Kashihara, A. et al. (Eds.) (2024). Proceedings of the 32nd International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Exploring the Impact of Integrating Auto-Photography and Imagery Strategies into Computer-Supported Collaborative Learning: A Case Study in a General Education Course on Climate Change

Wen-Lung HUANG[a*] & Chia-Jung CHANG[b]
[a]*Department of Communication, Fo Guang University, Taiwan*
[b]*Department of Information Communication, Yuan Ze University, Taiwan*
*wenleng.per@gmail.com

Abstract: This study investigates the impact of computer-supported knowledge building, auto-photography, and imagery on university students' cognition and engagement with climate change concepts in a general education course. The findings reveal that integrating Knowledge Forum (KF) with auto-photography and imagery strategies significantly enhances students' engagement and higher-order cognitive activities, such as analysis and creation, compared to using KF alone. However, no significant improvement was observed in the evaluation dimension, indicating the need for further qualitative research to explore the underlying reasons.

Keywords: Computer-Supported Collaborative Learning, Knowledge Forum, Auto-photography, Imagery

1. Introduction

Climate change is the greatest threat and challenge humanity faces this century, prompting international agreements like the United Nations Framework Convention on Climate Change (1992), the Kyoto Protocol (1997), and the Paris Agreement (2016). Since 2019, Taiwan has integrated climate change education into its twelve-year national education system and promoted related courses in higher education to enhance students' understanding and skills regarding climate change.

Despite these efforts, integrating climate change science education into curricula has had limited impact on students' beliefs (France et al., 2022). Previous research suggests that an overemphasis on knowledge per se often fails to promote environmentally sustainable behaviors. Effective curriculum design should enhance students' ability to find meaning, use their imagination, and act on climate change and sustainability issues (Stevenson & Peterson, 2015). This highlights the need for innovative educational approaches that go beyond traditional methods to more effectively engage students and inspire meaningful action on climate issues.

Recent advancements in information technology have driven the development of Computer-Supported Collaborative Learning (CSCL), which broadens instructional innovation and prompts shifts in learning models. Scardamalia's (2002) Knowledge-Building theory emphasizes group participation, reflective thinking, and continuous knowledge innovation. The Knowledge Forum (KF) platform, based on the Knowledge-Building theory, supports collaborative idea generation and refinement through posts and interactions. It automatically records these exchanges, enabling students and teachers to analyze the knowledge formation process while also materializing and visualizing ideas within the community for ongoing exchange and evolution (Zhang et al., 2011).

Additionally, auto-photography, especially landscape photography, can connect individuals to environmental sustainability and allow for personal reflection and emotional

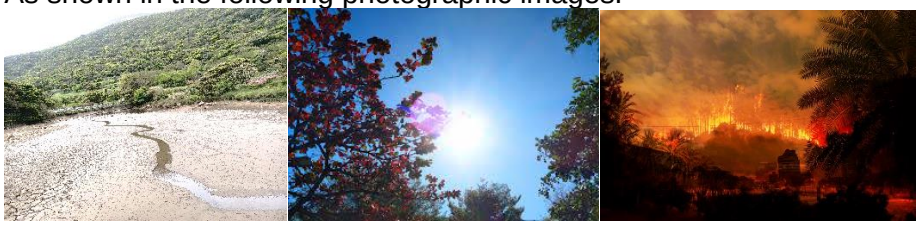
expression (Amerson & Livingston, 2014; Scott, 2014). According to Noland (2006), auto-photography involves participants capturing and choosing images that reflect their perspectives on specific topics. However, auto-photography and imagery pose challenges, such as the influence of others in the environment on the content of photos (Dean, 2007) and the potential for misinterpretation of the two-dimensional images (Thomas, 2009). To address these challenges, researchers frequently pair photos with participants' textual explanations to enhance the clarity of the visual data. For example, some studies revealed that the combination of auto-photography and textual descriptions provides a powerful way to explore complex concepts such as learning and ocean sustainability (Huang et al., 2022; Lin & Li, 2017).

According to the above statement, this study used the KF with auto-photography and imagery to guide students' discussion of questions to enhance university students' cognitive of and engagement with the concept of climate change, which was assessed through the Bloom's categorization method as modified by Anderson et al. (2001).

