INTEGRATING ART-BASED STRATEGIES IN THE DESIGN PROCESS FOR COMPLEX PROBLEM-SOLVING IN JAPANESE HIGH SCHOOL

Chaoqing JIA and Leon LOH
Kyushu University, Japan

ABSTRACT
This study aimed to identify key factors for integrating art-based strategies into the human-centred design process to help students gain a more holistic understanding of complex problems. This research employs a focus group discussion to investigate the feasibility of integrating art-based strategies into a 12-week Inquiry-Based, Cross-Disciplinary programme for complex problem-solving in a Japanese high school. The outcome of this study is to support teachers, who are not trained in art and design education, in guiding students to explore problems from multiple perspectives by combining art thinking with design thinking. The key findings from this study are as follows. Firstly, teachers demonstrated a positive and open attitude toward the integration of art-based strategies. Secondly, teachers require clear guidelines to help them distinguish the different between art thinking and design thinking, and to understand the integration purpose as a complementary approach for problem exploration and definition. Thirdly, ethical concerns related to photography and the difference of student abilities require diverse research methods, such as AI-assisted collage or video production. Lastly, integrating art-based strategies after students have selected a theme helps narrow the research scale and reduce understanding confusion.

Keywords: Design process, art-based strategies, design-based approach, problem identification, problem-solving

1 INTRODUCTION
Complex problem-solving (CPS) is a vital skill for fostering innovation in 21st-century education. In 2018, Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) introduced the *Period for Inquiry-Based Cross-Disciplinary Study* in high school to develop inquiry skills through problem discovery and resolution. Since 2019, the United Nations Sustainable Development Goals (SDGs) Design School at Kyushu University has collaborated with Fukusho High School to implement an Inquiry-Based Cross-Disciplinary Study programme using design thinking and design process for CPS. Design thinking is a human-centred problem-solving approach that emphasises user understanding, interdisciplinary collaboration and prototyping. Fostering creative problem-solvers from an early stage helps students enhance their empathy and understanding of social needs, the university–school partnership lays foundation for future contributions to higher education and design industry, cultivating design talent and supplying innovative individuals with design literacy across various sectors.

However, the authors' classroom observations and analysis of student workbooks from the SDGs Challenge Project 2024, which was renamed this year as the Inquiry-based Cross-disciplinary Study programme, found that students faced challenges in clarifying and understanding complex problems, often staying at a superficial level. The primary reasons are as follows: 1) students' selection of overly broad research problems, such as culture, history or environment, leads to vague problem statements and ideas that are weakly connected to their research problems; 2) Given teachers' traditional didactic methods and limited interdisciplinary teaching experience, they tend to focus on the methods and procedural steps of each stage in the inquiry-based cross-disciplinary programme, rather than helping students explore problems from multiple perspectives or providing effective guidance and feedback on their existing problems. To address these challenges, this study suggests integrating art-based approach (ABA) at the problem understanding and defining phases into the design thinking process as a

complementary strategy for problem exploration and definition. By encouraging students to observe and think problems from multiple perspectives, this integration facilitates the concretisation of abstract problems, helping students identify problems clearly and optimise their ideas, thereby supporting the subsequent development of solution and prototype. ABA uses art thinking and forms to explore, interpret and represent human experiences to develop problem-solving, critical thinking and creativity through metaphor and self-reflection [1]. Different from solution-oriented design, its goal is to enhance perspective diversity rather than seek certainty or create art products [2]. Given its visual and intuitive nature, ABA helps students better define problems and enhance flexible thinking. While most studies focus on combining design thinking and art thinking to enhance creativity and perspectives, few explore integrating ABA with design-based approaches to address CPS, especially in high school settings.
This study aims to identify key factors for integrating ABA into the Inquiry-Based Cross-Disciplinary programme to help high school students identify problems clearly and develop problem understanding ability. By exploring teachers' familiarity, acceptability and feasibility of these strategies, as well as the challenges they may face, this study will clarify its potential in enhancing students' CPS abilities.

2 LITERATURE REVIEWS

2.1 Complex problem-solving

Problem-solving is generally divided into simple problem-solving (SPS) and complex problem-solving (CPS). While SPS involves low-dimensional problems with a single goal, CPS deals with high dynamics, multiple goals, and interrelated factors, requiring flexibility in real-life situations [3]. Jonassen classifies problems into well-structured and ill-structured types. Well-structured problems have clear goals, defined solution paths, and established evaluation criteria, often solvable using linear methods. Ill-structured problems, on the other hand, have ambiguous goals, undefined solution paths, and lack universal evaluation criteria, requiring more flexible and complex solutions from multiple perspectives [4]. Meanwhile, enhancing students' ability to tackle complex problems has become a crucial educational objective. Recent research suggests that school-university partnerships provide an effective platform for students to develop CPS skills. For example, Manikutty et al. implemented a pre-university STEAM for Social Good project among middle and high school students. Guided by a university team that used design thinking and digital tools to address SDG-related community challenges, students proposed human-centered solutions while fostering creativity and social awareness. This study demonstrates the potential of secondary school students in CPS through the human-centered design process and builds a foundation for future innovations in both university and design industry [5].

