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Design Thinking and Learning Performance: A Case Study of Mobile Interface Design for the “Home Letters” App for the Elderly

Chieh Fang [1,*], Chuan Yu Lin [2], and Hao-Chiang Koong Lin [3]

[1]*Department of Information and Learning Technology, National University of Tainan, Taiwan*

[2]*Arts College, Wuyi University, China*

[3]*Department of Information and Learning Technology, National University of Tainan, Taiwan*

This study uses the " Home Letters " project as a case study, where middle school students design a mobile app interface for the elderly. Through field investigations of the elderly's mobile phone usage habits, building prototype products, and conducting validation, students empathize with the elderly's mobile needs. By integrating visual arts and digital technology, the project creates technological tools to foster a sense of intimacy between the elderly and teenagers. The design thinking curriculum creates authentic task scenarios to engage learners in the course. Through the problem-solving process, it demonstrates learners' integrated learning abilities. This study employs semi-structured interviews, analyzing students' field research data to summarize the usage needs of the elderly group. During the prototype design phase, the elderly's mobile phone functionality needs are integrated. Teachers observe and evaluate students' prototype designs, recording their understanding of the elderly's needs across different learning stages. Additionally, to interpret the course characteristics from students' experiences, the study analyzes their reflections to assess the impact of the design thinking curriculum on learning.

Keywords **-** Design Thinking, Empathy for the Elderly, User Interface (UI), User Experience (UX).

Relevance to Design Practice **-** The curriculum explored the needs of the elderly, examining the connection between course experiences and creative design. It organized key points for user experience and interface design for the elderly. Research findings indicate that middle school students demonstrated empathy for the needs of the elderly during the design practice process.

Introduction

In 2020, the teaching team participated in a design learning project addressing the topic of an aging society, utilizing digital tools to develop products that solve practical problems. Observing that many elderly individuals avoid using smartphones, the team explored the inaccessibility of existing app designs for older adults. Consequently, the teaching team designed a curriculum based on the Design Thinking framework, creating a "Never-Before-Seen" digital task. This task aimed to transform smartphones—often seen as symbols of the

digital divide between generations—into communication channels that foster intimacy and interaction between the elderly and youth.

The course guides teenage students to design customized smartphone interfaces (UI) for elderly family members. Students begin with unfamiliarity regarding the needs of the elderly and challenge their preconceived notions of interface design. Through the design and learning process, students use smartphone interface design to solve real-world problems. Additionally, through discussions and hands-on design practice, the course encourages students to care for their family members and develop empathy for the needs of the elderly, fostering intergenerational understanding and connection.

In the teaching process, the teaching method of design thinking differs from traditional teaching methods. Traditional courses evaluate learning outcomes through test scores, while the learning growth in design thinking occurs within each learning task, such as where learners find the task difficult, how they solve difficulties, and the process from self-understanding to empathizing with the elderly. These aspects of learning are difficult to measure through assessments or tests.

In the design thinking course, learners are assigned situational tasks to learn, and the enhancement of intimacy occurs during the design thinking learning process. When learners personally experience a closer relationship with elderly family members during the design process, the real experience of building relationships with elderly family members helps learners design products that meet the needs of the elderly. This process can lead to changes in learners' self-efficacy, which requires research to analyze and uncover.

Therefore, this study analyzes learners' interview records, design worksheets, and post-course learning feedback to examine the impact of design thinking on learning.

Research Objectives:

1. To explore the factors influencing middle school students' learning in the problem-solving process within a design thinking curriculum.
2. To summarize the knowledge of elderly interface design gained by learners through field research and prototype design.

Literature Review

Based on a design thinking curriculum tailored to the needs of the elderly, middle school students use mobile interface design as a medium to foster empathy between grandparents and their descendants. The research directions proposed in this study are divided into two aspects: the design thinking teaching curriculum and learning abilities, and the empathetic interface design of apps for the elderly. The details of each section are outlined as follows:

Design Thinking Teaching Curriculum and Learning Abilities

Design Thinking is a human-centered approach that focuses on users' needs and experiences. (Pandit et al., 2024)The theory of design thinking is primarily based on designers' creativity and problem-solving methods, which include five steps: empathize, define, ideate, prototype, and test. These steps are implemented

and reflected upon as part of the process. In the field of education, the design thinking process has been adapted into methods suitable for teaching practices.

First, empathy involves thinking and creating from the user's perspective. Research indicates that empathy in teenagers is an important socio-emotional concept that helps mediate friendships and family relationships. (Dawbin et al., 2021) ◦ Guiding teenage students to empathize with elderly family members contributes to fostering a sense of belonging to the family for both teenagers and the elderly.

The curriculum emphasizes training in problem-solving skills. During the problem-definition stage, research indicates that beyond design expertise, the complexity of the problem also affects the progression of informal design thinking workshops. (Mosely et al., 2018) Considering the complexity of problem definition based on students' life experiences is essential for initiating effective problem-solving and creativity. Ideation involves thinking and generating ideas to develop multiple solutions. Studies suggest a strong correlation between creativity and divergent thinking(Gralewski & Karwowski, 2019) Design thinking fosters creative problem-solving, which in turn cultivates students' creative abilities.

Creating prototypes involves selecting certain solutions and building prototypes for testing and evaluation, serving as a way to discuss products with others. In education, the importance of prototyping lies in addressing the fact that beginners lack the extensive professional practice and client interactions needed to refine their design skills. Research highlights the necessity of equipping beginners with design and prototyping skills to achieve best practices(Deininger et al., 2017). Prototypes assist beginners in utilizing prototyping spaces, engaging others in concepts, and facilitating communication. Dialogue, discussion, and information sharing during the design process are central to establishing successful collaboration and learning for students. Research indicates that cognitive processing and dialogic activities enable teams to make progress during teamwork(Kiernan et al., 2020). In particular, discussions and interactions between teachers and students support students in solving problems. During implementation and reflection, validating whether prototype designs empathize with users' needs is crucial. The process of implementation and adjustment ensures the design aligns closely with user requirements.

This study participates in the Quanta Design Learning Program and focuses on the "Listening to Family Letters" App curriculum, exploring the learning process of teenagers designing mobile app interfaces for the elderly. Through the design thinking teaching approach, the study examines its impact on learners' abilities in empathy, critical thinking, collaboration, communication, and creativity.

Designing App Interfaces with Empathy for the Elderly

User Interface Design (UI) is closely connected to User Experience (UX), using visual imagery to present information in a way that aligns with users' intuitive operations and reading habits, ensuring smooth navigation and guidance. One of the challenges in design is that not all users may find a UI easy to use. If users perceive the UI as difficult, it can lead to user

experience issues(Hui & See, 2015) . Therefore, before designing, user research and behavioral analysis are conducted to create functionalities that closely meet user needs.

The primary audience for apps is generally teenagers to middle-aged adults, with most interface designs catering to the needs of young and middle-aged users, using novel and multifunctional interfaces to attract them. However, research on interfaces for the elderly reveals that menus and hierarchical structures often confuse older users, making it difficult for them to navigate through functions. The switching between menus creates significant challenges(Li & Luximon, 2020) . Additionally, the unique physiological characteristics of older adults, such as reduced tactile sensitivity when using touchscreens, often result in accidental touches. This is a major reason many elderly individuals prefer traditional button-based phones over transitioning to smartphones.

When designing interfaces for the elderly, research suggests providing guided navigation pages, adjusting font styles, sizes, and line spacing, and pairing text with icons to align with common mainstream usage patterns (Ho & Tzeng, 2021) . Most UX designers lack knowledge about cognitive accessibility and design specifically for the elderly, particularly in the context of mobile devices (Pokinko, 2015) . Therefore, it is essential to acquire design knowledge tailored to elderly interfaces in the field of design to create apps that empathize with their needs.

This study focuses on a curriculum for designing interfaces for the elderly. When middle school students designed mobile interfaces for the elderly, they were not provided with pre-existing knowledge of appropriate interface design for older users. Instead, through their analysis of field research data, learners identified design principles suitable for the elderly. By engaging in the inquiry process, learners actively clarified the knowledge required to create elder-friendly mobile interfaces.

Research Methodology

Instructional Design

The teaching process for the " Home Letters " App (Figure 1) follows a backward design cycle. It includes defining key concepts, issuing a mission letter, establishing assessment criteria, prototyping, teaching intervention, and adjustments and modifications. Each stage is described below:

1. Defining Key Concepts: The course explores the theme of using an app to foster intimacy between the elderly and their families.
2. Defining a Problem: Using a Real-World Problem Scenario, Describe the Problem through the mission letter (Figure 2) establishes a learning context. It assigns students the role of designers tasked with solving problems, drawing on their life experiences to identify and address issues. The difficulties elderly family members face when using mobile phones are broken down into several course objectives:
    - **Task 1**: Conducting field research.
    - **Task 2**: Designing personalized visual elements for the elderly.

- **Task 3**: Developing an app tailored to the elderly's needs.

3. Establishing Assessment Criteria: Defining the rules and standards for evaluation, including grading rubrics and performance levels to categorize students' achievements.
4. Prototyping: Using visual design and app development knowledge to transform ideas into prototypes.
5. Teaching Intervention: The teaching team provides feedback and guidance to help students refine their existing projects.
6. Adjustments and Modifications: Students present their app prototypes to elderly family members for testing. Based on their feedback, students review the direction of revisions and propose improved designs.

The teaching schedule spans 13 weeks, with one visual arts class and one information technology class per week, totaling two classes per week. Each class session is 50 minutes long.

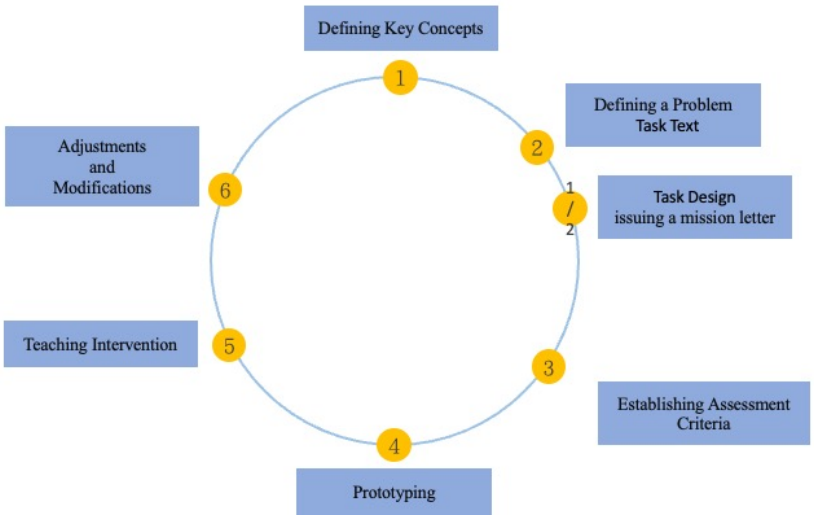
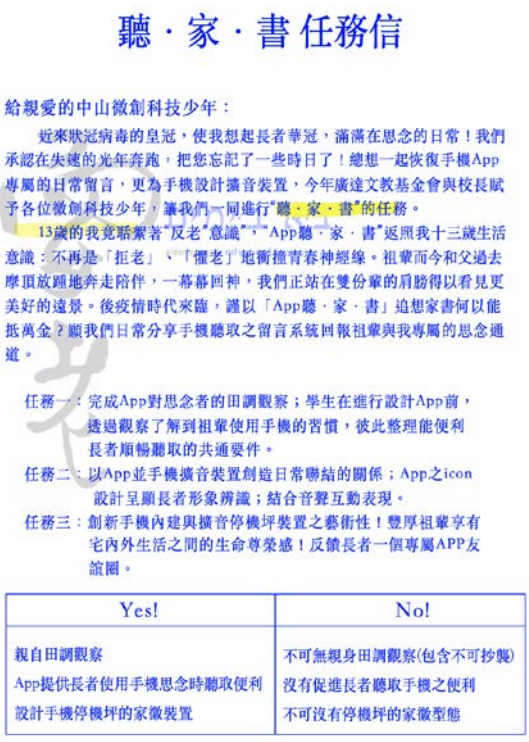


Figure 1. Teaching process for the "Home Letters" app.



聽・家・書 任務信

給親愛的中山微創科技少年：

近來肆冠病毒的皇冠，使我想起長者華冠，滿滿在思念的日常！我們承認在失速的光年奔跑，把您忘記了一些時日了！總想一起恢復手機App專屬的日常留言，更為手機設計擴音裝置，今年廣達文教基金會與校長賦予各位微創科技少年，讓我們一同進行"聽・家・書"的任務。

13歲的我竟駱駝著"反老"意識"，"App聽・家・書"返照我十三歲生活意識：不再是「拒老」、「懼老」地衝撞青春神經線。祖輩而今和父過去摩頂放踵地奔走陪伴，一幕幕回神，我們正站在雙份輩的肩膀得以看見更美好的遠景。後疫情時代來臨，謹以「App聽・家・書」追想家書何以能抵萬金？願我們日常分享手機聽取之留言系統回報祖輩與我專屬的思念通道。

任務一：完成App對思念者的田調觀察；學生在進行設計App前，透過觀察了解到祖輩使用手機的習慣，彼此整理能便利長者順暢聽取的共通要件。

任務二：以App並手機擴音裝置創造日常聯結的關係；App之icon設計呈顯長者形象辨識；結合音聲互動表現。

任務三：創新手機內建與擴音停機坪裝置之藝術性！豐厚祖輩享有宅內外生活之間的生命尊榮感！反饋長者一個專屬APP友誼圈。

Yes!	No!
親自田調觀察	不可無親身田調觀察(包含不可抄襲)
App提供長者使用手機思念時聽取便利	沒有促進長者聽取手機之便利
設計手機停機坪的家徽裝置	不可沒有停機坪的家徽型態

Figure 2. The mission letter.

Teaching Materials Introduction

The App project design course utilizes self-developed materials specifically tailored for beginners. In the interface design section, the process follows a structured approach. It begins with field research to understand user needs, followed by planning the functional map. Next, the interface functions and workflow are designed, leading to the creation and testing of a prototype. Finally, revisions are proposed to refine the design.

Defining Requirements

In this stage, students focus on understanding UI/UX interface design and user experience. They analyze existing interface examples from the market, examining the functions and purposes of interface icons and functional buttons and their corresponding user needs. Through case analysis, students gain insights into design directions.

Additionally, they collect experiences of elderly family members using mobile apps and, based on these usage needs, draft a functional framework. The insights gathered from field research into elderly family members' needs are used to develop a design structure through a functional map.

Interface Design

In this stage, students translate the functional framework into hand-drawn app interface sketches (Figure 3), creating visual layouts for each page. Using Figma software, they design interactive elements such as navigation between pages, trigger buttons, visual mockups, and functional prototypes.

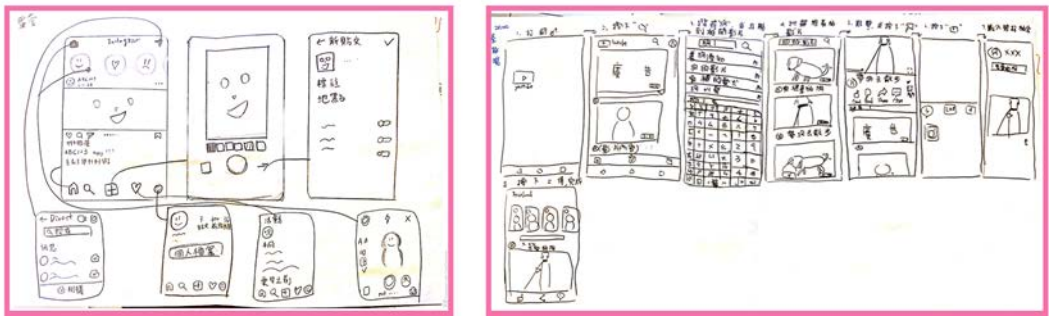


Figure 3. Student hand-drawn app interface sketch.

Research Participants

A total of 52 second-year students from a junior high school in Tainan, Taiwan, participated in the study. Their learning background includes one year of visual arts classes, equipping them with knowledge of the ten principles of visual composition and aesthetics. However, they had no prior experience in UX or UI design.

Data Analysis Methods

The analysis of elderly interface usage experiences was conducted using interview data collected by students. After consolidation, bar charts and descriptive statistics were used to display the trends, distributions, and needs of elderly users regarding mobile phone usage.

For the design thinking curriculum component, learning feedback from semi-structured interviews and teacher observations were analyzed and coded using the AI-based grounded theory method published by LIN (2025), combining TF-IDF and N-Gram for analysis.

Core concepts and themes were identified, illustrating the learning transformations resulting from the design thinking curriculum. Additionally, teachers' observational notes recorded students' learning behaviors and performance during the prototype design process.

Analysis Results

Learners' Summary of Elderly Interface Design Needs

Based on the results of the usage survey conducted with Categories of Apps Installed by Elderly Users (Figure 4), and their perceptions of the inconveniences in current app designs (Figure 5), the following insights were gathered:

First, app interfaces often use icons as graphical buttons to represent functions, with text provided as supplementary information in very small font sizes. Since elderly users are less accustomed to using the internet, they lack an intuitive association with graphical representations, making it difficult for them to recognize interface functions. Second, the design of apps like Taiwan's LINE is overly complex. Small graphical buttons often lead to frequent mis-taps, causing difficulties in using the software. This, in turn, affects the elderly's ability to maintain communication with their families.