2. Methods

The sample for this study consists of students enrolled in a climate change general education course at a private university in eastern Taiwan. The study is divided into two classes: Class A, with 56 students, engaged in knowledge-building discussions using the KF; and Class B, with 52 students, participated in similar discussions in the KF, supplemented by auto-photography or imagery teaching strategies. Additionally, prior to the experiment, we arranged a photography lesson for Class B taught by a professional photographer, instructing students on how to use their mobile phones to capture subjects they consider important. After the experiment began, students could use their phones to take photos related to the discussion topics, upload them to the Knowledge Forum (KF), and then provide textual explanations of the images to engage in discussions with their peers. Both classes were taught by the same instructor over a 12-week period, with each session lasting 2 hours. Following each session, students were given two weeks for asynchronous online discussions, totaling six sessions. Importantly, both classes discussed the same climate change-related topics, but Class B combined auto-photography or imagery with guiding questions to enhance their discussion. Examples of discussion questions for Classes A and B are provided in Table 1.

Table 1. *An Example of discussion question for Classes A and B*

	Question 1
Class A	The frequency of high-temperature weather events is increasing worldwide. Please discuss the effects of high temperatures and suggest solutions.
Class B	The frequency of high-temperature weather events is increasing worldwide. As shown in the following photographic images.  Please discuss the following questions: Q1: What features are in these photographs? What insights does it offer about our environment? Discuss the significance of the objects. Q2: Who do you think is responsible for the issues captured in the photograph, and what decisions need to be made? Q3: How do you feel about the content in the photograph? Q4: Can predictions be made from photographed phenomena?

3. Data analysis

To analyze the differences in students' perspectives on climate change between two classes, we collected data from the posts and replies of all community members on Knowledge Forum (KF) and conducted a quantitative content analysis of the interaction data. This analysis aimed to explore the impact of teaching strategies involving KF, auto-photography, and images on students' cognitive objectives related to climate change. Each post was coded according to the six levels of Bloom's cognitive theory, as revised by Anderson et al. (2001), and analyzed at the individual note level. Students' posts were assigned identification codes consisting of uppercase letters and numbers, where the letters indicated the students' class ("A" for Class A and "B" for Class B) and the numbers provided sequential identification for each student. Definition of coding scheme and students' responses to Question 1 as shown in Table 2.

Table 2. The coding schemes for the content analysis of cognitive objective.

Code	Definition	Textual example
Remember	Retrieve relevant knowledge from long-term memory.	I think it's because of the global warming issue that is making the temperatures warmer, and the climate issues that will happen in the future are becoming unknown. (A19) In the 21st century, if our human behavior does not improve now, the chances of natural disasters (be it rainstorms, high temperatures, tornadoes) will be more frequent in the future. (B7)
Understand	Understand the necessary knowledge; connect new knowledge based on past experiences.	The advancement of human civilization has created many damages that will seriously contribute to higher temperatures and worse climates in the future. Climate change has led to climate extremes, with hotter summers and colder winters. (A14) As you can see from the photos, the heat waves brought about by extreme climates have cracked the land, making it difficult to grow plants, and making it easier for forests to cause large fires that are not easy to extinguish. (B17)
Apply	To accomplish a task or solve a problem through some process or application.	Some powerful countries may be better able to formulate and implement environmental protection policies and invest in scientific and technological innovations to mitigate the effects of climate change. (A19) The way to mitigate high temperatures is to expand forests, which remove large amounts of CO2 every year and bring clean water and air. Developing renewable energy sources to replace fossil fuels and promoting green transportation so that people can commute to work by bike or on foot, or by public transportation. (B5)
Analyze	Break down and analyze knowledge into its components and show how some components relate to the whole.	As the urban population increases, so does the demand for buildings and infrastructure, which leads to land reclamation, deforestation, and ecosystem destruction. These activities release more greenhouse

