate technology into their teaching methods to support both in-class and out-of-class learning (Asriadi et al., 2023).

Advancements in science and technology have significantly influenced learning methods (Nuragnia et al., 2021). In this study, improvements in self-regulation skills and academic achievement were not solely attributed to the constructivist approach but also to its integration with web-based learning. This is because constructivist learning encourages students to build new knowledge based on their prior understanding and experiences. The web serves as a valuable tool for knowledge construction, aiding students in analyzing observations and exploring fundamental concepts (Deejring, 2014). Web-based learning provides students with open and flexible access to educational resources anytime and anywhere, making learning more engaging, efficient, and accessible (Yaw Obeng & Coleman, 2020). Additionally, it fosters student collaboration, enables active participation in learning communities, and facilitates discussions and idea-sharing (Ikhsan et al., 2019).

There is a significant positive correlation between academic achievement and self-regulation strategies in the learning process (Corazza et al., 2023). To further assess this, students' academic performance was measured using a concept mastery test on biodiversity (see Table 2). According to Arikunto’s criteria for concept mastery levels (Rusti, 2023), the results indicated that before implementing the constructivist approach, students' mastery of concepts was still low. No students met the minimum score of 75 required by the school’s minimum competency standards (KKM). This was likely due to inadequate learning preparation before class. Traditional teaching methods do not encourage students to develop their own understanding, as they primarily rely on teacher-delivered content rather than active student participation. Ideally, learning processes should be tailored to students' needs, equipping them with the necessary skills to overcome future challenges (Puteri et al., 2023).

Conclusions

Based on the previous analysis and discussion, it can be concluded that the web-oriented constructivist approach has a positive impact on improving students' self-regulation skills and academic achievement. However, the correlation between self-regulation skills alone and increased academic achievement is not highly significant, although it still shows a positive relationship. In contrast, the correlation between the web-oriented constructivist approach and academic achievement is significant, demonstrating a strong positive relationship.

In this study, self-regulation skills were measured solely through a self-assessment questionnaire completed by students at the beginning and end of the lesson. This method may have led students to respond with answers they perceived as positive rather than reflecting their actual self-regulation abilities. Therefore, further research is needed to assess self-regulation skills more comprehensively using multiple instruments, such as teacher observation sheets, achievement records, and specialized tests or assignments. Implementing a more diverse set of assessment tools will provide more accurate and reliable insights into students' self-regulation skills.

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