As a result, when using apps, elderly users prioritize ease of use as their highest requirement, followed by comprehensive functionality, with aesthetic design being the least important factor.

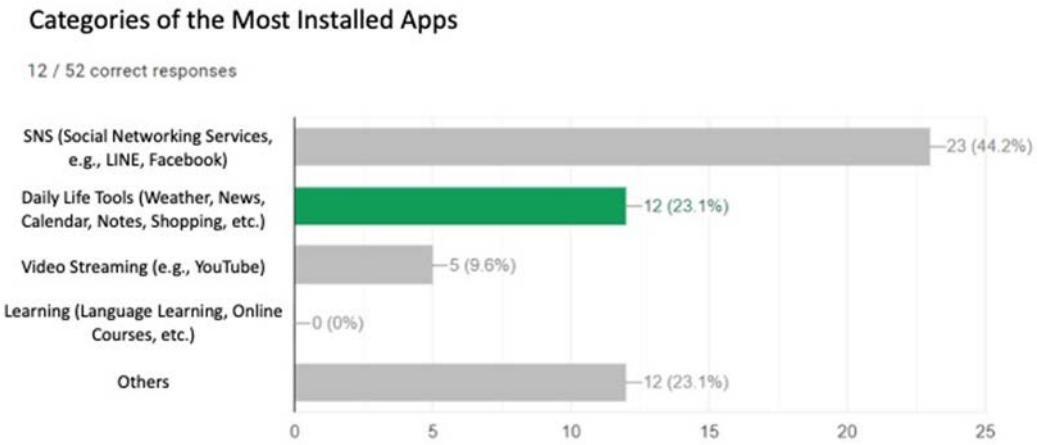


Figure 4. Categories of apps installed by elderly users.

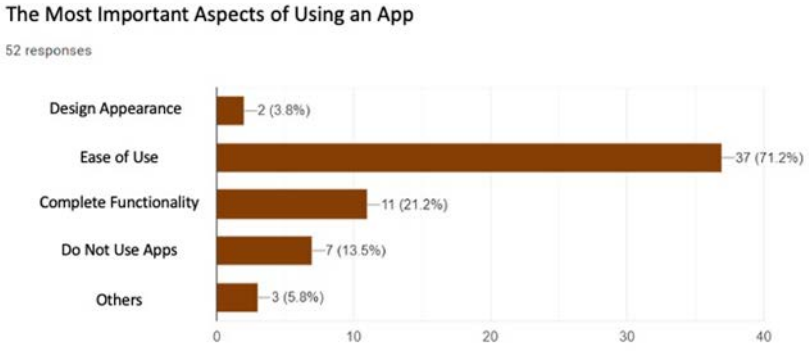


Figure 5. Usage needs of elderly users.

Teacher Observations of Student Designs

Based on teachers' observations of students' app design processes, grounded coding was applied to categorize the observations into four main themes: students' design preferences and styles, deviation from target group needs, analysis of elderly operational needs, and designing functional features for daily convenience. These themes reflect the learning behaviors students exhibited during the app prototype design process.

1. Students' Design Preferences and Styles (C1):

   This theme focuses on students incorporating their personal preferences

and styles into the design process. These design elements often include aesthetic and fashion pursuits, English text, celebrity images, baby illustrations, and other visual elements, as well as attempts to mimic the interfaces of popular social media applications.

The coding includes: Aesthetic and fashion design preferences, Adding personally preferred elements, Incorporating English text and celebrity images, Using baby illustrations and diverse visual applications, Mimicking social media interface designs. This reflects students' strong expression of personal preferences during the creative process, which often deviates from the core objective of addressing the needs of elderly users.

2. Deviation from Target Group Needs (C2):

This theme explores the phenomenon where students shift away from the needs of the target group during the design process. Some students gradually moved from focusing on the needs of elderly users to satisfying their own or their peers' needs, resulting in functional designs that fail to align with the actual usage scenarios of the elderly.

The coding includes: Shifting from elderly needs to student needs, Changes in the target group for functional design, Deviation in user needs during student design.

This highlights the importance of needs analysis and understanding the target users throughout the design process.

3. Elderly Operational Needs Analysis (C3):

This theme encompasses students' analysis of the challenges elderly users may face when operating an app, such as the need for functional guidance, Taiwanese Hokkien voice instructions, or enlarged font designs. These design details address the physiological characteristics and preferences of elderly users, enhancing the app's usability and accessibility.

The coding includes: The need for functional guidance when operating apps, Taiwanese Hokkien voice instruction features, Enlarged font design for interface readability.

4. Designing Functional Features for Daily Convenience (C4):

This theme focuses on students designing practical features to improve the convenience of elderly users' daily lives, such as memo functions and quick-dial buttons for important family members. These designs are closely aligned with the everyday needs of elderly users, aiming to simplify operations and enhance their quality of life. This reflects students' ability to think within real-world application scenarios.

The coding includes: Designing memo functions for elderly users, Quick-dial buttons for important family members, Features that simplify daily life for the elderly, Designing based on the needs of elderly users.

Comprehensive Analysis

Based on the teacher's observations of the students' design process, students summarized and analyzed the needs of elderly users.

From teacher observations, when students designed app prototypes, they often incorporated their personal preferences, making the app resemble designs they liked. They added elements such as images, English text, or visuals of celebrities, which resulted in overly complex interfaces and mismatched functionalities that deviated from the original user requirements. This reflected a neglect of the elderly users' needs and a shift in design direction.

However, some students successfully designed based on the actual needs of elderly users. They identified that elderly users required functional guidance, Taiwanese Hokkien voice instructions, enlarged interface fonts, memo functions, and quick-dial buttons for important family members. These practical features aligned with elderly users' needs and improved their convenience in daily life.

Design Thinking and Learning Performance

The study analyzed the learning feedback questionnaires from 52 learners, coding and summarizing their reflections on the learning experience. The feedback was categorized into five main themes: design creativity, exploration to mastery, elderly needs and empathy, classroom experience, and challenges with problem-solving. These themes indicate the abilities students needed to apply, the skills they acquired, their feelings about the design learning curriculum, and the approaches they used to address problems.

Table 1. Themes of learners' reflections on the design thinking curriculum.

Axial Coding ID	*Axial Coding Theme*	*Description*	*Open Coding*
C1	Design Creativity	Focusing on design creativity, compared to traditional curricula, generating new ideas is challenging and requires the application of interdisciplinary knowledge to solve problems.	Creativity Expression
			Design Sketches
			Integration of Art and Technology
			Function Details
			Visual Design
			Page Layout
C2	Exploration to Mastery	The learning curriculum fostered growth and transformation, enhancing problem-solving skills	Problem Solving
			Dynamic Linking
			Software Operation

		and deepening understanding of app development through hands-on practice.	Learning Progress
C3	Elderly Needs and Empathy	Using feedback from the elderly as the basis for design, students sought suggestions from the elderly and collaborated with them to develop the "Listening to Family Letters" app. This collaborative process fostered deeper understanding and served as a catalyst for nurturing care and empathy.	Elderly Needs Designing Practical Functions Emotional Elements in the Interface Empathy Interaction with the Elderly
C4	Classroom Experience	From concept to final outcomes, the design process involved open discussions where students engaged in peer reviews, sharing, and presenting their design concepts. The classroom was transformed into a learning environment that supported creative experimentation.	Relaxed and Fun Laboratory Environment Presenting Prototype Designs Viewing Peer Projects
C5	Challenges and Problem-Solving	The learning process included challenging aspects and methods for overcoming difficulties. Many students mentioned the challenges	Creating Dynamic Links Oversights Asking Teachers Seeking Peer Assistance

	of interface design and highlighted resolving issues by actively seeking help from teachers and peers.	

1. Design Creativity (C1)

In the course, emphasis was placed on design creativity. Compared to traditional curricula, generating new ideas proved to be a challenge and required applying interdisciplinary knowledge to solve problems. The coding includes creativity expression, design sketches, function details, visual design, page layout, and the integration of art and technology.

Student 12: "Creating an app requires creativity, as well as attention to small details and dynamic links."

Student 36: "The design thinking course focuses on design and creativity, while traditional courses emphasize diligence."

Student 8: "The class content was very interesting, and I often had to think about how to solve problems."

Student 10: "The ‘Home Letters’ App design thinking course combined art and technology, making the curriculum more challenging."

2. Exploration to Mastery (C2)

This theme focuses on the growth and transformation experienced during the learning process, highlighting the enhancement of problem-solving skills and a deeper understanding of app development through hands-on practice. The coding includes problem solving, dynamic linking, software operation, and learning progress.

Student 6: "I spent a lot of time exploring ways to improve the final product."

Student 39: "I worked hard to figure out what to do, researched relevant materials, and spent quite a bit of time on implementation, but I felt very happy when I finished."

Student 19: "At first, I didn’t know what to do and thought it was hard and annoying. Later, as I understood app design better, it became more fun."

Student 46: "When creating digital illustrations, I kept trying until I was satisfied because it didn’t initially meet my aesthetic expectations."

3. Elderly Needs and Empathy (C3)

This theme focuses on using feedback from the elderly as the basis

for design, seeking their suggestions, and collaborating with them to develop the " Home Letters " app. The collaborative process fostered deeper understanding and acted as a catalyst for cultivating care. The coding includes elderly needs, designing practical functions, empathy, emotional elements in the interface, and interaction with the elderly. Beyond functional needs, the emotional needs of the elderly were equally prioritized, such as creating personalized interfaces.

Student 3: "When designing the app, we need to consider the needs of the elderly and ask for their opinions."

Student 36: "I ended up chatting with the elderly at home more often because of this."

Student 41: "The design should be based on the perspective of grandparents, and I spent some time getting to know them better."

Student 14: "When creating a mobile app for my elderly family members, I designed an interface with an illustration of a family photo featuring the grandchildren and grandparents."

4. Classroom Experience (C4)

The classroom experience focused on open discussions from design concepts to final outcomes. The design process included peer reviews, sharing, and presenting design concepts. The classroom was transformed into a learning environment that supported creative experimentation. The coding includes a relaxed and fun atmosphere, laboratory-like environment, prototype presentations, and viewing peers' work.

Student 7: "It felt fresh and fun. During the presentations, I saw all kinds of creative projects."

Student 24: "It was like a lab where we could put our design sketches on the walls to observe and review them."

Student 43: "The classroom was decorated like an art gallery."

5. Challenges and Problem-Solving (C5)

The learning process involved challenging aspects and methods to overcome difficulties. Many students highlighted the complexity of interface design, particularly dynamic linking, and emphasized the importance of seeking help from teachers and peers to resolve issues. The coding includes creating dynamic links, addressing oversights, asking teachers, and seeking peer assistance.

Student 2: "The hardest part was the dynamic linking in Figma because it required connecting many lines."

Student 4: "The dynamic linking in the interface design was messy and needed to be reorganized."

Student 16: "The most challenging part was missing links in the dynamic linking. I had to play and

review the connections multiple times to ensure they were correct."

Student 42: "Creating prototypes required thinking about details from all aspects, not just the overall design but also the transitions between each page."

Most students sought peer assistance to solve problems:

Student 30: "I discussed many parts of the project with friends."

Student 28: "The course allowed us to create with classmates and find solutions together."

Student 38: "The most difficult part of the course was dynamic linking. I asked classmates for advice and learned from them."

Comprehensive Analysis

The design thinking curriculum emphasizes creativity, from initial design sketches to functional details and the overall visual presentation. The classroom environment was closely tied to fostering creativity, as teachers displayed students' design drafts on the walls, transforming the classroom into a laboratory-like space that encouraged experimentation and idea generation.

In the beginning of the learning process, students found the app design workflow and tools challenging. Through repeated trial and error, they gradually mastered the interface design process and overcame obstacles, eventually understanding how to create apps. This iterative process provided students with a sense of accomplishment in their learning.

The refinement of app functionality and prototype testing progressively aligned the designs with the needs of elderly users. Interviews with the elderly created opportunities for students to discuss and collaborate with family members, strengthening intergenerational bonds.

Teacher observations of interface design revealed that during prototype testing, students used their app interface prototypes to allow elderly family members to test the designs. Based on the evaluations recorded in learning worksheets, students observed the actual user experience and discovered that certain creative design choices reflected personal preferences rather than meeting the needs of elderly users.

During prototype validation and adjustments, students modified the " Home Letters " app based on feedback from elderly users, ensuring that the final prototypes closely met the needs of their target audience.

Conclusion

The " Home Letters " app design thinking curriculum focused on elderly needs as the core design issue. Students began their exploration from their own life experiences, with elderly family members as the target users. Throughout the process, students acquired app operation and design skills while achieving a sense of self-fulfillment by creating apps tailored for their elderly family members. Additionally, the elderly were actively involved in the design process, as they were interviewed by their grandchildren. This reciprocal relationship transformed the students and elderly into co-subjects of the project. Through mutual empathy,

the design process used mobile-related issues as a medium to strengthen intergenerational relationships. Elderly family members saw app designs featuring hand-drawn wallpapers of themselves and their grandchildren, along with short audio messages recorded by the students expressing care and greetings. This process deepened understanding between generations.

The design thinking curriculum integrates task-based imaginative scenarios with the needs of the elderly, creating a context for divergent creative problem-solving. Real-world societal contexts serve as the foundation for learning and applying skills, transforming the analysis of societal issues into the core of the curriculum. Through a mission letter, issues are introduced to learners, encouraging them to engage consciously in design-oriented exploratory actions.

The design thinking curriculum enabled students to learn problem analysis, creative thinking, and the implementation of solutions through design practice while tackling problem-solving processes. Starting from their own life experiences, students designed with elderly users' needs in mind and learned how to apply interdisciplinary knowledge to solve real-world problems. Through repeated experimentation and adjustments, the course encouraged students to face problems, seek peer assistance, and develop creative solutions with empathy for the elderly, enhancing their problem-solving abilities through practice.

Students participated in field research and prototype design for elderly interface design, learning to collect the needs of elderly users and translate these needs into specific design functions, such as voice guidance and enlarged fonts, to improve the user experience for elderly individuals. These designs addressed the functional needs of the elderly while also considering their emotional needs. Throughout the process, students developed empathy and created interfaces with emotional connections. Based on interactions with elderly users, they continuously adjusted their designs to reflect the real needs of the elderly in the app prototype.

Acknowledgments

I would also like to extend my appreciation to Teacher RH-Ei Kao for teaching mobile interface design and for assisting in the creation of statistical charts based on students' field research on elderly users' needs for mobile phones.

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Designing for Maternal Health: Enhancing the Health Education Experience through a Cross-Cultural Study of Taiwan and Japan's Maternal Health Handbooks

Yi-Chen Lai [1,*], Tao-Hua Wang [2], and Hao-Chiang Koong Lin [3]

[1]*Department of Multimedia and Animation, Tainan University of Technology, Tainan, Taiwan*
[2]*Science Education Department, National Museum of Natural Science, Taichung, Taiwan*
[3]*Department of Information and Learning Technology, National University of Tainan, Taiwan*

The United Nations' "2030 Sustainable Development Goals" emphasize the global importance of maternal and child health. Japan and Taiwan have developed comprehensive maternal healthcare systems to support the well-being of mothers and infants. Taiwan's Maternal Health Handbook features a standardized national design that helps healthcare professionals and expectant mothers quickly understand and apply its content, enhancing service efficiency. In contrast, Japan's Maternal and Child Health Handbook includes both a "Standard Format" and an "Optional Format," reflecting diverse, locally adapted, and culturally enriched design approaches. This study highlights the importance of aligning handbook design with cultural context and user needs to improve maternal health communication and education. Drawing on international design practices, it examines how visual and structural enhancements can improve usability, accessibility, and engagement. Based on comparative analysis, the study recommends incorporating key content elements—such as "Usage Instructions," "Woman's Occupation and Home Situation," "Dentist's Report During Pregnancy," "Father and Family Record," "Parenting Class Record," "Messages for Expectant Mothers and Fathers," "Self-Paid Examination Records," "Birth Plan," "Exclusive Parking Permit," and "Hepatitis B Virus Screening Record"—to strengthen the design, functionality, and sustainability of maternal health handbooks. These recommendations support more inclusive, user-centered, and context-sensitive healthcare communication strategies.

Keywords – Cultural Design, Health Education, Maternal Health Handbook, Maternal and Child Health, Sustainable Design, User Experience.

Relevance to Design Practice – This study offers practical insights into culturally responsive health communication design, providing a reference for designers to create user-centered maternal health materials that enhance usability, accessibility, and educational effectiveness across different healthcare systems.