2.2 Design thinking and art thinking

Design thinking and art thinking share the common goal of problem-solving and creativity but differ in how they approach issues. Design thinking is user-centred, solution-focused, and follows a systematic structure, serving as a mediator between complex problems and unexpected variables to provide effective solutions [6]. In contrast, art thinking is process-oriented, emphasising exploration and symbolic processing, aiming to enhance perspectives rather than provide solid explanations [7]. Art thinking fosters breakthrough innovation and radical ideas by exploring the problem space, whereas design thinking, with its more user-centred and solution-focused approach that provides incremental improvements [8]. Thus, art thinking focuses on identifying and proposing problems, while design thinking aims to solve them, with art thinking creating the conditions for problem resolution within the design process.

2.3 Art-based approach for learning

Art-based approach (ABA) uses artistic forms like performance, visual arts, poetry, and storytelling to explore and communicate knowledge, emphasising emotional and sensory engagement to address complexities that traditional scientific methods may overlook [9]. ABA is widely used in education, healthcare and social issues, enhancing students' learning skills and academic performance. Rooney highlights that it promotes students' interest, motivation and self-esteem, and also enhancing thinking skills, communication, and neural functions [10]. In high school education, ABA is often integrated into the curriculum to enhance students' understanding and interdisciplinary skills, with Pablo demonstrating that art-based programmes improve academic performance in language, math, and academic scores, as well as creativity and cultural engagement [11]. Furthermore, Tuveri et al. use storytelling and theatrical techniques to teach high school students about black holes and gravitational waves, leading to greater

engagement and motivation, particularly among humanities students [12]. Beyond education, ABA has been explored for its therapeutic potential in healthcare, especially in mental health treatment and patient rehabilitation. Van Lith et al. demonstrated that art-based practices aid mental health recovery by fostering psychological and social healing, promoting self-discovery, self-expression, interpersonal relationships, and social identity [13].

3 RESEARCH METHODOLOGY

3.1 Research questions and methods

Two research questions are set in this study. Firstly, how is the teachers' familiarity in facilitating the design-based project using art-based strategies in their activities? Secondly, what kind of challenges may teachers face when integrating art-based strategies into the design process?

To answer these questions, this study focuses on assessing the feasibility of integrating the ABA into the design process to help students solve complex problems. It also includes evaluating teachers' acceptance of ABA and predicting the potential challenges in its future implementation. Since the participating teachers come from diverse academic backgrounds with limited exposure to systematic art education, they may experience resistance or anxiety when engaging in ABA teaching.

This research employs a qualitative approach, using Fukusho High School as a pilot school in a case study within the Inquiry-Based Cross-Disciplinary Study programme, which applies a design-based approach to enhance students' CPS skills. As Fukusho High School is a typical Japanese public high school, the challenges its students face are likely present in other public high schools in Japan. The outcome of this pilot study will be useful for other public high schools and educational researchers to use as reference for further research developments. For investigating teachers' perspectives, a focus group was conducted to gather feedback from four Fukusho High School staff on a lesson plan proposed for integrating art-based strategies into the programme. The participating staff include a vice principal, an English teacher, a Japanese teacher, and a Fine Art teacher. These four participating educators are chosen for their involvement in the overall coordination of the Inquiry-Based Cross-Disciplinary Study programme in the *Period for Inquiry-Based Cross-Disciplinary Study*. In addition, these four educators will provide a multidisciplinary perspective as they are all specialised in different teaching subjects and have diverse teaching backgrounds.

3.2 Research Design and Implementation

This study employs a focus group discussion to explore the integration of art-based strategies into a 12-week Inquiry-Based Cross-Disciplinary Study programme for CPS. Based on the SDGs, the programme follows an iterative design process to support students in addressing complex issues related to community. It is structured into eight stages: 1) exploring the problem, 2) selecting the problem, 3) understanding the problem, 4) defining the problem, 5) generating ideas, 6) creating concepts, 7) prototyping and evaluation, and 8) solution presentation.