		gases and adversely affect the global climate. (A22) Global climate change raises temperatures and alters rainfall patterns, increasing drought frequency and intensity, particularly in drought-prone regions due to geography. Over-exploitation and land degradation, combined with increased evaporation from global warming, further reduce soil moisture and surface water, worsening drought conditions. (B41)
Evaluate	Make judgments or evaluations based on criteria and standards.	The government's attitude and policies on environmental issues play a crucial role in climate change. A proactive government can reduce greenhouse gas emissions and slow global warming through sustainable policies, while inaction or insufficient measures can worsen the problem. (A26) These events highlight the need to protect biodiversity and restore ecosystems while emphasizing sustainable development in areas like urban planning, land use, and climate adaptation. They also underscore the importance of international cooperation in sharing resources, knowledge, and technology to tackle climate change and natural disasters. (B2)
Create	Bringing the different elements together and completing a complete and useful whole.	Economic growth and increased energy consumption can worsen global warming, which in turn may harm the economy. Government policies and awareness influence the warming issue, so a balance between development and environmental protection is essential to reduce greenhouse gas emissions while fostering economic growth. (A26) Preventing human-caused forest fires involves raising public awareness, regulating fire use during high-risk periods, and avoiding open flames near forests. Firebreaks, regular clearing, and modern technologies like satellite surveillance and drones can help detect and control fires early. Additionally, stricter penalties for fire prevention violations can deter human-caused fires. (B45)

It is important to note that each note allows for multiple coding. To investigate the impact of two different teaching strategies on college students' cognition and engagement with climate change, we coded each student's note. Researchers first identified the units of analysis for each note, and two experienced scholars then used the revised Bloom's Taxonomy by Anderson et al. (2001) for the coding process. Initially, the two coders independently reviewed the text descriptions from the first online discussion activity and coded each marked content. During the process, codes with high agreement were retained, while those with low agreement were further discussed until consensus was reached. The researchers then developed explanations for each code to be used in training sessions for the evaluators. Subsequently,

the two coders continued to individually code all the collected data. Finally, Cohen's kappa was used to calculate inter-rater reliability, yielding a high kappa value of 0.86.

4. Results and Discussions

According to the cognitive objective analysis framework, the number of cognitive levels identified from the notes posted by students in Classes A and B is presented in Table 3. The *t*-test results for the cognitive levels of Classes A and B are presented in Table 4.

Table 3. The number of cognitive related to climate change among students.

	Class A		Class B	
Cognitive	Number	%	Number	%
Remember	107	41.31	214	34.97
Understand	95	36.68	162	26.47
Apply	23	8.88	107	17.48
Analyze	24	9.27	79	12.91
Evaluate	9	3.47	6	0.98
Create	1	0.39	44	7.19
Total	259	100	612	100

Table 4. The t-test for cognitive of climate change among students in Classes A and B.

	Class A (n = 56)		Class B (n = 52)		t	Cohen'd
Cognitive	Mean	S.D.	Mean	S.D.		
Remember	1.91	2.34	4.11	2.54	-4.70	0.90
Understand	1.70	1.68	3.12	2.86	-3.11*	0.61
Apply	0.41	0.89	2.06	2.14	-5.20***	1.02
Analyze	0.43	0.83	1.52	1.92	-3.77***	0.75
Evaluate	0.16	0.50	0.12	0.38	0.53	-0.09
Create	0.02	0.13	0.85	1.21	-4.91***	0.98

* $p < .05$, ** $p < .01$, *** $p < .001$

Based on Table 3, Class B students demonstrated a lower percentage of lower-level cognitive activities (i.e., remember and understand) and a higher percentage of higher-level cognitive activities (i.e., analyze and create) compared to Class A. Additionally, the *t*-test results in Table 4 indicate significant differences in lower-level cognitive activities (i.e., understand and apply) as well as higher-level cognitive activities (i.e., analyze and create). According to Cohen's rough characterization, an effect size of $d = 0.2$ is considered small, $d = 0.5$ is medium, and $d \geq 0.8$ is large. Therefore, the effect sizes for apply ($d = 1.02$) and create ($d = 0.98$) indicate large effects, while understand ($d = 0.61$) and analyze (d = 0.75) indicates a medium effect. The statistical significance obtained from the *t*-test shows that there is a significant difference between the two teaching strategies on students' cognition of climate change.

5. Conclusion and Future

The integration of KF with auto-photography and imagery teaching strategies has been shown to enhance student engagement and higher-level thinking. However, no significant improvement was observed in the evaluate dimension. Future studies could incorporate qualitative interviews to better understand the reasons behind this, providing valuable insights for educators in the field.

Acknowledgements

This study is supported in part by the National Science and Technology Council of Taiwan, under NSTC 112-2410-H-431-001- and 113-2410-H-155 -009 -

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