Introduction

Research Background

In 2015, the United Nations introduced the "2030 Sustainable Development Goals" (SDGs), outlining 17 global priorities. Among them, Goal 3—"Ensure healthy lives and promote well-being for all at all ages"—calls on governments and organizations to advance health equity and reduce preventable mortality. A key target under SDG-3 is to reduce the global maternal mortality ratio to fewer than 70 per 100,000 live births by 2030 and to eliminate preventable deaths among newborns and children under five (United Nations, 2015). Achieving these goals requires comprehensive maternal and child healthcare systems that support individuals throughout all stages of life. The World Medical Association highlights the importance of providing health services from pre-pregnancy to postpartum, including immunization and health education, to ensure maternal safety and fetal development (The World Medical Association, 2023). As global fertility rates decline, enhancing reproductive, maternal, newborn, child, and adolescent health (RMNCAH) has become essential to population stability and sustainable development (Qiao et al., 2021). In this context, health handbooks have emerged as effective tools for promoting health literacy and improving communication between patients and healthcare professionals. Taiwan's Maternal Health Handbook and Japan's Maternal and Child Health Handbook serve as comprehensive resources that provide prenatal guidance, encourage positive health behaviors, and support informed decision-making. Research shows that these handbooks strengthen the trust between pregnant women and medical professionals, ultimately improving maternal and infant health outcomes (Magwood et al., 2019; Nakamura, 2024; Tobe et al., 2022). Given their impact on health communication and education, these national handbooks offer valuable design references. A comparative analysis of Taiwan and Japan's approaches can reveal how culturally responsive, user-centered design contributes to sustainable maternal and child healthcare practices.

Research Objectives

This study aims to: (1) examine the visual and communicative features of the cover designs of Taiwan's Maternal Health Handbook and Japan's Maternal and Child Health Handbook, with particular attention to cultural representation and user engagement; (2) analyze the structural composition and content formats of both handbooks, focusing on how design elements contribute to clarity, accessibility, and educational effectiveness; and (3) propose design-informed recommendations for the global enhancement of maternal health handbooks, offering insights to guide future revisions that promote culturally responsive and user-centered healthcare communication.

Literature Review

The Importance and Design Value of the Maternal and Child Health Handbook (MCH)

Maternal and child health is a core priority within the United Nations' Sustainable Development Goals (SDGs), particularly under Goal 3, which seeks to reduce maternal and neonatal mortality and promote health equity. The Maternal and Child Health Handbook (MCH) is recognized as a vital tool in advancing

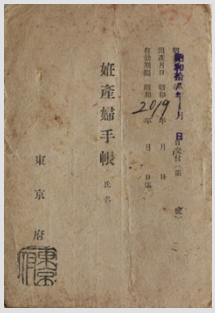
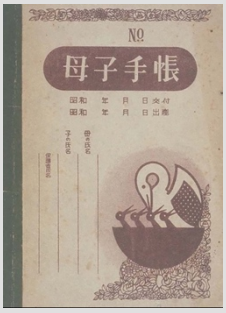
this mission. Functioning as both a self-care guide and a communication bridge between families and healthcare providers, the MCH Handbook contributes to improved public health outcomes and more inclusive healthcare systems (The World Medical Association, 2023; Nakamura, 2024). Designed to be accessible and informative, it integrates content on prenatal care, childbirth, infant development, immunization schedules, and growth milestones. Its usability in home environments makes it especially effective for populations with limited access to digital or institutional resources, including individuals with disabilities, refugees, immigrants, ethnic minorities, and other vulnerable groups, thereby aligning with the SDG principle of "Leave no one behind." Beyond storing medical records, the MCH Handbook also facilitates behavior change and early intervention through health education and referral mechanisms (Zelka et al., 2023; Osaki & Aiga, 2019). For the handbook to reach its full potential, three enabling conditions must be addressed: improved female literacy, strengthened public health literacy, and a stable sociopolitical environment that empowers families to engage with healthcare systems confidently (Nakamura, 2014). To date, over 50 countries and regions have adopted or adapted the MCH Handbook, localizing its content and design to reflect unique social, economic, cultural, and religious contexts. While its primary roles are clinical and educational, design plays a crucial role in shaping user engagement and understanding. Key design factors such as visual clarity, cultural relevance, and effective information architecture enhance its function as a health communication tool. Thus, the MCH Handbook serves not only as a healthcare record but also as a globally adaptable design artifact—demonstrating how culturally responsive, user-centered design can support inclusive and sustainable maternal and child health practices (Nakamura, 2024).

The Origin and Development of Japan's Maternal and Child Health Handbook

Japan's Maternal and Child Health Handbook (MCH) has evolved from a wartime necessity into a globally recognized model of integrated maternal and child health documentation. Originating in 1942 during the Pacific War, the government introduced the Pregnancy Handbook to monitor women's health, encourage regular prenatal examinations, and document childbirth. It also served practical functions, such as facilitating access to food rations and essential supplies (Nakamura, 2024). Following the enactment of the Child Welfare Law in 1947, a more comprehensive version was launched by the Ministry of Health, Labour and Welfare in 1948, officially titled the Maternal and Child Handbook. This 20-page handbook included both maternal medical records and childcare guidance, shifting its role from purely clinical documentation to an educational, family-centered health communication tool. In 1966, following the implementation of the Maternal and Child Health Act in 1965, it was renamed the Maternal and Child Health Handbook. With the 1991 decentralization policy, local governments were given authority over its printing and distribution, resulting in two components: a "Standard Format" mandated by the Ministry and an "Optional Format" created by municipalities, allowing for localized adaptations in layout, visuals, language, and content structure. In 2024, the Oyako Kenko Techo Promotion Association introduced an extended version capable of

recording health information over a 20-year span (Hayashiya, 2022; Nakamura, 2024; Oyako Kenko Techo Promotion Association, 2024). The Japanese MCH Handbook thus exemplifies the adaptability of health communication design across time, policy, and regional contexts, while maintaining its core function of supporting maternal and child well-being. Its user-centered design, cultural sensitivity, and visual flexibility serve as a valuable reference for other countries aiming to develop inclusive, sustainable, and effective maternal health communication tools (Yoshida, 2021). For the design aspects related to Japan's Maternal and Child Health Handbook, please refer to Table 1.

Table 1. Japan's Issuance of the "Pregnancy Handbook," the "Maternal and Child Handbook," and the 20-Year Usable "Maternal and Child Health Handbook".

		
Pregnancy Handbook, published in 1942	Maternal and Child Handbook, published in 1948	The 20-Year Usable Maternal and Child Health Handbook published in 2024

Source: Okinawa Pediatric Health Association. (2023)；Oyako Kenko Techo Fukyu Kyokai. (2024).

The Origin and Development of Taiwan's Maternal Health Handbook

Aligned with the World Health Organization's vision of "Health for All," Taiwan implemented its National Health Insurance system in 1995, which incorporated the nationwide issuance of the Maternal Health Handbook as part of its maternal healthcare services (Health Promotion Administration, 2023). Designed to support both clinical care and public health education, the handbook serves as a prenatal health record and an educational resource for expectant mothers. From 1995 to 2024, it has undergone 18 editions and three major revisions (see Figure 1). The initial version enabled access to ten prenatal checkups and included content on examination records, lifestyle recommendations, oral hygiene, the harms of smoking and alcohol, nutrition, weight management, and breastfeeding—reflecting a dual focus on medical monitoring and behavior-oriented health education. A significant redesign in 2015 introduced structured record pages for each prenatal visit and expanded the educational content to include genetic screening, the importance of routine examinations, breastfeeding guidance, and contraceptive knowledge. In 2020, the handbook shifted toward a user-centered design approach, integrating feedback from both healthcare professionals and pregnant women. The revised content was divided into two volumes: the

Maternal Health Handbook and the Maternal Education Handbook. Redundant information was removed, and dense text was replaced with illustrations and infographics to improve clarity and engagement. Design enhancements also improved usability, with simplified record forms, clearer typography, and an updated visual language for the cover. Environmentally conscious modifications were implemented, such as removing plastic covers, adding paper compartments for health card storage, and incorporating QR codes linking to digital resources. In 2022, a third volume—the Enhanced Prenatal Examination Handbook—was introduced in response to expanded prenatal care policies initiated in 2021. The latest edition also depicted both mothers and fathers on the cover, reflecting a cultural shift toward inclusive parenting and paternal involvement. In 2023, Taiwan adopted eco-friendly printing practices using Forest Stewardship Council (FSC)-certified paper and soybean-based inks, aligning the handbook with sustainable design principles. Taiwan's iterative, user-informed approach demonstrates an evolving understanding of how healthcare design, accessibility, and culturally sensitive education can be seamlessly integrated to promote maternal well-being. These enhancements not only improve the handbook's usability and effectiveness in health literacy but also serve as a model for other countries aiming to develop holistic and sustainable maternal health communication systems.

Figure 1. shows the "Maternal Health Handbook" issued in Taiwan from 1995 to 2024.

Source: Health Promotion Administration. (2024a).

Methods

Comparative Analysis Method

This study adopts a comparative analysis method to systematically examine the design and content of maternal health handbooks in Taiwan and Japan. Comparative analysis allows researchers to identify similarities and differences across systems, policies, and cultural contexts, facilitating a more nuanced understanding and the development of cross-contextual, evidence-based recommendations (Bolbakov et al., 2020). The primary materials analyzed include the 2024 edition of Taiwan's Maternal Health Handbook and the 2024 edition of Japan's Maternal and Child Health Handbook. The analysis focuses on three key aspects: (1) visual design features, (2) content structure and educational layout, and (3) cultural and policy reflections embedded in the handbooks. By categorizing and comparing these elements, the study evaluates the strengths and limitations of each country's approach to maternal health

communication design. The findings aim to generate design-informed insights that can inform future revisions and promote the global advancement of inclusive, user-centered maternal health communication tools.

Discussion

Cover and Back Cover Design of the Handbooks

The cover design of a publication plays a crucial role in shaping users' first impressions and expectations. As Gudinavičius and Šuminas (2017) observe, elements such as color schemes, imagery, and layout can convey the purpose and tone of a publication, thereby attracting users and guiding their engagement. In the context of maternal healthcare, handbook cover design is not merely aesthetic—it influences emotional resonance, inclusivity, and practical usability. Taiwan's Maternal Health Handbook (2024 edition) features a nationally unified design developed by the Health Promotion Administration under the Ministry of Health and Welfare, with support from the Tobacco Control and Health Care Fund. The cover illustrates an expectant couple, symbolizing the shared joy and responsibility of pregnancy, subtly reinforcing the value of paternal involvement and reflecting a contemporary, family-centered healthcare perspective. However, some usability issues remain. For instance, personal identification information—such as the user's name—is currently placed on the back cover, which may hinder efficiency in clinical settings where multiple handbooks are in use, such as during group education sessions. Relocating the name field to the front cover could enhance accessibility and reduce handling time. Additionally, in response to digital trends, the cover includes a QR code that links users to online resources, integrating printed and digital tools to enrich health education and improve information accessibility (Health Promotion Administration, 2024a). In contrast, Japan's Maternal and Child Health Handbook employs a decentralized approach. While a standardized "mandatory format" is regulated by the Ministry of Health, Labour and Welfare, municipalities are authorized to produce "optional formats" that include localized content, benefits, and unique cover designs (Hayashiya, 2022). As shown in Table 2, cities such as Shizuoka, Tsukuba, and Niigata feature distinctive visual styles that reflect regional identity and creativity. In Japan, the handbook is often regarded as a personal keepsake, treasured well into a child's adulthood. Although many Japanese covers adopt playful and visually engaging designs, they typically focus on the child or mother, with limited representation of fathers. Compared to Taiwan's inclusive cover imagery, this presents an opportunity to promote more balanced parental representation in future designs. Notably, Japanese handbooks display the user's name and serial number on the front cover—a practical design feature that enhances clarity and reduces the likelihood of mix-ups, particularly in institutional contexts. This user-oriented detail offers a valuable reference for other countries developing or revising maternal health communication materials.

Table 2. Cover Designs of the "Maternal and Child Health Handbook" Issued by Various Local Governments in Japan in 2024.

		
Shizuoka City's "Maternal and Child Health Handbook"	Tsukuba City's "Maternal and Child Health Handbook"	Niigata City's "Maternal and Child Health Handbook"

Source: Niigata City, (2024); Tsukuba City, (2024); Shizuoka City.

Content Planning and Educational Structure of Taiwan's and Japan's Maternal Health Handbooks

This study compares the content architecture and educational structure of Taiwan's Maternal Health Handbook and Japan's Maternal and Child Health Handbook, aiming to identify their respective strengths and areas for improvement (see Table 3). Both handbooks are organized around key stages of maternal care, including pregnancy, childbirth, health education, and health tracking. However, their approaches to content planning differ significantly, shaped by distinct policy frameworks, user needs, and cultural design logic. Japan's Maternal and Child Health Handbook integrates content across the full continuum of early life—from pregnancy through infancy and early childhood—into a single unified volume. This all-in-one structure promotes continuity in record-keeping and supports a longitudinal perspective on maternal and child health, making it particularly effective for families seeking a consolidated personal health archive. The handbook is often regarded as a meaningful keepsake. In contrast, Taiwan's system separates maternal and child health documentation into two specialized handbooks: the Maternal Health Handbook and the Children's Health Handbook (see Table 4). This division allows for more focused and stage-specific educational content. Taiwan's Maternal Health Handbook emphasizes prenatal education and clinical documentation, providing structured health record forms aligned with each prenatal examination. This enables expectant mothers to monitor their health status over time. Complementary educational topics—such as nutrition, oral hygiene, prenatal screening, and mental well-being—are embedded within the layout, with QR codes linking to relevant online resources (Health Promotion Administration, 2024a). The specialization of Taiwan's handbook reflects a more medically focused and professionally oriented approach, while Japan's comprehensive format fosters long-term engagement and familial value. These contrasting models illustrate how content planning directly influences user experience, perceived value, and the overall effectiveness of health communication. Each system offers

unique insights into how maternal health information can be curated, structured, and delivered through thoughtful design.

Table 3. Content Planning of Taiwan's "Maternal Health Handbook" and Japan's "Maternal and Child Health Handbook".

Taiwan's "Maternal Health Handbook"		***Japan's "Maternal and Child Health Handbook"***	
Ministry of Health and Welfare National unified printing and distribution		Ministry of Health, Labour and Welfare Issues "Mandatory Format" and "Optional Format"; local governments print and distribute their own versions	
Published in March 2024		Published in April 2024	
78 pages		54 pages	
Pregnancy	Handbook usage instructions	Pregnancy	Health status of pregnant women
	Words for Expectant Mothers		Woman's Occupation and Home Situation
	Words for Expectant fathers		Pregnancy record (1)～(4)
	Prevention reminders for danger signs		Progress of pregnancy
	Schedule and services for prenatal examinations		Examination record
	Prenatal examination record form		Record for fathers and surrounding people
	My past pregnancy and childbirth history		Parenting Class Record
	Comprehensive prenatal examination record		Dentist's Report on Mother's Teeth During Pregnancy
	Prenatal ultrasound examination record (3 times)		Status of childbirth
	Prenatal ultrasound screening explanation		Postpartum health record of the mother
	Health education guidance record	Childbirth	Self-condition record of the mother
	Prenatal self-check record (14 times)		
	Prenatal examination record (14 times)		Postpartum care record
	Record of self-paid examination items		Newborn health check record

	Birth plan		Stool color check record
Childbirth	Childbirth record		Parents' records (infants)
	Discharge instructions		Baby health check (infants)）
Health Education	Understanding tobacco hazards		Parents' records (toddlers)
Health Tracking	Hepatitis B follow-up examination record for pregnant women		Baby health check (toddlers)
		Infants and Young Children	Infant body growth curve (boys)
			Toddler body growth curve (boys)
			Infant body growth curve (girls)
			Toddler body growth curve (girls)
			Time schedule and records of vaccinations

Source: Health Promotion Administration. (2024a)；Children and Families Agency, Government of Japan. (2025, April)

Table 4. Cover and Back Cover Design of Taiwan's "Children Health Handbook" Issued in July 2024.

	
Cover of the Taiwan Children Health Handbook	Back cover of the Taiwan Children Health Handbook

Source: Health Promotion Administration. (2024b).

Advantages of the Design and Planning of Japan's Maternal and Child Health Handbook

Inclusion of "Woman's Occupation and Home Situation" Section

A notable feature of Japan's Maternal and Child Health Handbook is the inclusion of a section titled "Woman's Occupation and Home Situation," which records comprehensive information about the pregnant woman's work and living conditions. This form documents not

only job type and duties, but also environmental risk factors such as prolonged standing, secondhand smoke exposure, irregular work hours, commuting routines, household composition, noise levels, and natural lighting at home. This section highlights the handbook's dual role as both a clinical record and a tool for monitoring social determinants of health. In the context of declining global fertility rates, such data collection supports informed policymaking and workplace reform to create pregnancy-friendly environments. Research has shown that occupational and environmental exposures—including air pollution, shift work, heat, and extended working hours—can adversely affect maternal and fetal health (Atkin et al., 2024; Cai et al., 2020). By systematically documenting these factors, the handbook allows healthcare providers to identify risks and offer tailored guidance. From a design standpoint, this section reflects a user-centered, context-aware approach that acknowledges pregnancy is influenced by both biological and socio-environmental factors. Incorporating similar record forms into maternal health handbooks in other countries—such as Taiwan—could enhance health equity, raise contextual awareness, and enable preventive care through thoughtful design.