Based on previous research showing that students often struggle to explore relevant issues and clearly understand the problems they address; while preserving existing approaches, a lesson plan is designed to incorporate collage and photography as supportive art-based strategies. In this plan, collage and photography help with observation, data collection, and analysis. Photography serves as a data collection tool to help capture unexpected details and reduce interference [14], while collage acts as an analytical tool to link fragmented information and visualise abstract problems. As Butler-Kisber et al. emphasised, collage is not only a reflective and intuitive visual method that supports early-stage conceptualisation and sense-making but also a unique analytic tool that helps generate new insights by linking emotional fragments into meaningful wholes. Through this engaging process, abstract ideas can be made tangible, helping students conceptualise research questions and consolidate their thinking. Moreover, collage's hands-on process of cutting and pasting is also easy for novices [15]. To assist teachers in understanding these strategies, a collage sample with step-by-step instructions that uses Japan's aging population as an example is provided. Since students begin the CPS exploration with broad and unclear themes, their ideas tend to be weakly connected to the research issues, art-based strategies are introduced from weeks 3 to 6 during the problem understanding and defining stages to help students refine research issues. Before the discussion, participants are informed of the focus group's purpose and data usage, granting permission for content analysis. A two-hour session is conducted at the researchers' university with audio and video recordings. Following the session, a thematic analysis is conducted while ensuring teacher anonymity.

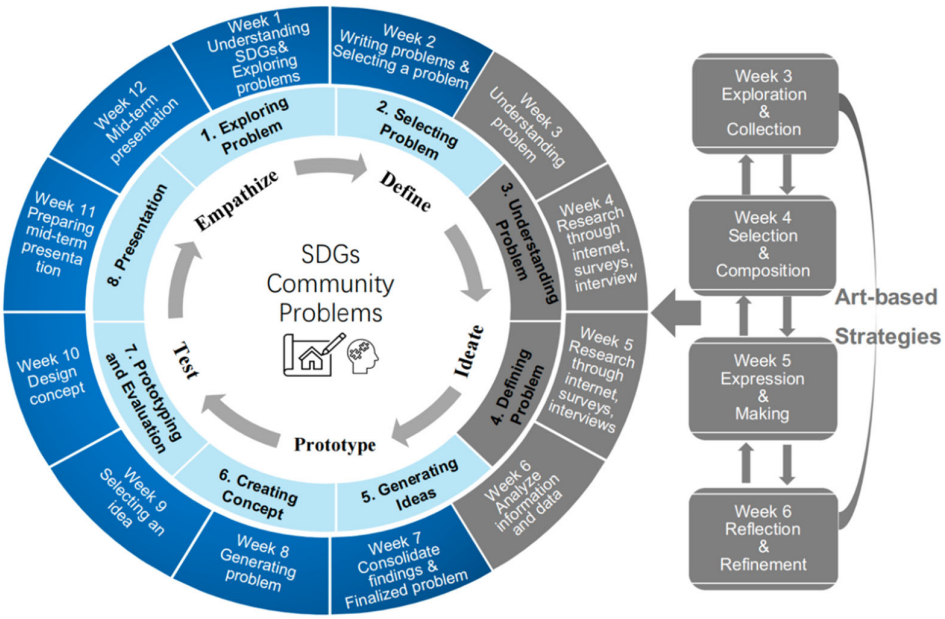

Figure 1. A four-week lesson plan for integrating art-based strategies into design process

4 FINDINGS

The findings highlight teachers' feedback on integrating art-based strategies to support students in addressing complex problems within the design-based programme.

Table 1. Teachers' feedback of integrating art-based strategies

Theme	Sub-theme	Key Findings
Understanding Confusion	Difficulty in distinguishing art thinking and design thinking	• Art teacher expresses difficulty in distinguishing the difference between art thinking and design thinking. • Lost track in the middle or halfway. • Which should focus more on design or art perspective?
	Confusing the purpose of collage	• Teachers do not understand why this method is used. • Clarifying the purpose of collage in expanding and integrating thinking is needed, focusing on the collage itself will not be effective. • It is more effective to approach collage-making as a means of expression or output. • Teachers are uncertain whether creating a collage requires artistic skills such as composition and colour.
Integration Timing	Inserting stage of art-based strategies	• Searching for photos without a clear decision leads to scattered themes. • Art teacher suggests that art-based strategies be incorporated starting from week three or four, after students have selected one theme, can help expand their thinking. • Integrating art-based strategies after applying the mind map (a visual method used to organise and expand ideas) and the decision matrix (a method for evaluating and prioritising options) to help students narrow down their problems can enhance the effectiveness of these strategies.
Photography ethics	Limitations and suggestions of photography	• Some problems, like roadside litter, are easy to photograph, while others, such as gender roles or teaching practices, are harder to capture visually. • Prohibit the use of internet images when conducting field research through photography. • Prior learning of copyright, image rights, and photo scales.
Attitudes towards integration	Effective methods	• Art teachers are sure art-based strategies can deepen relationships and expand understanding. • Vice principal thinks using collage is a very effective approach this time. • Adding art-based strategies would work, photography is needed for field research and for increasing empathy.
Alternative methods	AI generation	• AI tools and applications can quickly create collage. • Students who are not skilled in art can use AI to generate viewpoints and create samples.
	Video	• High school students are more comfortable with creating and watching video. • Video allows students to combine all content into a collage or short film easier.

