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Enhancing Students' Future Thinking Skills on Deforestation Through the Know, Understand, Do (KUD) Strategy: A Quasi-Experimental Study

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ABSTRACT

Future thinking skills are essential for preparing students to face complex global challenges through imaginative, strategic, and anticipatory thinking. However, empirical research on these skills is still limited, especially at the high school level. Based on observations, students' future thinking skills at SMAN X Sukabumi City are still low because learning does not encourage future thinking. This study aims to examine the effect of the Know, Understand, Do (KUD) strategy on students' future thinking skills, analyze skill levels across specific indicators and gender, and explore students' responses to the learning. Using a quasi-experimental design with a non-equivalent control group, data were collected through validated essay tests and student response questionnaires. Results indicate that the KUD strategy significantly improves students' future thinking skills ($p = 0.018$), with higher normalized gain scores (N-Gain = 0.70) compared to the control group (N-Gain = 0.59). Analysis of indicators shows notable improvements in visioning, predicting, planning, anticipating, and evaluating. Gender differences did not significantly affect outcomes. Additionally, student responses revealed a high level of engagement and perceived relevance of the strategy. These findings highlight KUD as a promising strategy to foster anticipatory and sustainable thinking among students.

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1. INTRODUCTION

Education for sustainable development (ESD) can equip students to become active and sustainable citizens in shaping the future (UNESCO, 2017). One of the core competencies supported by ESD is future thinking. This ability involves students to project the future that will happen, making strategic choices based on data to support long-term sustainability by considering various possibilities that will occur (Gardiner & Rieckmann, 2015). Future thinking can change the way of thinking and help raise awareness of the importance of knowledge for future sustainability (City of Helsinki, 2018; OECD, 2019; UNESCO, 2017). According to Al-Hussaeini *et al.* (2021) state that future thinking skills can be defined as a complex mental activity that includes understanding, analyzing and synthesizing information about past and present problems. Thus, the process aims to form mental images and expectations related to the future in anticipating opportunities and risks. This is an integral part of the sustainability competency framework to anticipate future challenges (Nations, 2022).

The problem in Indonesia is that students' forward thinking skills have not been specifically measured in international surveys. In general, Indonesia faces challenges in improving forward thinking skills. Based on observations, the forward thinking skills of students at State High School X in Sukabumi City have not been trained. This is because most learning approaches do not encourage future thinking (Al-Abdullah & Ward, 2022). Therefore, learning that integrates future thinking skills must be done. Thus, students can define a vision to create goals that are in line with sustainable development principles, predication or trend analysis can help students when making decisions (González-pérez & Ramírez-montoya, 2022). Planning activities in learning can improve students' ability to work together to achieve long-term success. Not only that, anticipation and evaluation help students assess the impact of decisions and refine actions based on feedback (Durance, 2010 in

Suhendar *et al*., 2025). Research on measuring future thinking skills among secondary school students is still limited (Afikah *et al*., 2022; Nagai, 2019; Suhendar *et al*., 2025).

One of the strategies used to integrate students' future thinking skills is the Know, Understand, Do (KUD) strategy. Students are guided to know the learning concepts learned (Know), understand thoroughly (Understand), and be able to apply them in real life (Do). According to research conducted by Suwaidi & Hassan (2023) the KUD strategy can be promising as learning to increase student interest and enthusiasm. The KUD strategy can also improve students' future thinking skills (Al-Abdullah & Ward, 2022). The researcher seeks to maximize the KUD strategy through a deforestation case study to analyze problems, take relevant actions, strengthen self-control over future challenges and consider the long-term impact of these actions. Deforestation is the condition of forest area that has decreased due to land conventions used for infrastructure, settlements, agriculture, mining and plantations (Yakin, 2011). Various causes of deforestation consist of forest burning, agricultural conversion, timber harvesting and firewood use (Fund, 2020). Forest land loss is a problem that is difficult to overcome, so it requires good knowledge and cooperation between various parties to actively participate and support programs that can solve problems to be faced together (Forest Watch Indonesia, 2020).

This study aims to examine the effect of KUD strategies on students' future thinking skills, analyze the level of students' future thinking skills for each indicator, analyze future thinking skills based on gender differences, and explore students' responses to learning. The study is expected to show that KUD strategies can improve students' future thinking skills in adapting to future challenges.