Integration of Oral Health Monitoring During Pregnancy

Another strength of Japan's Maternal and Child Health Handbook is the inclusion of a "Dentist's Report on Mother's Teeth During Pregnancy" section, which monitors the oral health of pregnant and postpartum women. This reflects a recognition of oral care as an essential component of maternal health. Conditions such as gingivitis, periodontal disease, and oral infections during pregnancy have been associated with adverse outcomes like premature birth and low birth weight (Testa et al., 2022). To address this, the handbook promotes preventive oral care by documenting dental assessments, encouraging floss use, and reinforcing the importance of dental visits during pregnancy. This integration exemplifies a holistic, preventive approach to maternal care. By embedding oral health structurally and visually into the handbook, it normalizes dental care as part of routine prenatal monitoring. In contrast, Taiwan's Maternal Health Handbook lacks a dedicated section for dental records. To enhance the comprehensiveness of maternal health documentation, future editions could incorporate oral health education and dental check-up forms, developed in collaboration with dental professionals to ensure clinical accuracy and user clarity. Inspired by Japan's model, this addition would support interdisciplinary education and contribute to a more complete maternal care experience through thoughtful design.

Promoting Emotional Support through the "Father and Family Record" Section

Pregnancy is a transformative period marked by physical changes, emotional shifts, and increased vulnerability. During this time, support from partners and family members plays a vital role in promoting maternal well-being. Studies show that over 80% of pregnant women desire active partner involvement in learning about pregnancy and childbirth, along with consistent emotional support (Silalahi & Sipayung, 2024; World Health Organization, 2022). Addressing this need, Japan's Maternal and Child Health Handbook includes a dedicated "Father and Family Record" section, inviting partners and family members to write

messages, share feelings, and offer encouragement to the expectant mother. Though seemingly symbolic, this section serves an important emotional function by affirming the family's role in the pregnancy journey and fostering a sense of shared responsibility. From a design perspective, it exemplifies a human-centered approach that integrates emotional well-being into maternal healthcare. It transforms the handbook into a personal artifact that supports not only clinical and educational purposes but also familial bonding and psychosocial support. Future editions of maternal health handbooks—particularly in countries such as Taiwan—could benefit from adopting similar features to encourage partner involvement and family participation. By embedding emotional care into both the visual and structural design, such enhancements contribute to a more holistic maternal health education experience.

Encouraging Co-Participation through a "Parenting Class Record" Section

Pregnancy and childbirth are both physiological and emotional transitions that benefit from professional guidance and structured health education. Prenatal classes led by obstetricians, midwives, and nurses play a crucial role in preparing expectant parents for childbirth and early parenting. These sessions have been shown to reduce maternal anxiety, ease physical discomfort, and improve emotional well-being and delivery satisfaction (Derya et al., 2021; Eddy & Fife, 2020). Including a "Parenting Class Record" section in maternal health handbooks provides an opportunity to document participation and highlight the importance of prenatal education. By encouraging both expectant mothers and fathers to attend together, the handbook becomes a tool for promoting shared learning, mutual understanding, and co-parenting engagement. This design element transforms the handbook from a passive record into an active educational platform that fosters emotional and relational support during pregnancy. Recording class attendance can also motivate parental involvement while supporting health professionals' efforts to normalize and standardize prenatal education across systems. Future editions of maternal health handbooks—especially in countries like Taiwan—could benefit from incorporating this feature. A co-learning record form would strengthen the handbook's educational function and promote a more inclusive and supportive family dynamic through thoughtful design.

Facilitating Navigation with an Edge Index System

A notable design feature of Japan's Maternal and Child Health Handbook is the edge index system—a fore-edge navigation tool that visually marks content sections for quick reference. As the handbook integrates both maternal and child health records into a single volume, the edge index helps users efficiently locate information without flipping through every page. This system uses printed markings visible along the outer edge, even when the book is closed, dividing the content into seven thematic categories: pregnancy, childbirth, postpartum care, infancy, toddler development, growth curves, and immunization records. Functioning like tabbed dividers or color-coded sections, the edge index enhances usability by offering intuitive visual cues (Bookbinding and the Conservation of Books: A Dictionary of Descriptive Terminology, 2024). In the context

of health education and maternal care, this feature aligns with user-centered design principles, improving information accessibility—especially for users navigating under emotional or time constraints. From a design perspective, the edge index is a low-cost, high-impact solution that enhances readability and reduces cognitive load. Future editions of Taiwan's Maternal Health Handbook, or those from other regions, could benefit from adopting similar navigational aids to improve user orientation, streamline healthcare interactions, and enhance the overall educational experience through thoughtful visual design.

Advantages of the Design and Planning of Taiwan's Maternal Health Handbook

Clear Usage Instructions to Support User Orientation

A key strength of Taiwan's Maternal Health Handbook is the inclusion of clearly structured usage instructions on the first page. These guidelines offer essential information to expectant mothers, such as reminders to bring the handbook and National Health Insurance (NHI) card to every prenatal visit. They also prompt healthcare providers to sign and record each examination, reinforcing the handbook's dual role as a health log and communication tool between patients and medical staff. Additionally, users are encouraged to write down questions before appointments, promoting active engagement and facilitating two-way communication. This reflects a user-centered approach that fosters clarity, autonomy, and patient involvement in care management. From an information design perspective, placing clear instructions upfront reduces uncertainty and cognitive load—particularly for first-time users unfamiliar with the handbook's format or function. Compared to systems where such information is dispersed or missing, Taiwan's approach offers a strong model of how accessible guidance can enhance both usability and educational impact. This practice provides a valuable reference for future editions of maternal health handbooks in other regions, including Japan, where standardized usage instructions could improve consistency across municipalities and strengthen healthcare communication.

Creating Emotional Dialogue through "Words for Expectant Mothers" and "Words for Expectant Fathers"

Taiwan's Maternal Health Handbook includes two message sections—"Words for Expectant Mothers" and "Words for Expectant Fathers"—that offer gentle encouragement, foster emotional connection, and promote shared responsibility during pregnancy. These messages are framed not as clinical instructions but as personal notes that establish a warm tone and initiate symbolic dialogue between the healthcare system and the expectant family. In the "Words for Expectant Mothers" section, women are congratulated on their journey and reminded of the importance of self-care, including regular checkups and healthy lifestyle choices. The language is affirming, reinforcing the partnership between mothers and healthcare providers as co-stewards of the baby's well-being. The "Words for Expectant Fathers" section speaks directly to male partners, emphasizing emotional support, shared responsibility, and active participation. Fathers are encouraged to contribute through everyday actions—such as attending prenatal visits, creating a calm home environment, and offering

consistent support—which have been shown to reduce maternal anxiety and strengthen family bonds (Eddy & Fife, 2020; Silalahi & Sipayung, 2024). From a design perspective, these message sections function as textual user interfaces, using tone and language to emotionally engage users. They demonstrate how carefully crafted written content can humanize health education, promote gender-inclusive dialogue, and increase user engagement with printed materials. As part of a user-centered, culturally responsive design strategy, such sections offer a valuable model for future maternal health publications, emphasizing empathy, reassurance, and emotional connection alongside informational content.

Enhancing Comprehension through Visual Cues for Warning Signs

Taiwan's Maternal Health Handbook employs visual design strategies to communicate critical health information effectively. A key example is the use of illustrated warning signs that prompt users to seek immediate medical attention under specific conditions—such as vaginal bleeding (regardless of amount), severe or persistent abdominal pain, or reduced fetal movement. Each illustration is paired with a brief, clearly written description, forming a dual-coding approach that integrates visual and verbal cues. Research in health communication shows that combining images with concise text improves message clarity, enhances recall, and supports comprehension across diverse user groups, including those with limited health literacy (Schubbe et al., 2020; Nakamura, 2024). This strategy aligns with best practices in health information design, where visual elements reduce cognitive load and help users identify and remember urgent health messages. It also ensures accessibility for users who may be overwhelmed, stressed, or unfamiliar with medical terminology. As shown in Table 5, this visual-verbal integration enhances the handbook's function not only as a clinical record but also as a proactive communication tool for early intervention and self-monitoring. Other maternal health handbooks—such as those in Japan—could benefit from adopting similar visual techniques to improve comprehension and encourage timely healthcare-seeking behavior.

Table 5. Warning Signs for Pregnant Women in Taiwan's "Maternal Health Handbook.

	
Warning Sign Notice-1	Warning Sign Notice-2

Source: Health Promotion Administration. (2024a).

Planning "Records of Self-Paid Prenatal Examinations" to Make Health Information More Complete

Prenatal examinations are essential for the early detection of health issues, and a positive correlation has been observed between regular checkups and improved neonatal outcomes (Silalahi & Sipayung, 2024). In Taiwan, prenatal examinations are categorized into public (government-subsidized) and self-paid services. Public services include 14 obstetric checkups, 3 ultrasound scans, 1 Group B Streptococcus screening, 2 prenatal education sessions, gestational diabetes screening, and an anemia test (Health Promotion Administration, 2023). In Japan, upon pregnancy confirmation, women must notify their local municipal office to receive the Maternal and Child Health Handbook and vouchers subsidizing part of their maternity examinations (Nagamine et al., 2023). Due to limited public funding and varying individual health needs, self-paid prenatal examinations remain necessary in both countries. Taiwan's Maternal Health Handbook addresses this by including a dedicated "Records of Exam at Your Own Expense" section, allowing expectant mothers to document their self-funded checkups. This section helps ensure more complete medical records, supports personalized care, and facilitates a smoother pregnancy journey, ultimately contributing to better maternal and neonatal health outcomes..

Standardized Format to Support Consistency and Service Efficiency

A key strength of Taiwan's Maternal Health Handbook is its nationally standardized design, compiled and issued by the Health Promotion Administration under the Ministry of Health and Welfare. This unified format ensures that all pregnant women across the country receive consistent information, facilitating clear communication between users and healthcare providers. It also streamlines clinical workflows, enabling healthcare professionals to navigate and utilize the handbook efficiently in various settings. In contrast, Japan's Maternal and Child Health Handbook follows a decentralized model. While its core content adheres to a nationally mandated format, local governments are free to add optional content and customize layout, visual style, and even physical dimensions. Formats vary regionally—from A6 and B6 to A5—depending on local preferences and resources (Mama no Te Editorial Department, 2023). Although this flexibility supports cultural expression and administrative autonomy, it can pose practical challenges. Variations in size and structure complicate the use of protective covers, create difficulties for health professionals managing diverse versions, and hinder national data integration and staff training. For users, inconsistency in layout may confuse first-time readers or those relocating between regions. Taiwan's standardized format, by contrast, enhances clarity, portability, and system-level efficiency. It illustrates how consistent design across jurisdictions can improve both user experience and institutional performance. As maternal health systems become more digital, physical standardization may also facilitate future integration with electronic health records or mobile applications. Japan's handbook system could benefit from harmonizing physical specifications—such as size and section structure—while retaining visual and cultural flexibility at the local level. Such a hybrid approach would balance national consistency with regional identity, improving usability and

cross-system interoperability.

"Birth Plan": Respecting Pregnant Women's Autonomy

The World Health Organization's 2018 intrapartum care recommendations emphasize supporting women in achieving a positive childbirth experience. Research indicates that developing a birth plan can help pregnant women articulate their preferences, reduce prenatal stress and anxiety, and promote a sense of control during labor (Barnes et al., 2023; Leinweber et al., 2022). Taiwan's Maternal Health Handbook includes a chapter on the "Birth Plan," which underscores the importance of respectful, rights-based, and woman-centered care. It promotes autonomy and encourages communication between pregnant women and healthcare providers (Health Promotion Administration, 2024a). The thoughtful design of this chapter serves as a valuable model for fostering positive birth experiences, strengthening doctor-patient communication, and enhancing the overall quality of maternal healthcare.

Promoting Accessibility through an Embedded Exclusive Parking Permit

As part of Taiwan's broader efforts to create a family-friendly environment and encourage childbirth, the Maternal Health Handbook includes a practical, policy-integrated design feature: an exclusive parking permit for pregnant women and parents with young children. Embedded directly within the handbook, this permit can be used immediately upon receipt, eliminating the need for a separate application process. Implemented under the Regulations on the Management of Parking Spaces for Pregnant Women and Those with Children Under Six Years Old (2018) and supported by the Children and Youth Welfare and Rights Act (2021), this measure legally requires government agencies and public institutions to provide designated parking spaces for eligible users. Including the permit in the handbook ensures it reaches the intended audience—pregnant women and new parents—at a timely and relevant moment. From a service design perspective, it exemplifies seamless policy delivery through user-centered design. The permit is perforated for easy tear-out, intuitively positioned for visibility, and ready for immediate use. It reduces administrative burden and enhances physical accessibility, particularly by minimizing walking distances in public spaces. This feature extends the handbook's function beyond health education, transforming it into a multi-functional civic tool that supports user well-being through integrated design and public service planning. It reflects a holistic approach to maternal care—one that addresses not only clinical needs but also the environmental and logistical realities of pregnancy and early parenthood. As countries like Japan consider updates to their maternal health handbooks, such embedded service elements offer valuable models for linking healthcare communication with real-world infrastructure and support..

Preventing Vertical Transmission through a "Hepatitis B Screening Record" Section

Chronic Hepatitis B (CHB) remains a significant global health challenge, especially in regions with high endemicity. In response, the World Health Organization aims to eliminate viral hepatitis as a public health threat by 2030. Despite widespread vaccination efforts, mother-to-child (vertical) transmission remains a major

route of infection—accounting for over 50% of CHB cases in highly endemic areas and resulting in 4–5 million new pediatric infections annually (Belopolskaya et al., 2021). To proactively address this risk, Taiwan's Maternal Health Handbook includes a dedicated "Hepatitis B Screening Record" section. This feature allows healthcare providers to document key prenatal screening results such as HBsAg status, and when relevant, HBeAg presence, HBV viral load, ALT levels, and HBsAg titers. The structured format ensures that critical risk indicators are clearly communicated, centrally documented, and easily referenced throughout prenatal care. From a design perspective, this section exemplifies evidence-based information architecture, transforming clinical guidelines into a user-friendly recording tool that supports both medical decision-making and patient education. It reinforces prevention as a core function of maternal healthcare documentation, contributing to a more holistic health communication system. By embedding this record into the handbook, Taiwan aligns with global maternal health strategies while offering pregnant women a tangible, visible reminder of essential viral testing procedures. This integration increases the likelihood of timely intervention and follow-up in high-risk cases, improving perinatal outcomes and reducing preventable infections. Other countries, including Japan, could benefit from incorporating similar disease-specific screening records into their maternal health documentation—bridging global health objectives with locally responsive design.

Conclusion & Recommendations

Cover Design: Balancing Standardization and Localized Expression

The cover design of maternal health handbooks plays a crucial role in setting the tone for user engagement and shaping perceptions of care. Taiwan's Maternal Health Handbook adopts a nationally standardized format, compiled and distributed by the Health Promotion Administration under the Ministry of Health and Welfare. This consistency facilitates efficient usage across medical institutions and enhances both service quality and user familiarity. The 2024 edition features a warm and inclusive cover illustration of a couple, symbolizing shared responsibility and emotional connection during pregnancy. However, from a usability standpoint, minor refinements could further enhance the design. For example, relocating the name and identification fields from the back cover to the front would improve accessibility—particularly in clinical settings where multiple handbooks are handled simultaneously. In contrast, Japan's Maternal and Child Health Handbook incorporates a dual-format system consisting of a "Ministerial Ordinance Format" (nationally standardized content) and an "Optional Format" (locally customized sections). This approach empowers local governments to adapt content based on regional needs and to include culturally relevant visuals, localized welfare information, or area-specific healthcare policies. As a result, the handbook exhibits a rich diversity in visual presentation and thematic focus across different municipalities. While Japan's decentralized model encourages cultural representation and regional innovation, it also introduces challenges related to format inconsistency—such as variations in handbook size, layout, and

usability. A potential recommendation would be to retain local creative freedom while establishing core standards—such as fixed dimensions and uniform placement of critical information—to ensure greater consistency in user experience nationwide. This comparative analysis illustrates how cover design can go beyond aesthetics to reflect broader values of healthcare equity, access, and cultural sensitivity. Striking a balance between national standardization and localized flexibility represents a promising direction for the future development of maternal health communication tools.