Five key themes are identified:

- Understanding confusion: All teachers struggled to distinguish art thinking from design thinking, confusing art-based strategies with traditional art teaching, and emphasised clarify the purpose of these integration strategies.
- Integration timing: Teachers suggested introducing art-based strategies in weeks 3 or 4, after students choose one research topic to avoid scattered content.
- Photography ethics: Teachers viewed photography as useful for students' research but raised concerns about using internet images and sensitive themes, stressing the need to understand image rights and copyright.
- Attitudes towards integration: Despite some confusion, teachers recognised the value and feasibility of art-based strategies, expressing support words like "sure" and "effective," and raising helpful questions and suggestions for improvement.
- Alternative methods: Teachers noted that not all students are skilled in art and suggested using AI tools to help create collage samples. They also proposed video production as a more accessible way for students to express ideas, as it is easier for students to combine content into a short video.

5 DISCUSSIONS AND LIMITATIONS

The findings show that although teachers lack familiarity with art-based strategies, they generally hold an open and accepting attitude towards integrating art-based strategies. The results also demonstrate the feasibility of incorporating these strategies into the Inquiry-Based Cross-Disciplinary Study programme for CPS.

A main challenge is teachers are unable to distinguish the difference between art thinking and design thinking. This confusion is common as both fields emphasise creativity, visual processes, and problem-solving, which results in overlap between them. Compared to art, design has a relatively shorter history as an independent discipline, and many teachers still perceive it as part of art and view it merely as decorating art for human use. Therefore, targeted teacher training is essential to clarify their differences, complementarities and the purpose and value of integrating art-based strategies into the programme. Meanwhile, teachers acknowledged the benefits of collage and photography but also noted their limitations. Photography is useful for promoting students' fieldwork but raises privacy and ethical concerns when involving sensitive topics. Collage improves creativity and perspectives but may not suit all students due to individual differences. Teachers suggested raising students' ethical awareness and proposed alternatives like AI and video， which lower technical barriers increase engagement, broaden students' perspectives, and accommodate their abilities. However, video-making also raises ethical concerns like privacy and copyright issues related to photography, and AI-generated collage may cause students' dependence on technology, hindering independent thinking and problem understanding.

Furthermore, the insertion timing of art-based strategies emphasised by the Fukusho High School teachers aligns with the schedule set in this study's lesson plan, which is prepared for the focus group discussion, reinforcing the rationality and feasibility of the proposed timing. Moreover, it is important to note that these strategies and integration timing designed in this study are tailored to Fukusho High School's context. As a flexible method, ABA can be adapted to different research problems and is not limited to a specific stage. When employed as a creative pedagogical intervention for CPS, ABA focuses on individual experiences and emotions to stimulate empathy, build visual and emotional resonance channels. This approach enables learners to observe social realities more critically, develop humanistic concerns, cultivate critical consciousness and social responsibility, leading students to generate more creative and human-oriented solutions. Although ABA's broaden perspectives foster creative exploration, they may result in unclear solutions, this limitation can be mitigated by combining ABA with design thinking. Since design thinking's structured approach refines artistic divergence into actionable solutions while maintaining its user-centred focus that typically yields incremental improvements, whereas art thinking excels at uncovering overlooked problems through deeper inquiry. These two approaches complement each other as art thinking discovers and defines problems, while design thinking provides solutions. Meanwhile, their integration is consistent with CPS needs of ill-structured problems require nonlinear thinking exploration and structured solutions.

As this study focuses on teachers' perspectives, the generalisability of the findings is limited by the small sample size just from one pilot school. Future research will include more teachers from different schools to expand their applicability and also will refine these strategies based on teachers' feedback to facilitate

their implementation in actual classroom practice in the new academic year, October 2025.

6 CONCLUSIONS

This study aimed to clarify the feasibility and key factors for integrating art-based strategies into a human-centered design process within a 12-week inquiry-based cross-disciplinary programme for complex problem-solving in a Japanese high school. The outcome will assist teachers in guiding students to explore problems from multiple perspectives by combining art thinking with design thinking. Findings conclude that, despite initial confusion between art thinking and design thinking, teachers showed an open and accepting attitude toward integrating art-based strategies into the design-based programme. Challenges such as distinguishing art thinking from design thinking, integration purpose, photography ethical concerns, and diverse student abilities are noted, with teachers suggesting AI-assisted collage and video production to support students with varying skill levels. Timing of integrating art-based strategies after students have selected a theme helps narrow the problem scale and prevents confusion.

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