2. RESEARCH METHOD

The method used was a quasi-experiment with a non-equivalent control group design. This study was conducted in May 2025 at SMAN X Sukabumi City. The research population consisted of 11 classes with a total of 396 tenth-grade students in the even semester of the 2024/2025 academic year at SMAN X Sukabumi City. The sample was selected using purposive sampling based on students' low cognitive scores in biology, lack of active involvement in learning, and psychological considerations referring to the characteristics or mental and emotional conditions of relatively balanced individuals. Based on these criteria, two classes were selected as the research sample, with a total of 57 students, as shown in Table 1. There was a difference in the number of students between the experimental class and the control class because some students were absent, so their data was not included to maintain the consistency and accuracy of the research results.

Table 1. Research Sample

Class	Gender	Number of Students
Experiment	Female	16
	Male	13
Control	Female	20
	Male	8

Data collection was conducted using test instruments and student response questionnaires on KUD strategy learning for future thinking skills. The test instruments were tested for readability by a number of students to ensure clarity of language, and for validity by expert judgement to assess the quality of the instrument's content and ensure that each item was aligned with the indicators of students' future thinking skills. These assessment aspects were included likert scale assessment sheet for validation. The assessment results showed that the test questions could be used with some improvements to the wording of the questions and adjustments to the level of difficulty for students. Then reliability, difficulty level, and discriminating power were tested using Anates software. The student response questionnaire was also tested for validity by the same expert judgement. This validation meets the criteria for statement relevance to student engagement aspects, language clarity, and format appropriateness. The instrument is deemed suitable for use after minor revisions.

The analysis of future thinking skills test data was conducted in several stages. Before the treatment was administered, an initial test was conducted to measure the students' initial abilities and ensure equality between groups. Subsequent stages involved applying targeted interventions designed to enhance future thinking skills. Following the treatment, a post-test was administered to evaluate the effectiveness of the interventions and assess any improvements in the students' abilities. Hypothesis testing was performed using the Independent Sample Test with the help of SPSS, and measuring the improvement in students' future thinking skills using N-Gain. The student response questionnaire was non-test-based, with each statement given a positive to negative score using a likert scale.

3. RESULT AND DISCUSSION

The Effect of KUD Strategy on Students' Future Thinking Skills

The results of data analysis show that the application of the KUD learning strategy can have an influence on students' future thinking skills. Evidenced by the significant difference between the experimental class and the control class, as shown in the results of the independent sample test postest value of 0.018 ($p < 0.05$) table 2.

Table 2. Statistical Test Results

Class	N-Gain	Normality			Homogeneity		Uji Independent Sample Test		
		Shapiro-Wilk			Levene Statistic	Sig.	df	Sig. (2-tailed)	Description
		Statistic	df	Sig.					
Control	0.59	0.958	28	0.304	0.115	0.735	55	0.018	Significantly Different
Experiment	0.70	0.952	29	0.201					

Based on the N-Gain, the experimental class that used the KUD learning strategy had a higher score (0.70) compared to the control class (0.59). The use of this learning strategy is based on the theory of constructivism consisting of three stages (Know, Understand, Do) which can increase the potential and ability of students adaptively (Yassin and Raji, 2012 in Al-Abdullah & Ward, 2022). The initial stage (Know), helps students know the problem as a whole. At this stage, students are more interested and connected to the future context. The next stage (Understand), provides an opportunity to learn information, understand its impact and relate to situations that may occur in the future. In the final stage (Do), students create practical solutions by using the previously gained understanding to make decisions. The series of stages are interconnected to solve problems through deforestation case studies that connect students' future thinking skills in facing future challenges. The KUD strategy can be promising as learning to increase students' interest and enthusiasm (Al-Abdullah & Ward, 2022)**.**

KUD learning is supported by student responses that show interest in understanding the impact of deforestation through KUD learning (indicator 1) with a percentage of 84% and student assessment of learning (indicator 4) with a percentage of 92% can be seen in figure 2. Both student response results are categorized as very good. The learning is well received by students in providing interesting experiences, encouraging students to participate actively and think long term. The KUD strategy is able to improve students' future thinking skills (Al-Abdullah & Ward, 2022).