Content Planning: Structuring for Clarity and Educational Effectiveness

Both Taiwan's Maternal Health Handbook and Japan's Maternal and Child Health Handbook share common thematic planning in their content structure, covering key domains such as pregnancy, childbirth, health education, and health tracking. However, their approaches to content organization and delivery reveal notable differences in design strategy and user experience. Taiwan adopts a modular, stage-specific approach by dividing its documentation into two separate handbooks: the Maternal Health Handbook for prenatal care and the Children's Health Handbook for postnatal and early childhood development. This separation—uniformly compiled and distributed by the Health Promotion Administration—allows each volume to focus on the health priorities and educational needs of a distinct phase, thereby reducing cognitive load and enhancing information absorption. Japan, by contrast, integrates all maternal and child content into a single, multi-purpose handbook. While this unified format fosters continuity and serves as a lifelong health record, it may risk overwhelming users with dense or overlapping information. Moreover, the absence of a standardized national format—both in content layout and physical dimensions—can lead to inconsistencies in how educational materials are accessed and interpreted across municipalities. From a design and communication perspective, segmenting information by developmental stage, as demonstrated in Taiwan's model, enhances educational clarity and promotes phase-appropriate user engagement. This approach is particularly beneficial for first-time parents or individuals with limited health literacy. Future iterations of Japan's handbook system might consider adopting a dual-booklet structure, separating prenatal and postnatal content, while also introducing standardized size specifications to facilitate use, storage, and compatibility with supplementary accessories (e.g., protective covers, storage pouches). Such refinements would support more targeted educational delivery while preserving the cultural richness and local relevance offered by Japan's decentralized design model.

Designing for Sustainable Development in Maternal Health Communication

As maternal and child health remains a global priority under the United Nations' Sustainable Development Goals (SDGs), future versions of maternal health handbooks across countries should be designed not only to meet immediate healthcare needs but also to support long-term sustainability in health communication, equity, and system usability. To achieve this, handbooks must be culturally contextualized and functionally responsive to each nation's unique social, economic, and healthcare landscape—while also drawing upon

successful international practices. Taiwan's Maternal Health Handbook serves as a compelling example of how thoughtful design can contribute to sustainability by integrating clinical functionality with human-centered values. Features such as the "Woman's Occupation and Home Situation" form, the "Dentist's Report" during and after pregnancy, and the "Hepatitis B Screening Record" underscore a strong emphasis on preventive care and comprehensive documentation—both of which are essential for reducing long-term health burdens. Sections like "Words for Expectant Mothers" and "Words for Expectant Fathers" foster emotional engagement and gender-inclusive communication, while the "Record of Father and Family" and the "Parenting Class Record" reflect a commitment to family-centered care. In terms of usability, elements such as edge index tabs, clear usage instructions, and structured fields for self-paid examinations enhance information accessibility and support continuity of care. Environmental and infrastructural considerations—most notably the embedded Exclusive Parking Permit—further demonstrate how handbook design can intersect with public policy and promote mobility equity. Taken together, these features contribute to a more holistic, inclusive, and sustainable model of maternal health communication—one that prioritizes health equity, patient empowerment, interprofessional coordination, and lifespan health literacy. Future maternal health handbooks in Japan and other countries may benefit from adopting or adapting these features as part of a design strategy that aligns with global health goals while remaining locally relevant, culturally sensitive, and practically usable.

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The Voices of College Students about the VC-Related English Self-Introduction Activity

Ching-Huang Wang [1,*], Hong-Yi Pai [2], Zi-Yi Chuang [3], Ting-Jung Chang [3], Yu-Ting Shen [3], Pei-Hsien Lin [3], and Guan-Yi Li [3]

[1]*Professor, Applied Foreign Languages, National Formosa University, Taiwan*

[2]*Associate Professor, Multimedia, National Formosa University, Taiwan*

[3]*Senior, Applied Foreign Languages, National Formosa University, Taiwan*

This study centered on the perspectives of 16 Taiwanese college students regarding an English self-introduction activity involving Virtual Characters (VCs). It aimed to address the research question: How did Taiwanese college students respond to the VC-related English self-introduction activity? Data were collected through three sources: students' activity scripts, a paper-based six-point Likert scale questionnaire, and their mind maps. The results of the current study indicated that (a) Taiwanese college students generally agreed that this activity enhanced their skills, particularly speaking, reading, and vocabulary; (b) The activity primarily improves the participants' speaking ability, with less impact on grammar; (c) Gender differences were not found; both male and female students had similar positive attitudes toward the activity; (d) Male students experienced significant improvements in vocabulary, listening, speaking, and reading, while gains in writing were minimal; (e) Female students showed the greatest enhancement in speaking ability, with relatively minor improvements in grammar; (f) The most pronounced gender difference was observed in grammatical development, while vocabulary acquisition showed no notable variation between male and female students. The questionnaire findings were reinforced by students' scripts and mind maps, indicating that employing the Virtual Avatar Interactive Live System (VAILS) enhanced their enjoyment, engagement, motivation to learn, fun, and self-confidence in the activity. In conclusion, integrating multimedia technologies such as the VAILS holds significant potential for enhancing English teaching and learning experiences.

Keywords **-** English Self-introduction Activity, Virtual Avatar Interactive Live System (VAILS), Virtual Character (VC), Taiwan.

Relevance to Design Practice - VAILS can be a useful design tool for design.

Introduction

A key principle of multimodality theory is that reliance on textbooks and

passive engagement with texts is no longer sufficient for effective learning (Hsueh & Lin, n.d.), particularly in non-traditional settings such as English as a Medium of Instruction (EMI) classrooms. Students should be encouraged to engage with diverse educational modalities (Hsueh & Lin, n.d.), such as body language, textbooks, film clips, mind maps, YouTube, and even emerging AI tools like ChatGPT and Copilot. Modern instructors should try their best to get familiar with education-oriented multimedia technologies and then select some to motivate students and boost their school achievements (Hsueh & Lin, n.d.).

Multimedia technology has played a crucial role in educational settings, which can satisfy students' audio and visual senses (Ahmadi, 2018). There has been a steady escalation to implement the use of multimedia technology into language learning to help engage learners in hands-on activities and increase their learning achievements (Pai et al., 2024). Without common pencil and paper, multimedia technology offers students an opportunity to create and complete their class tasks on the computer (Ahmadi, 2018), which makes it possible to increase the quality and efficiency of their language learning and enhance their practical application ability (Shen & Guo, 2022). In short, multimedia technology can create student-centered environments to allow students to play active roles in learning (Ahmadi, 2018; Dawson et al., 2008; Gilakjani, 2014).

Virtual characters (VCs) are particularly-created individuals representing humans in virtual reality (Shen & Guo, 2022). Recently, the application of VCs, breaking the traditional teaching mode of education, has been an inevitable trend in language education, especially in English learning, which can boost students' learning efficacy (Mousas et al., 2018) and encourage them to speak English. The virtual character (VC) system or device is a form of multimedia technology. It is equipped with visual sensors which can capture users' facial expressions and body movements (Borovikov & Yershov, 2016; Pai et al., 2024). The strength of the VC can reduce users' anxiety and fear of speaking foreign languages in public and can rerecord their narratives physically and emotionally until they are satisfied with them. Thus, in the VC system, users can choose human-like avatars to engage or interact with to complete their tasks in an anxiety-free environment and further enjoy the experience in both physical and virtual worlds (Borovikov & Yershov, 2016; Pai et al., 2024).

Plenty of previous studies worked on the use of multimedia technology on English teaching and learning, but few of them focused on the implementation of a Virtual Character (VC) device into Taiwanese undergraduates' English self-introduction activity in terms of English acquisition. The current study investigated Taiwanese college students' attitudes toward the VC-related English

self-introduction activity. The research question posed to motivate the current study was: How did Taiwanese college students respond to the VC-related English self-introduction activity?

Literature Review

The conceptual framework in the current study is multimodality. Multimodality refers to the use of two representational modes or more for interaction (Hsueh & Lin, n.d.) among people. That is to say, people employ diverse representational modes to create meaning of ideas and interact with others (Hsueh & Lin, n.d.; Kress, 2009). A mode, simply put, is viewed as a way of communication within a specific culture (Kress, 2009). As well as traditional texts and spoken language, people, in the era of technology, can employ multiple modes to communicate with others, including figures (like pictures and photos) and multimedia (like 3D objects, AR and VR) (Hsueh & Lin, n.d.). The same concept can be utilized in language teaching and learning contexts (Kress, 2009). Today, students are so exposed to multimedia that various digital tools and materials are as important as texts and lecturing (Hsueh & Lin, n.d.) in the classroom. As such, diverse teaching and learning modes can be selected and employed to motivate students in their learning processes and maximize their learning achievements (Hsueh & Lin, n.d.). In the current study, the teaching and learning modes included a textbook, lectures, group discussion, PPT, and Virtual Avatar Interactive Live System (VAILS).

Multimedia technology has been an important and convenient instrument in humans' daily life, including education (Chang & Hung, 2019; Pazilah et al., 2019) like English teaching and learning (Shen & Guo, 2022). Multimedia technology provides learners with the environment for authentic learning (Ahmadi, 2018; Pazilah et al., 2019) by using animation, audio and visual effects (Shyamlee & Phil, 2012). A wealth of research studies supported the value of multimedia technology in language teaching and learning (Shyamlee & Phil, 2012). The use of multimedia technology in language learning is indispensable in that it can make student-centered learning more attractive, effective, and productive than teacher-centered learning (Altun, 2015; Shyamlee & Phil, 2012). In short, the implementation of multimedia technology into language learning plays a vital role in engaging learners to class activities and enhancing their learning achievement (Ahmadi, 2018; H. J. Becker, 2000).

Chang and Hung (2019) conducted a meta-analysis to investigate the effectiveness of multimedia technology on second language or foreign language (L2) acquisition among 84 qualifying studies (i.e., journal papers, conference

proceedings, theses and dissertations) conducted from 1990 to 2015, as well as the factors that affected students' learning effectiveness. Two research questions were (a) What is the overall effectiveness of empirical studies that implement technology to facilitate L2 acquisition? and (b) What variables pertaining to methodological and contextual features of studies significantly affect the effectiveness? The results of the present study indicated that (a) The use of technology in L2 classrooms remarkably increased students' learning motivation and achievement, and (b) Such factors as sample size, educational level, technology device, and software type could significantly affect students' learning effectiveness.

Montero-Saizaja (2022) investigated the impact of multimodality on EFL (English as a foreign language) learners' productive vocabulary. Sixty Spanish 12th-graders were divided into two groups: multimodality (n=24) and unimodality (n=36). Two research instruments were the Learning Style Survey (Cohen et al., 2001) used to group the participants into two, and the 2,000-word version of the Productive Vocabulary Levels Test (Laufer & Nation, 1999) for the measurement of the participants' productive vocabulary levels. The result indicated that the multimodality group gained more productive vocabulary (1,186 words) than the unimodality group (948 words). The major point in the paper was the importance of multimodality use in language learners' vocabulary acquisition. As such, the research results suggested that EFL learners increase vocabulary power via various sensory modalities.

The above-mentioned literature review, especially previous studies, revealed the relationship between language learners and multimodality or multimedia technology. The same is true for the current study, but the researchers aimed to explore the voices of AFL (Applied Foreign Languages) undergraduate students about the implementation of VAILS in the English self-introduction activity.

Methodology

The current study aimed to investigate college students' perceptions of the VC-related English self-introduction activity in a *Tour Manager and Tour Guide English* course. This section addresses the participants' demographics, data collection and procedures, nature of the class, Virtual Avatar Interactive Live System (VAILS), and the VC-related English self-introduction activity.

Participants

Table 1 shows the participants' demographics. For the sample convenience, the students enrolled in the course titled *Tour Manager and Tour*

Guide English were recruited to be the participants in the current study. In the beginning, the class size was 18, but one female student hadn't attended the class from the beginning to the end of the semester. One male student, who had only participated in the rehearsal phase using VAILS, was unable to complete his VC recording task due to illness during Week 17, the penultimate week of the semester. Therefore, the total of the participants in the current study were 16, with 6 males (37.5%) and 10 females (62.5%). Among them, there were 15 four-year-night-school-program AFL freshmen and one 5th year AFL undergraduate student at a five-year college.

Table 1. Participants' Demographics.

Characteristics	***Gender***		***Total***
	Male	Female	
Four-Year Night School Program – AFL Freshman	6	9	15
Five-Year College – AFL 5th Year Undergraduate Student	0	1	1
Total	6	10	16

Data Collection

The data sources included: (a) scripts from 16 students for a VC-related English self-introduction activity, (b) 15 paper-based questionnaires using a six-point Likert scale, and (c) mind maps created by 13 students. Followings are the description of the data sources:

Scripts for VC-Related English Self-Introductions

All students were required to compose scripts for their VC-related English self-introductions and upload them to the university's u-Learn platform (https://ulearn.nfu.edu.tw/course/12268/learning-activity#/31049?view=scores)—a digital space facilitating interaction between teachers and students—by Week 10 as their mid-term examination. In the end, 17 scripts (see one sample in Appendix A) were collected, but one male's script was excluded in the current study because he did not complete his VC recording in Week 17.

Questionnaire

The paper-based questionnaire utilized a six-point Likert scale and consisted of two parts: Part I included six closed-ended items, while Part II invited free-form comments (see Table 4 or 5). To avoid "any central tendency errors" (Luo, 2024, p. 4), the scale ranged from 6 (strongly agree) to 1 (strongly disagree),

with intermediate points representing varying degrees of agreement or disagreement. In Part I, five of the six items were adapted from the first five questions in the questionnaire developed by Wang et al. (2022). The sixth item was newly added by the current researchers to address the specific context of this study. In Part II, participants were invited to freely express any thoughts or feedback related to the research theme. In week 18, one female student was absent because of her job, so 16 students signed the consent form and rated the questionnaire and all of them were valid. However, excluded was the one questionnaire rated by one male student who did not complete his VC recording because of his illness in the previous week. Thus, 15 questionnaires were collected for analysis and comparison.

The questionnaire demonstrated high reliability, with a Cronbach's alpha value of 0.904, exceeding the commonly accepted threshold of 0.7 (G. Becker, 2000). To assess the construct validity of the user satisfaction questionnaire, exploratory factor analysis (EFA) was conducted. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.724, and Bartlett's test of sphericity was significant (p = 0.000 < 0.05), indicating the data were suitable for factor analysis (see Table 2).

Table 2. The Validity of the User Satisfaction Questionnaire.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		***0.724***
Bartlett's test of Sphericity	Approx Chi-Square	59.110
	df	55
	Sig.	0.000*

*p < 0.05

Mind Maps

The assignment of mind mapping focused on the students' reflections on the VC-related English self-introduction activity. After rating the questionnaire, the students were required to draw their personal mind maps on the posters (see Figures 2-5) with colored pens. They were required to submit their original mind maps; prior to submission, they photographed the maps and upload the images to the university's u-Learn platform. Out of the 16 participants, 12 submitted paper mind maps and 12 uploaded their work to u-Learn. However, one female participant submitted only the paper mind map, while another submitted only the u-Learn post. In total, 13 posters (M = 4, F = 9) were collected for analysis, as three participants (M = 2, F = 1) neither submitted their paper mind maps nor uploaded their work to u-Learn.

Nature of the Class

This elective course, titled *Tour Manager and Tour Guide English*, was primarily designed for first-year AFL students enrolled in a four-year night school program. Grounded in the theories of critical thinking and place-based learning, the course met once a week for 100 minutes (equivalent to two class sessions) under the instruction of the course instructor. The course aimed to help students: (a) expand their vocabulary repertoire, (b) cultivate habits of cultural, critical, and positive thinking, (c) foster collaborative relationships with peers, (d) enhance technological literacy (e.g., through tools like YouTube and Virtual Characters), and (e) broaden their understanding of tourism as well as both local and global cultures.

Virtual Avatar Interactive Live System (VAILS)

With the virtual character menu (i.e., Fox. Little Prince, Pilot, and Rose) (see Figure 1). Virtual Avatar Interactive Live System (VAILS) comes in the Webcam Motion Capture software, the Vseeface software and the OBS Studio software. The Webcam Motion Capture software utilizes AI's motion recognition function to track performers' body movements and hand gestures. These captured data are then seamlessly transferred to express the narrative presentation of virtual characters.

The VSeeFace software synchronizes the performer's mouth movements and detects emotions, such as those expressed through the eyes and eyebrows, by recognizing AI-driven facial expressions. It also allows presenters to control and customize their facial expressions—such as smiling, amusement, anger, sorrow, and shock—using designated buttons. Additionally, OBS Studio provides a comprehensive suite of features, including virtual character image synthesis, customizable presentation backgrounds, and seamless transmission of audio, video, and live broadcasts (Pai et al., 2024).

Figure 1. Four virtual characters: Fox, Little Prince, Pilot, and Rose (from left to right).

The VC-Related English Self-Introduction Activity

This VC-related English self-introduction activity spanned a whole semester. Table 3 shows the procedures of the activity practice. In week 1, the instructor introduced the students to the activity in discussing the course syllabus. During Weeks 2 to 9, students developed their English self-introduction scripts as a take-home assignment, which they submitted via the u-Learn platform as their mid-term examination. Students were reminded to consult the sample English self-introduction provided in the textbook by Wang et al. (2021) as a reference during the script-writing process. By Week 11, the instructor reviewed and provided individualized feedback on all students' scripts, posting them on the u-Learn platform. Students were encouraged to revise their scripts based on the instructor's comments and suggestions during Weeks 12 to 14. In Week 15, each student rehearsed by reading their script aloud, after which the instructor offered additional in-class feedback, focusing on sentence structure and spelling. From Weeks 16 to 18, students took turns selecting their favorite virtual characters and recording their VC-related English self-introductions in a small meeting room. To make efficient use of class time, students were allowed to view their own and their classmates' video recordings on the classroom screen while waiting for their turn.