Differences in Students' Future Thinking Skills Per Indicator

On each indicator of future thinking skills in experimental and control classes can be seen in table 3.

Table 3. Future Thinking Skills Per Indicator

Future Thinking Indicators (Suhendar et al., 2025)	Class	Average Value				N-Gain
		Pretest	Std. Deviation	Posttest	Std. Deviation	
Visioning and Emotion	Experiment	44.82	0.55	87.06	0.50	0.76
	Control	38.79	0.48	81.03	0.50	0.69
Predicting	Experiment	30.17	0.41	75	0.59	0.64
	Control	32.75	0.47	64.65	0.67	0.47
Planning	Experiment	32.75	0.47	77.58	0.61	0.66
	Control	34.48	0.49	69.82	0.52	0.53
Anticipating	Experiment	35.34	0.50	82.75	0.76	0.73
	Control	38.79	0.50	72.41	0.66	0.54
Evaluating	Experiment	32.75	0.54	80.17	0.61	0.70
	Control	33.62	0.46	70.68	0.65	0.55

The experimental class had better indicators of future thinking skills than the control class. Visioning and emotion build awareness and emotional responses to future problems as shown by the highest N-Gain (0.76). Concerns and expectations can determine long-term goals (Suhendar *et al*., 2025). Students with better visual imagery can describe events in more detail are able to imagine the future with greater meaning (D'Argembeau *et al*., 2011). Anticipating has the largest N-Gain difference between experimental and control classes (+ 0.19), indicating that through KUD learning helps students become more prepared to face changes in figure 1. Predicting had the lowest N-Gain in the control class (0.47). This low achievement was due to the students' limitations in systematically connecting current information with possible future events. In the control class,

students tended to rely on factual knowledge, resulting in inaccurate and general predictions. This may have occurred due to obstacles in future thinking, including: (1) backward bias, overestimation of the likelihood that has predicted the occurrence of an event; (2) unrealistic optimism; (3) planning errors; (4) the effects of overconfidence; and (5) underestimation of the variability of sustainable trends (Colin *et al*., 2022). All posttest standard deviations in the experimental class were between (0.50) and (0.76) indicating that the scores were spread out with stable averages and improvement occurred evenly.

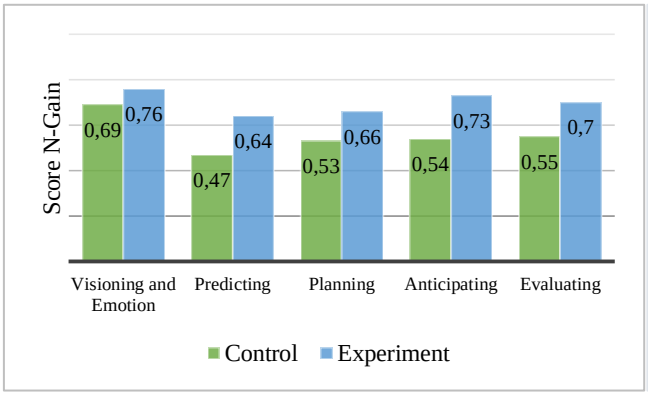

Figure 1. N-Gain Value of Future Thinking Indicator

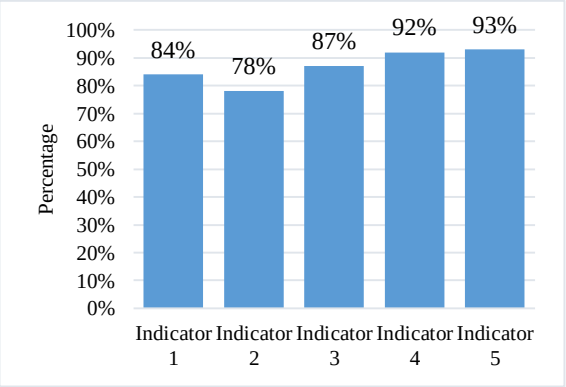

Figure 2. Student Response Questionnaire

The increase in each indicator is supported by students' response to the awareness of the importance of thinking about the long-term impact of the case study (indicator 2) with a percentage of 78%, students' willingness to contribute to environmental conservation efforts in the future (indicator 3) with a percentage of 87%, and students' assessment of increased motivation to find solutions to protect the environment (indicator 5) with a percentage of 93% can be seen in figure 2. This lesson was well received by students, which can increase student awareness and involvement in future challenges, especially in case studies of deforestation that require anticipatory, reflective, and adaptive thinking.