Table 3. Procedures of the VC-related English Self-Introduction Activity.

Week	*Main Issues*	*Teaching Method(s)*
1	Introduction of the VC-related English self-introduction activity (in the classroom)	Teacher-centeredness
2-9	Having students work on the composing of English self-introduction	Student-centeredness
10	Having students post their English self-introduction writings on u-Learn	Student-centeredness
11	Instructor's revision of students' writings	Teacher-centeredness
12-14	Having students revise their writings per se the instructor's revision	Student-centeredness
15	Instructor's listening to students read their writings on the screen; having students revise their writings and practice pronouncing certain words (in the classroom)	Teacher-centeredness
16-18	Having students complete VC recordings one by one (in a meeting room) and at the same time instructor's listening to students' private rehearsals with more revision; playing the completed VC English self-introduction recordings (in the classroom)	Teacher-centeredness; student-centeredness

Results and Discussions

The current study aimed to explore the attitudes college students took toward the VC-related English self-introduction activity. Quantitative data were analyzed using Excel and SPSS Statistics V19.0. The subsequent analysis and discussion focused on the entire participant group, gender groups, mind maps, and additional relevant findings.

Entire Participant Group

All participating college students generally agreed that the VC-related English self-introduction activity significantly contributed to their English acquisition, as indicated by the grand

mean score of 5.23 (see Table 4). To be more specific, all participants perceived the activity as beneficial in enhancing various aspects of their English proficiency, including vocabulary knowledge (Item 1: M = 5.33), listening ability (Item 2: M = 5.13), speaking ability (Item 3: M = 5.53), reading ability (Item 4: M = 5.40), writing ability (Item 5: M = 5.07), and grammatical competence (Item 6: M = 4.93). Among these, the activity was reported to be most effective in improving speaking ability (Item 3: M = 5.53) and least effective in enhancing grammar (Item 6: M = 4.93).

Table 4. Results of the Questionnaire – Entire Participants (N=15).

Item: The assignment of English Self Introduction along with VC (Virtual Character) Recording was useful to increase my _____.	***St. A % (6)***	***A % (5)***	***So. A % (4)***	***Total***	***M***	***SD***
1.vocabulary power	46.67 %	40.00 %	13.33 %	100 %	5.33	.724
2. listening ability	33.33 %	46.67 %	20.00 %	100 %	5.13	.743
3. speaking ability	60.00 %	33.33 %	6.67%	100 %	**5.53**	.640
4. reading ability	53.33 %	33.33 %	13.33 %	100 %	5.40	.737
5 writing ability	26.67 %	53.33 %	20.00 %	100 %	5.07	.704
6. grammar power	20.00 %	53.33 %	26.67 %	100 %	**4.93**	.704
Grand Mean					**5.23**	

Note. St. A: *Strongly Agree* (6); A: *Agree* (5); So. A: *Somewhat agree* (4). All the percentages and means were rounded up from the second decimal point. One female student did not rate the questionnaire because of her absence in Week 18.

Gender Groups

Both male and female participants generally agreed that the activity was

beneficial for their English acquisition, as reflected in their grand means of 5.25 and 5.22, respectively (see Table 5). Based on these grand means, the two groups' overall attitudes toward the activity were nearly identical. Notably, the largest difference between the two groups was observed in item 6 "increasing grammar power," with a mean difference of 0.39 (males = 5.17, females = 4.78). In contrast, there was no difference in responses to item 1 "increasing vocabulary knowledge," where both groups reported an identical mean score of 5.33.

For male college students, the activity was perceived as most beneficial in enhancing vocabulary knowledge, listening ability, speaking ability, and reading ability (Items 1–4: M = 5.33), while it was least beneficial in improving writing ability (Item 5: M = 5.00). In contrast, female college students reported the greatest benefit in speaking ability (Item 3: M = 5.67), and the least in grammatical competence (Item 6: M = 4.78).

Table 5. Results of the Questionnaire – Gender Groups.

Item: The assignment of English Self Introduction along with VC (Virtual Character) Recording was useful to increase my _____.	***Gender (M=6; F=9)***	***St. A % (6)***	***A % (5)***	***So. A % (4)***	***Total***	***M***	***SD***
1.vocabulary power	M	50.00 %	33.33 %	16.67 %	100 %	**5.33**	.816
	F	44.44 %	44.44 %	11.11 %	100 %	5.33	.707
2. listening ability	M	50.00 %	33.33 %	16.67 %	100 %	**5.33**	.816
	F	22.22 %	55.56 %	22.22 %	100 %	5.00	.707
3. speaking ability	M	50.00 %	33.33 %	16.67 %	100 %	**5.33**	.816
	F	66.67 %	33.33 %	0.00 %	100 %	**5.67**	.500

4. reading ability	M	50.00 %	33.33 %	16.67 %	100 %	**5.33**	.816
	F	55.56 %	33.33 %	11.11 %	100 %	5.44	.726
5 writing ability	M	33.33 %	33.33 %	33.33 %	100 %	**5.00**	.894
	F	22.22 %	66.67 %	11.11 %	100 %	5.11	.601
6. grammar power	M	50.00 %	16.67 %	33.33 %	100 %	5.17	.983
	F	0.00 %	77.78 %	22.22 %	100 %	**4.78**	.441
Grand Mean		M vs. F				**5.25 vs. 5.22**	

Note. St. A: *Strongly Agree* (6); A: *Agree* (5); So. A: *Somewhat agree* (4). All the percentages and means were rounded up from the second decimal point. One female student did not rate the questionnaire because of her absence in Week 18.

Moreover, there was no significance in the six questionnaire items (i.e., vocabulary power, listening ability, speaking ability, reading ability, writing ability, and grammar power) between male and female students (see Table 6). These results were supported by an independent samples *t*-test, with non-significant two-tailed *p*-values ranging from 0.312 to 1.000 ($p > 0.05$). In summary, there were no statistically significant differences between male and female students' attitudes toward the course activity.

Table 6. Independent Samples *t*-Test Results Comparing Male and Female Students on Questionnaire Items 1–6.

	Levene's Test for Equality of Variances		***t-test for Equality of Means***					
	F	Sig.	*t*	df	Sig (2-taile	Mean Diff	Std. Error Differ	95% Confidence Interval of the

						d)	eren ce	ence	Difference	
									Lowe r	Upp er
Item 1	Equal variances assumed	.170	.6 86	.000	13	1.00 0	.000	.396	-.855	.855
	Equal variances not assumed			.000	9.73 0	1.00 0	.000	.408	-.913	.913
Item 2	Equal variances assumed	.800	.3 87	.842	13	.415	.333	.396	-.522	1.18 9
	Equal variances not assumed			.816	9.73 0	.434	.333	.408	-.580	1.24 6
Item 3	Equal variances assumed	2.60 0	.1 31	-.98 7	13	.341	-.33 3	.338	- 1.063	.396
	Equal variances not assumed			-.89 4	7.51 9	.399	-.33 3	.373	- 1.202	.536
Item 4	Equal variances assumed	.078	.7 84	-.27 7	13	.786	-.11 1	.402	-.979	.757
	Equal variances not assumed			-.27 0	9.94 0	.793	-.11 1	.412	- 1.030	.808
Item 5	Equal variances assumed	1.22 5	.2 88	-.29 0	13	.777	-.11 1	.384	-.940	.718
	Equal variances not assumed			-.26 7	8.00 9	.796	-.11 1	.416	- 1.071	.849
Item 6	Equal variances assumed	9.70 5	.0 08	1.05 3	13	.312	.389	.369	-.409	1.18 7
	Equal variances not assumed			.910	6.35 9	.396	.389	.427	-.643	1.42 1

*p < 0.05

Mind Maps

The findings from the questionnaire were further supported by the analysis of students' mind maps. Specifically, the mind maps of four students—identified by the pseudonyms Miao, Shing, Yi, and Yu (presented in alphabetical order)—were selected for detailed presentation and discussion in this section.

In Miao's mind map (see Figure 2), the female student indicated that the activity contributed to her English acquisition. Specifically, she enhanced her vocabulary (e.g., "competent," "accomplished," and "unforgettable"), improved her listening skills by watching her classmates' VC-related English self-introduction videos in class, and strengthened her reading ability by reviewing the textbook template/sample

(Wang et al., 2021, p. 329) and viewing her classmates' PPT- or Word-based English self-introduction scripts on the screen in class.

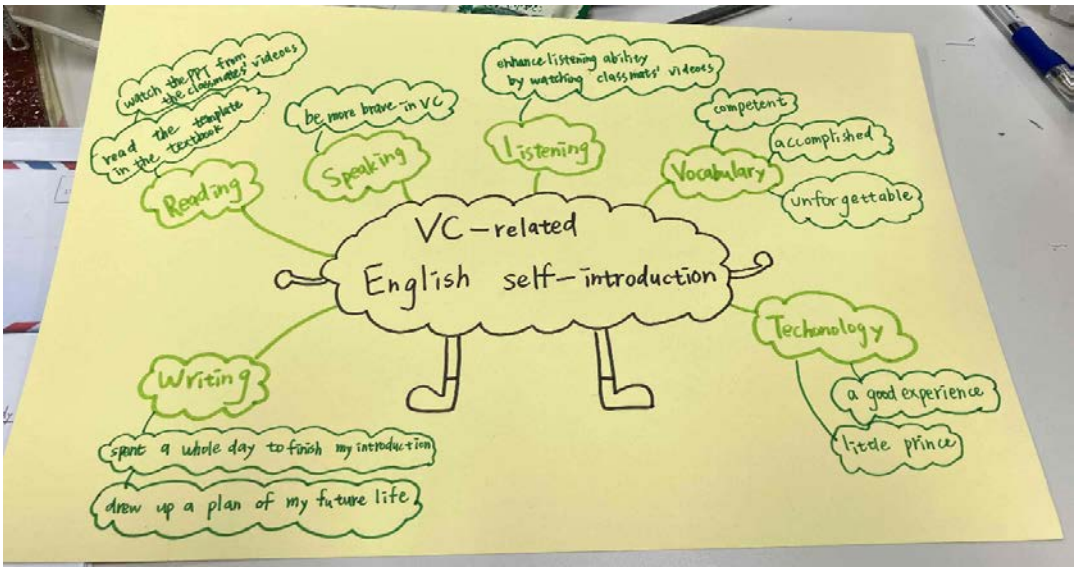

Figure 2. Mind Map by Miao.

In Shing's mind map (see Figure 3), the female student indicated that the activity was beneficial in enhancing her vocabulary acquisition, listening skills (e.g., through listening to her classmates' videos), speaking skills (e.g., by presenting in front of the class), and writing proficiency. Specifically, she learned to substitute the word "unique" with "special," based on her teacher's suggestion, as the latter was easier for her to pronounce. This reflects her acquisition of a commonly used paraphrasing strategy: the use of synonyms.

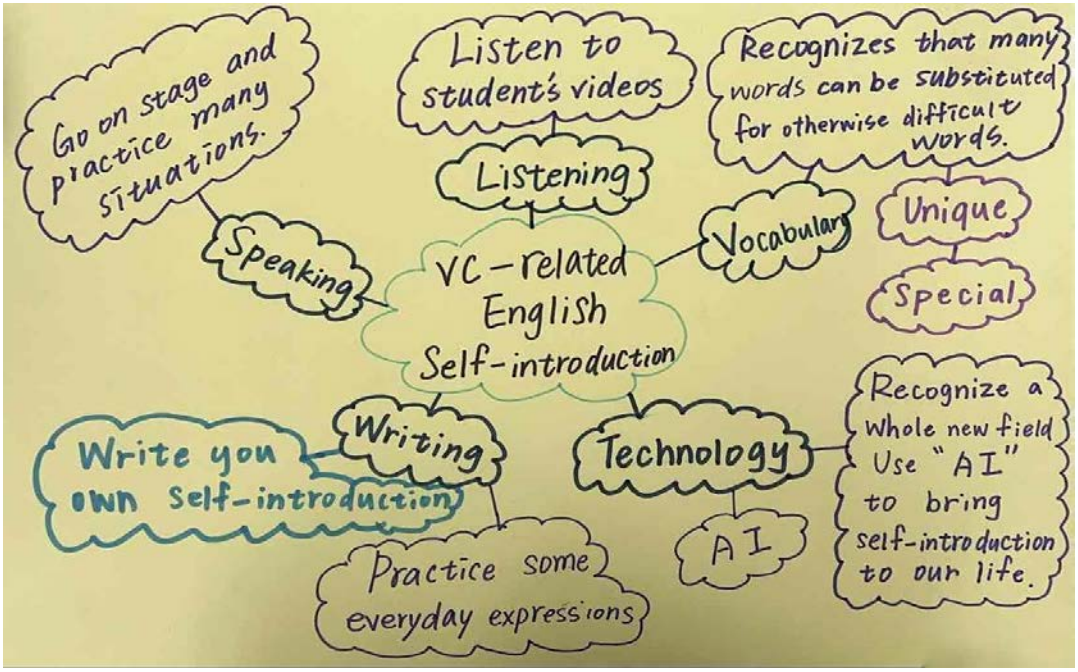

Figure 3. Mind Map by Shing.

In Yi's mind map (see Figure 4), the female student perceived the activity as beneficial for expanding her vocabulary and improving her understanding of certain grammatical structures. Additionally, she gained experience in introducing herself in English in public settings.

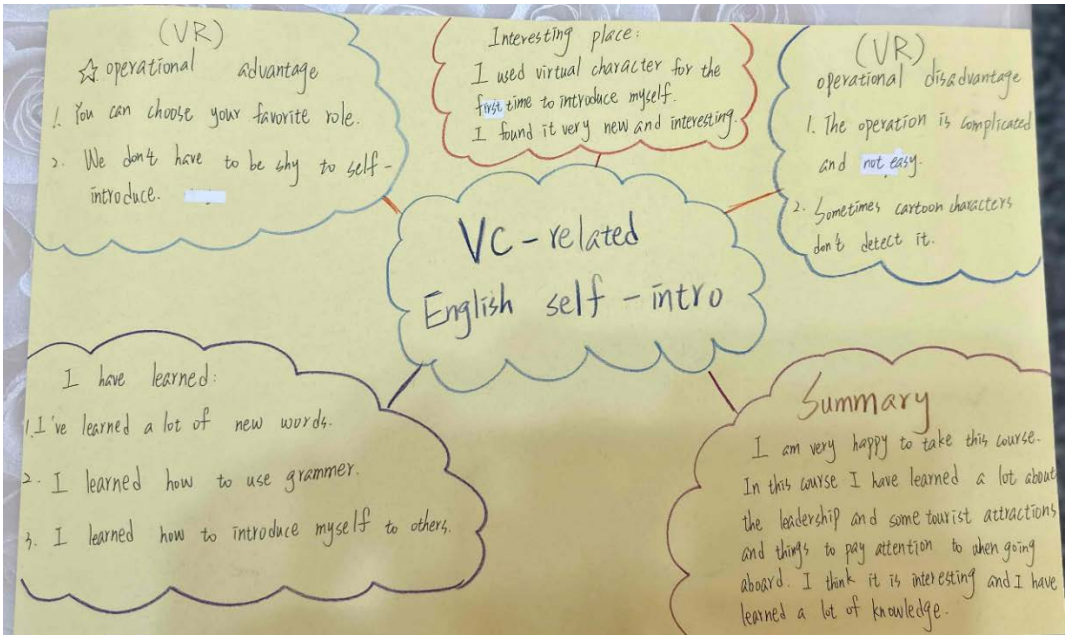

Figure 4. Mind map by Yi.

In Yu's mind map (see Figure 5), the female student believed that the activity contributed significantly to her English language development. She acquired a

range of vocabulary related to tourism as well as everyday English expressions. Additionally, she became aware of grammatical differences between academic writing and spoken English. The activity also helped her learn how to compose a complete article and improve her pronunciation by listening to her classmates' English self-introductions. Most notably, she demonstrated increased confidence by introducing herself in English in front of her peers.