Students' Future Thinking Skills Based on Gender

The analysis of students' future thinking skills based on gender differences is carried out to find out between female students and male students in responding to each question regarding the case study that has been given to the future thinking skills of table 4.

Table 4. Future Thinking Skills Based on Gender

Class	Gender	Average Value		N-Gain	Independent Sample Test		
		Pretest	Posttest		df	Sig. (2-tailed)	Description
Experiment	Female	34.06	80.94	0.71	27	0.889	Not Significantly Different
	Male	36.54	80.38	0.69			
Control	Female	35.50	73.75	0.59	26	0.814	Not Significantly Different
	Male	36.25	74.38	0.58			

The results of the Independent Sample Test for the two classes did not show any statistically significant differences. This means that the future thinking skills of female and male students are equivalent or not significantly different. The findings in this study differ from the results of Suhendar *et al*. (2025), which showed that female students scored significantly higher in five dimensions of future thinking skills. The results indicate a tendency for girls to excel in prospective and systemic thinking. However, item-level analysis of certain questions within the anticipation and prediction dimensions actually favored male students. This suggests variations in performance based on gender characteristics. Conversely, in this study based on N-Gain scores, female students had an advantage in almost every indicator, as can be seen in figures 3 and 4. However, the difference in scores for this improvement was very small and not significant. The results of this study show that gender does not consistently affect students' future thinking skills, depending on the measurement tools used in the study.

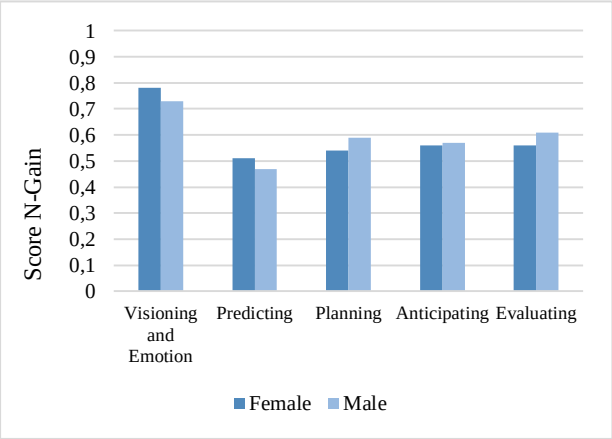

Figure 3. Differences in N-Gain Scores by Gender in the Control Class

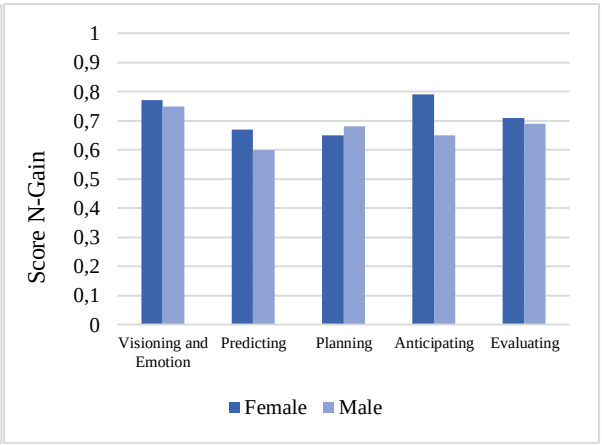

Figure 4. Differences in N-Gain Scores by Gender in the Experimental Class

In addition, one of the factors that can affect future thinking is biological disturbances such as fatigue, memory decline, or distraction. The more one externalizes one's memory, the less optimally trained the brain's memory may be (Colin *et al*., 2022). Conversely, the more memories that are relevant to a subject can result in more qualified future thinking about that subject (Frederiks *et al*., 2019).

4. CONCLUSION

Based on the research conducted, the Know, Understand, Do (KUD) strategy has a significant impact on students' future thinking skills. All indicators show varying degrees of improvement, ranging from the highest to the lowest N-Gain scores. In this study, gender differences did not affect students' future thinking skills. Overall, it can be concluded that the research objectives were achieved, and the KUD strategy was proven effective in enhancing students' future thinking skills, particularly in the case study on deforestation.

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