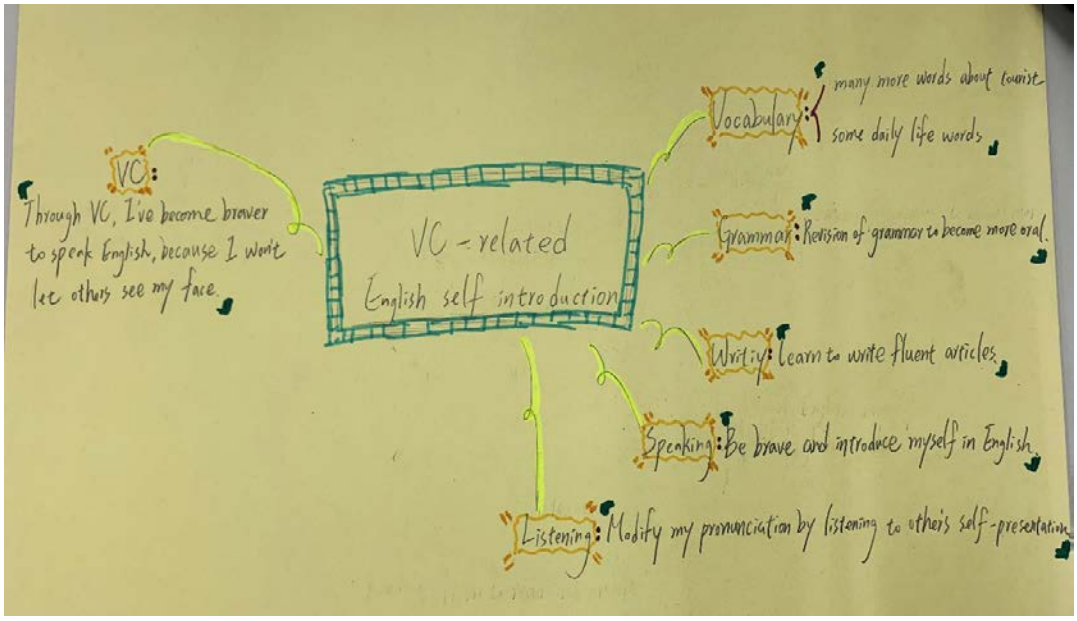

Figure 5. Mind Map by Yu.

Additional Relevant Findings

The participants generally exhibited a positive attitude toward the integration of VAILS into the activity. An inductive thematic analysis of their mind maps revealed five perceived advantages of using the virtual character (VC) recordings: enjoyment, engagement, increased learning motivation, a sense of fun, and enhanced self-confidence. However, two key disadvantages were also identified: first, the system's operation was perceived as complex and challenging for some students; second, there were occasional delays in the virtual characters' responses to participants' physical gestures.

Conclusions

To the best of the researchers' knowledge, the current study made a significant contribution to the understanding of Taiwanese undergraduates' attitudes towards the VC-related English self-introduction activity from the perspective of English acquisition, which was the purpose of the current study. The results of the current study are shown below:

1. In the activity, all the college students could increase their vocabulary power, listening ability, speaking ability, reading ability, writing ability, and grammar power to a rather considerable extent.
2. In the activity, all the college students increased their speaking ability the most and increased their grammar power the least.
3. No significant gender differences were observed in terms of English language acquisition — vocabulary knowledge, listening, speaking, reading, writing, and grammatical proficiency. Overall, both male and female students demonstrated similarly positive attitudes toward the course activity.
4. In the activity, male students increased their vocabulary power, listening ability, speaking ability, reading ability the most but increased their writing ability the least.
5. In the activity, female students increased their speaking ability the most and increased their grammar power the least.
6. The most notable difference between male and female students emerged in the area of grammatical development, where variation was observed; however, no gender differences were found in vocabulary acquisition.

Furthermore, the use of tablet touch and voice of the VAILS for bi-directional interaction allowed the participants to actively join in the virtual performance and foster meaningful engagement with the given virtual characters. The VAILS brought the participants the positive learning experiences of enjoyment, satisfaction, and fun, and even increase their language learning motivation and confidence in English expressions. Additionally, they learned from one another via reading and watching their classmates' rehearsal scripts and VC-related works on the screen in the classroom, which echoed Keser et al.'s (2011) statement that learners learned from other peers by reading their works.

Traditional English teaching functions in helping students understand the vocabulary, grammar, structure, sentence patterns, and function of the English language. Traditional teaching tends to be linear and allows for little immersive context, while the use of multimedia technology like VAILS employed in the current study can immerse participants to their textual phenomena, following the change of their facial expressions and vocal emotions (Pai et al., 2024). The successful combination of traditional teaching and

the use of VAILS into the class activity (see Table 3) allowed the college students to enhance the overall improvements of five skills (grammar, listening, speaking, reading, and writing) as well as vocabulary power.

Engaging students and boosting their learning motivation are the paramount challenges that educators are facing. The use of multimedia technology in language learning is beneficial to students, especially when 3C devices are increasingly popular among new generation students (Altun, 2015). In line with the growing trend of incorporating multimedia technology as a supportive educational tool, teachers are encouraged to adopt appropriate technologies such as VAILS not only to enhance the dynamism and engagement of their lectures (Shyamlee & Phil, 2012), but also to facilitate more effective and meaningful student learning. Thus, the integration of appropriate multimedia technologies into language learning warrants continued support and enhancement, as Salbego et al. (2015) in their studies addressed the value of employing multimodality in language classrooms.

The limitations of the current study included subjective self-reported measurements (i.e., paper questionnaire and reflection mind-maps), a small sample size of the participants (n=16), the disproportion of gender, the lack of a control group, and the lack of the pretest, the lack of interviews, novelty effect, and unfamiliarity effect, among others. Both novelty effect and unfamiliarity effect may have skewed the results of the current study. Some participants may have rated the questionnaire more positively because of novelty effect referring to a positive influence in relation to the newness of an innovation but not the innovation itself (Elston, 2021). The unfamiliarity effect may have affected some participants' attitude toward the course activity in that they did not master the use of the VAILS. Most importantly, the subjective self-reported data collected totally based on the participants' perceptions of the VC-related English self-introduction activity were always hard to be completely compatible with their authentic learning, a similar statement made by Noroozi et al. (2018). Future research studies may tackle these issues to gain more meaningful results that can be generalized to various learning settings.

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Appendices

Appendix A - A Male Student's English Self-Introduction Script

Hello, everyone. My name is Kai-Ming KAO.I am a college student who studies in the Department of Applied Foreign Languages at XXX University. I think working in the tourism field is a good choice.

I have learned Tourism English and Tour Manager and Tour Guide English in two different semesters, so I learned a lot about tourism from these two courses/classes. Once the school specially invited a professional tour guide and manager to give a speech in the class. She shared many experiences about the problems she had encountered and what skills we should have for the tour guide exam. From then on, I have had a great passion and decided to prepare for the tour guide exam.

When I was in higher vocational school, I obtained a certificate for intermediate English proficiency testing, so talking to foreigners wouldn't be a big problem to me. I plan to learn Japanese and Vietnamese to improve my language skills. In this way, when I become a tour guide in the future, I can take more people from different countries to travel.

So far, I have been to Japan three times, including Tokyo, Osaka, and Hokkaido. As I have been with tour guides, I have some knowledge of the history and culture of local attractions, and I also understand what tour guides should do. This has made me more interested in the job of tour guide[s].

In summary, I highly recommend myself as a formal tour guide. When guests have any problems, I will do my best to solve them. It is a great honor to introduce myself to everyone and thank you for listening.

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The Impact of Augmented Reality in Guided Drawing on Children's Engagement, Creativity, and Depression

Ruei Shan Lu [1], Tao-Hua Wang [2*], and Hao-Chiang Koong Lin[3]

[1]*Department of Management Information System, Takming University of Science and Technology, Taipei 100, Taiwan*

[2]*Science Education Department, National Museum of Natural Science, Taichung, Taiwan*

[3]*Department of Information and Learning Technology, National University of Tainan, Tainan, Taiwan*

The rapid pace of societal change has transformed contemporary children into digital natives, immersed in a world of computers and the Internet from birth. They seldom listen to the radio or read newspapers, preferring touch screens and graphic-based information. This shift has led to a decreased ability to verbally express inner feelings and manage emotions, potentially resulting in depression and adversely affecting their learning. This study investigates the use of guided strategies to enhance learning engagement. Through diverse guidance methods and encouragement, the research aims to improve young children's observation and thinking skills, facilitate the expression of their inner feelings, and stimulate a broader range of ideas. The study incorporates augmented reality (AR) drawing tools to adapt coloring games, providing a medium for emotional expression through drawing. This approach allows students to think freely and create independently, fostering their uniqueness and self-expression.

This research involved 42 fifth-grade students from an elementary school in southern Taiwan, who participated in a guided AR drawing program. Utilizing AR coloring tools, students could modify images to convey their thoughts and emotions, thereby increasing interactivity. A set of guided strategies was developed by integrating semiotic concepts. Pre- and post-test assessments were conducted using the Learning Engagement and Emotional Dissatisfaction Scale, the Creativity Scale, and the Children's Depression Inventory to explore the impact of the guided AR drawing process. Relevant data were collected and statistically analyzed.

The study employed quantitative analysis using ANCOVA and independent sample t-tests. The

findings revealed significant differences in “learning engagement,” “creativity,” and “childhood depression” when guided strategies were applied to AR drawing. The use of AR drawing in elementary school curricula effectively captured learners’ interest. The experimental group, which received the guided curriculum, demonstrated more pronounced positive effects. The guided strategies facilitated student engagement in learning, effectively redirecting their attention to curriculum activities and fostering positive emotions. Engaging activities that allow students to immerse themselves in a stress-free and relaxed state can stimulate creativity. Consequently, this approach led to an improvement in learners’ depressive symptoms and an effective enhancement of their creativity and learning engagement.

Keywords - Guided strategy, Augmented reality, Children’s drawing, Children’s depression, Learning engagement, Creativity
Relevance to Design Practice - The use of AR drawing in elementary school curricula effectively captured learners’ interest.

Introduction

Research Background and Motivation

Contemporary children, often termed digital natives, are immersed in technology from a young age, leading to shifts in communication preferences and, in some cases, challenges in emotional expression and management. This can potentially contribute to depressive symptoms and negatively impact learning (Hwang, Tu, & Wang, 2018). Drawing offers a valuable medium for subconscious expression and emotional release. This study explores how integrating guided strategies with augmented reality (AR) drawing tools can enhance learning engagement, improve observational and thinking skills, facilitate emotional articulation, and stimulate creativity in children. Traditional educational approaches are evolving, with a growing emphasis on interactive, student-centered learning that fosters critical thinking and innovation. Guided learning aligns with these reforms by promoting active participation and multifaceted thinking (Situmorang et al., 2018).

Augmented Reality (AR) technology, which overlays virtual information onto real-world environments, presents novel interactive learning opportunities (Berryman, 2012). AR has demonstrated potential in improving learning engagement and creativity (Wei, Weng, Liu, & Wang, 2015), making it a promising tool for childhood education. Given that positive emotional states are conducive to creativity (Hirt, Devers, & McCrea, 2008), and that children aged 11-13 are transitioning towards more conscious imaginative processes (Lowenfeld,

1957), appropriate guidance is crucial. This research introduces guided learning methodologies combined with AR coloring tools to encourage diverse thinking, foster positive learning emotions, enhance intrinsic motivation, and ultimately cultivate artistic creativity and engagement while mitigating depressive symptoms.

Research Objectives and Questions

This study aims to investigate the effects of a guided AR drawing intervention. The primary objectives are to:

1. Determine the effect of guided AR drawing on students' learning engagement.
2. Assess the impact of guided AR drawing on students' creativity.
3. Examine how guided AR drawing influences changes in students' depressive emotions.

These objectives will be addressed by analyzing data collected through pre-test and post-test administrations of standardized scales measuring learning engagement, creativity, and depression.

Research Limitations

This study acknowledges several limitations. Firstly, the participants were 42 fifth-grade students from a single elementary school in southern Taiwan; thus, the findings may not be generalizable to students in other regions, grade levels, or those with different backgrounds or special needs. Secondly, the instructional materials, while based on Decroly's learning process and semiotic theory, were self-developed and did not encompass all possible guided strategies. Thirdly, the experimental duration was six weeks, which may not be sufficient to capture long-term effects or account for all external factors influencing student outcomes.

Literature Review

Guided Learning Strategies

Guided learning, contrasting with traditional rote methods, emphasizes interactive classroom dynamics and encourages students to engage in multifaceted thinking and articulate their perspectives. Sternberg (1996, as cited in Chen, 2002) highlighted that teachers, through facilitative methods like discussions and questioning, can foster logical thinking in young children. In early childhood education, diverse activities such as images, videos, and real-world experiences are used to stimulate learning motivation (Lu, 2003). Well-designed innovative learning materials effectively enhance student motivation and confidence (Jin, Johnson, & Dekhane, 2020). Guided strategies promote student engagement, enabling participation in problem-solving across various dimensions (Situmorang et al., 2018). When coupled with immediate feedback, these strategies can immerse students in the curriculum, encourage in-depth thinking, and spark innovative ideas (Hwang, Tu, & Wang, 2018),

thereby promoting sustainable teaching and learning (Ibrahim, 2020).

Children construct imaginative worlds from authentic life experiences. Teachers and parents significantly influence young children's drawing experiences; individual differences lead to diverse manifestations, and varied guidance yields different artistic outcomes (Rose, Jolley, & Burkitt, 2006, as cited in Lu, 1996). Multifaceted guidance and encouragement enhance children's observation and thinking skills. The drawing process itself allows them to reflect, experience, and express observations or differing ideas (Su, 2000). In early childhood, drawing guidance aims to foster a love for drawing; art activities emphasize diverse guidance methods to enrich life experiences and stimulate imagination (Pan, 1996).

Augmented Reality in Education

Augmented Reality (AR) enhances the real world by overlaying digital information, creating interactive and immersive experiences. Its application in education has grown, with studies showing AR can improve learning motivation, engagement, and achievement (Yousef, 2021). AR makes abstract concepts more tangible and engaging than traditional methods. For instance, Dalim et al. (2020) found AR with speech input beneficial for non-native children's language learning. Similarly, AR applications have been developed to improve emotion recognition in children (Daniel et al., 2019) and support empathy development through interactive storybooks (Gil et al., 2014).

In children's education, AR is particularly promising. Oranç and Küntay (2019) noted that AR effectively supports early childhood learning by providing interactive experiences that capture attention and enhance understanding. For drawing, AR adds a dynamic dimension, transforming static images into interactive experiences, thereby increasing engagement and creativity. Ha, Lee, and Woo (2011) developed an interactive AR book for a cultural experience, demonstrating AR's potential for engaging learning. The ability of AR to bridge physical and virtual realities enhances user experience (Berryman, 2012) and has been shown to improve learning engagement and creativity (Wei, Weng, Liu, & Wang, 2015).

Semiotics in Children's Drawing

Semiotics, the study of signs and symbols, provides a framework for understanding children's drawings as communicative acts. Drawings are a visual language through which children express thoughts, emotions, and experiences that may be difficult to verbalize (Chandler, 1994). Visual signs operate through iconic (resemblance), indexical (causal connection), and symbolic (conventional) relationships. Understanding these relationships helps interpret the meanings embedded in children's artwork.

Children's drawing development progresses through distinct stages. Lowenfeld (1947) identified stages from scribbling to adolescent art, each characterized by different cognitive and motor skills. Gardner (1980) emphasized that artistic development involves both cognitive and emotional aspects, aligning with his theory of multiple intelligences. Torii (2012) focused on the connection between drawing and cognitive development, suggesting that drawing enhances observational skills and emotional expression. Ligorio et al. (2017) explored children's representations of learning through drawings, highlighting how drawings can reveal their understanding and perspectives.

Children's Creativity

Creativity in children involves generating novel and valuable ideas and solutions. Torrance (1990) identified key components: fluency (number of ideas), flexibility (variety of ideas), originality (uniqueness of ideas), and elaboration (detail in ideas). Guilford (1950) was a pioneer in the systematic study of creativity. Kaufman (2012) expanded this with the Kaufman Domains of Creativity Scale (K-DOCS), encompassing everyday, scholarly, performance, artistic, and mechanical/scientific creativity. Holmes et al. (2019) explored the relationship between young children's language abilities, creativity, play, and storytelling, finding significant interconnections. Oliveira et al. (2021) highlighted the potential of open-ended student drawing to foster creativity in science learning.

Emotional Well-being and Drawing

The link between creativity and emotional well-being is significant. Positive emotions can facilitate creative thinking (Hirt, Devers, & McCrea, 2008), and engaging in creative activities can help children process and express emotions, potentially reducing depressive symptoms. Drawing, as a creative outlet, allows children to externalize internal states, offering diagnostic insights and therapeutic benefits (Brechet, D'Audigier, & Audras-Torrent, 2020). Garner (2010) emphasized the role of emotional competence in teaching and learning. Research by Iordanou, Allen, and Warmelink (2021) examined the content of children's drawings in relation to their verbal memory reports, finding that drawing can elicit different types of information. The act of drawing can be a calming and self-soothing activity, contributing to emotional regulation.

Research Methodology

Research Framework and Design

This study employed a quasi-experimental research design, incorporating pre-test and post-test assessments to evaluate the impact of a guided augmented reality (AR) drawing intervention. The participants were divided into two groups: an experimental group that received the guided AR drawing curriculum and a control group that engaged in AR drawing activities without the guided component. The independent variable in this study was the instructional approach—specifically, the presence or absence of guided strategies accompanying the AR drawing activities. The dependent variables were students' learning engagement, creativity levels, and depressive emotions, measured at the beginning and end of the intervention period. The core of the research framework rested on comparing the changes in these dependent variables between the two groups to determine the efficacy of the guided AR intervention.

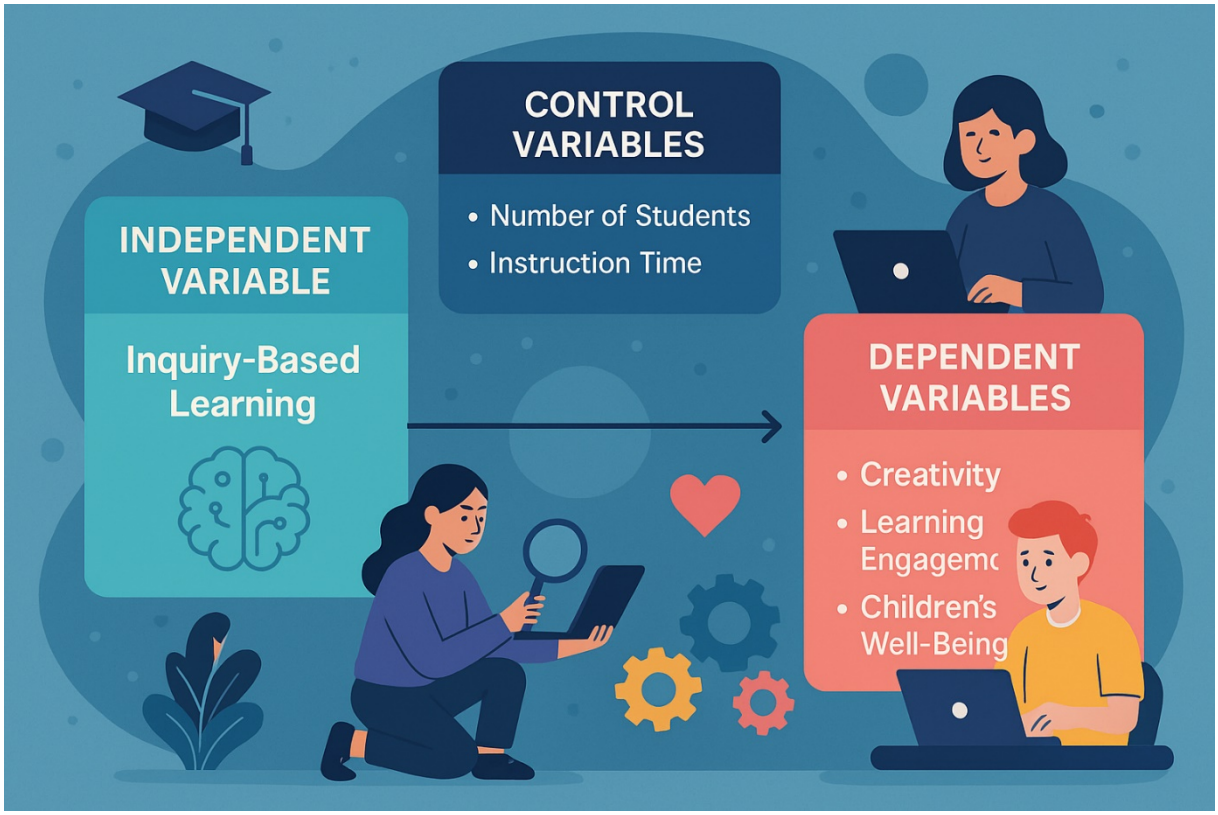


Figure 1. Research Model.

The experimental group was exposed to a curriculum where AR drawing tasks were preceded by specific guided learning strategies. These strategies were designed based on semiotic theory and Decroly's learning process, aiming to enhance observation, association, and expression. In contrast, the control group participated in the

same AR drawing activities using the identical AR tools but did not receive the structured guidance provided to the experimental group. Both groups were allocated an equal amount of time for their respective drawing activities to ensure comparability. The study's design aimed to isolate the effect of the guided strategies by keeping other factors, such as the AR technology and the duration of engagement, constant across both groups.

Participants and Procedure

The participants in this study were 42 fifth-grade students, typically aged between 11 and 13 years, from a public elementary school located in southern Taiwan. These students were randomly assigned to either the experimental group (n=21) or the control group (n=21) to minimize selection bias. The entire experimental procedure was conducted over a period of six consecutive weeks.

Figure 2. Experiment Environments.

The first week was dedicated to an initial orientation session, where students were familiarized with the AR drawing tools and the overall research process. During this week, pre-test data for learning engagement, creativity, and depressive emotions were collected from all participants using standardized assessment instruments. From the second week through the fifth week, the intervention was implemented. The experimental group received a 30-minute guided instruction session before engaging in a 60-minute AR drawing activity each week. The guided instruction focused on specific themes and techniques related to the AR drawing tasks, incorporating elements of semiotic theory and encouraging students to explore concepts of icon, index, and symbol in their artwork. The control group, during the same period, engaged directly in 90

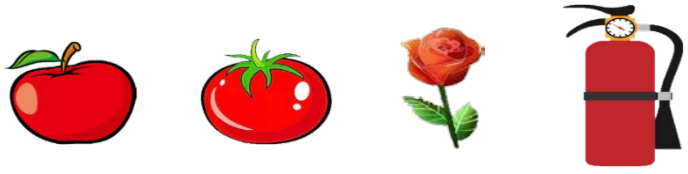
minutes of AR drawing activities without any preceding guided instruction. The AR drawing tasks and themes were consistent for both groups. All sessions were conducted within the students' regular classroom environment to maintain ecological validity and minimize disruption to their normal school routines. The final week, week six, was allocated for the administration of post-test questionnaires to measure the changes in the dependent variables following the intervention period.

Instructional Materials and Tools

Guided Learning Materials

The guided learning materials for the experimental group were meticulously developed by the researchers. These materials were grounded in established pedagogical principles, primarily drawing from semiotic theory and the three-step learning process (Observation, Association, Expression) advocated by the Belgian psychologist Ovide Decroly (Varela & Serrano, 2017). The worksheets and instructional prompts were designed to encourage students to actively observe their surroundings, make associations between colors, shapes, and emotions or experiences, and then express their unique thoughts and feelings through their AR drawings. For example, students might be guided to consider how different colors could represent different moods or how certain symbols could convey particular messages within their artwork. The aim was to provide a structured yet flexible framework that would stimulate deeper thinking and more meaningful engagement with the drawing process, rather than simply providing technical instructions for using the AR tool.

Table 1. Guided Worksheet Part 1.

Question	
What red things can you find on campus?	
What green things can you find on campus?	

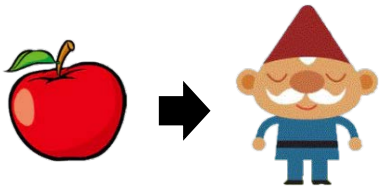
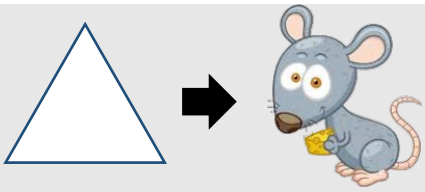
What orange things can you find in daily life?	
What purple things can you find in daily life?	

Table 2. Guided Worksheet Part 2.

Question	
What symbols or signs come to mind when you see red and black?	
What symbols or signs come to mind when you see orange, green, and red?	
What symbols or signs come to mind when you see green, white, and blue?	

What symbols or signs come to mind when you see blue, red, and white?	

Table 3. Guided Worksheet Part 3.

Question	
Today there is a red apple. . .	 Today, a dwarf named Biggie is holding a red apple..
There is a triangle	 A mouse with a triangle-shaped face has stolen a piece of cheese...

Augmented Reality Drawing Tools

The primary AR drawing tool utilized in this study was Quiver (formerly known as colAR Mix). Quiver is a mobile application that allows users to color pre-designed templates. Once colored, these templates can be brought to life as animated three-dimensional (3D) models when viewed through the camera of a compatible mobile device (smartphone or tablet) running the Quiver app. This tool was selected for several reasons: its user-friendly interface is suitable for elementary school students; it has a clear educational focus, with many templates designed to be both engaging and informative; and its core functionality of transforming static 2D drawings into interactive 3D experiences aligns well with the study's aim of enhancing engagement and creativity. The interactive nature of the animated 3D models provides immediate visual feedback and a sense of accomplishment, which can be highly motivating for young learners.

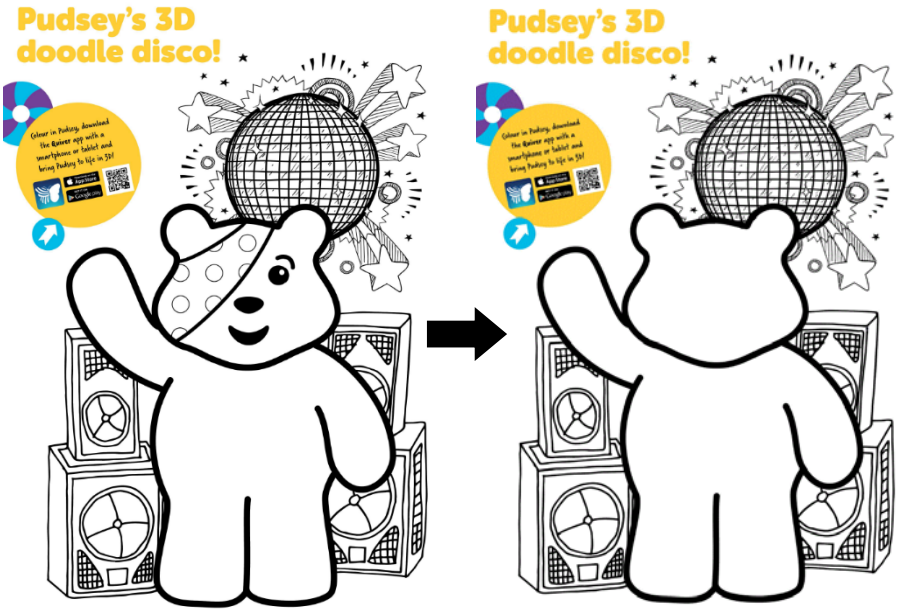


Figure 3. Quiver: The Augmented Reality Drawing Tool.

Assessment Instruments

To measure the impact of the guided AR drawing intervention, three standardized assessment instruments were administered to all participants at both pre-test and post-test stages:

1. **Learning Engagement and Emotional Disaffection Scale:** This scale, developed by Skinner, Kindermann, and Furrer (2009), was used to assess students' engagement in the learning activities. It comprises subscales measuring behavioral engagement (e.g., effort, attention participation), emotional engagement (e.g., interest, enjoyment), behavioral disaffection (e.g., passivity, withdrawal), and emotional disaffection (e.g., boredom, anxiety). Items are typically rated on a 5-point Likert scale, providing a quantitative measure of students' involvement and emotional response to the learning tasks.
2. **Kaufman Domains of Creativity Scale (K-DOCS):** Developed by J. C. Kaufman (2012), the K-DOCS was used to assess students' self-perceived creativity across various domains. This instrument asks individuals to rate their creativity in areas such as everyday problem-solving, artistic expression, and scholarly pursuits, typically on a 5-point scale comparing themselves to their peers. It provides a multifaceted view of creativity

beyond just artistic skill.

3. **Children's Depression Inventory (CDI):** The CDI, developed by Maria Kovacs (1992), is a widely used self-report instrument designed to evaluate the presence and severity of depressive symptoms in children and adolescents aged 7 to 17. It consists of 27 items, each with three statements from which the child chooses the one that best describes them in the past two weeks. The items cover cognitive, affective, and behavioral aspects of depression. Higher scores indicate more significant depressive symptomatology.

All selected instruments have established records of reliability and validity for use with elementary school-aged children. The data collected from these instruments were then subjected to statistical analysis to compare the outcomes between the experimental and control groups.

Experimental Results & Analysis

Upon detailed post-experimental analysis, a comparative review of the augmented reality (AR) drawings produced by students in both the experimental and control groups revealed marked differences in artistic expression and thematic coherence. Students in the experimental group, who received guided instruction prior to their AR drawing activities, demonstrated a significantly more sophisticated use of color and a stronger grasp of thematic development in their artwork. Their color palettes were notably more vivid and purposeful; for instance, they often employed a wider spectrum of hues, utilizing contrasting colors to create visual emphasis and complementary colors to achieve harmony, thereby imbuing their creations with greater emotional resonance and visual dynamism. This deliberate and expressive use of color was often directly linked to the thematic content of their drawings, suggesting that the guided strategies helped them to associate specific colors with particular moods, ideas, or narrative elements.

Furthermore, the thematic clarity in the experimental group's work was distinctly more pronounced. Their drawings frequently exhibited a greater degree of compositional integrity, with elements arranged in a more considered and balanced manner. There was a discernible narrative quality in many of their pieces, where the chosen objects, figures, and symbols appeared to be meaningfully interconnected, contributing to a cohesive and understandable central theme. For example, if the theme was 'a happy day,' students in the experimental group might not only use bright, cheerful colors but also depict scenes with clear positive interactions between characters or elements that collectively conveyed a sense of joy and activity. This suggests that the guidance provided, which likely included prompts for

observation, association, and expression based on semiotic principles, effectively scaffolded their ability to translate abstract concepts or feelings into coherent visual narratives.

In stark contrast, the artwork produced by students in the control group, who engaged in AR drawing without the preceding guided instruction, while often meticulously colored in terms of filling spaces, generally displayed a less developed sense of creativity and thematic focus. Their color choices, though complete, tended to be more conventional or random, lacking the deliberate vibrancy and expressive intent observed in the experimental group. For example, colors might be applied uniformly without much consideration for contrast, shading, or emotional impact, resulting in flatter and less visually engaging images. The thematic focus in the control group's drawings was frequently ambiguous or underdeveloped. While individual elements might be competently drawn and colored, they often lacked a clear relationship to one another or a unifying central idea. This could manifest as a collection of disparate objects or figures that did not coalesce into a discernible story or message, making it difficult for an observer to grasp the intended theme or emotional content. Consequently, the overall presentations from the control group were often perceived as less complete and less impactful. This difference could be attributed to the absence of structured guidance designed to stimulate deeper observational skills, encourage associative thinking between visual elements and meaning, and foster more intentional expressive choices, potentially leaving these students more reliant on pre-existing schemas or less motivated to explore novel creative avenues within the AR drawing task.

Figure 4. Revised Image by the Experimental Group.

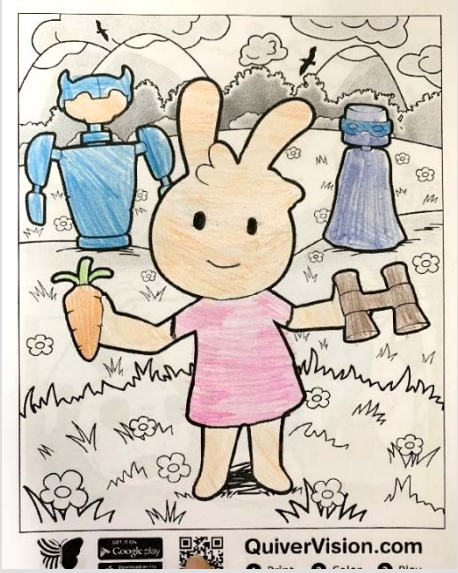


Figure 5. Revised Image by the Control Group.

This section presents the statistical analysis of the data collected from the pre-test and post-test administrations of the Learning Engagement and Emotional Disaffection Scale, the Kaufman Domains of Creativity Scale (K-DOCS), and the Children's Depression Inventory (CDI). The primary analytical methods employed were independent samples t-tests and Analysis of Covariance (ANCOVA) to compare the outcomes between the experimental (guided AR drawing) and control (AR drawing only) groups.

Learning Engagement

To assess the impact of the guided AR drawing intervention on students' learning engagement, post-test scores on the Learning Engagement and Emotional Disaffection Scale were compared between the two groups, using pre-test scores as a covariate in an ANCOVA where appropriate, or an independent samples t-test if assumptions for ANCOVA were not met or for simpler comparisons of mean differences. The results indicated a statistically significant difference in overall learning engagement. The experimental group, which received guided instruction, demonstrated a mean post-test engagement score of 3.67 (Standard Deviation, SD = 0.42), while the control group reported a mean score of 3.31 (SD = 0.38). An independent samples t-test revealed that this difference was statistically significant, $t(40) = -2.09$, $p = .043$ (assuming equal variances not assumed if Levene's test

was significant, adjusting degrees of freedom accordingly). This suggests that the incorporation of guided strategies alongside AR drawing activities led to a notable increase in students' active participation and involvement in the learning process.

Further analysis of the engagement subscales (behavioral and emotional engagement) provided more nuanced insights. For behavioral engagement, the experimental group showed a mean post-test score of 3.75 (SD = 0.50) compared to the control group's mean of 3.40 (SD = 0.45). For emotional engagement, the experimental group's mean post-test score was 3.59 (SD = 0.48) versus the control group's 3.22 (SD = 0.40). These differences suggest that the guided component not only encouraged more active physical participation but also fostered greater interest, enjoyment, and positive emotional connection to the learning tasks. The guided strategies appeared to help students immerse themselves more quickly and deeply in the curriculum, leading to enhanced attention, more frequent participation in discussions or asking questions, and a greater reported enjoyment of the drawing activities.

Creativity

The impact of the intervention on students' creativity was evaluated using the K-DOCS. An ANCOVA was performed on the post-test creativity scores, with pre-test creativity scores serving as the covariate, to determine if there were significant differences between the experimental and control groups. The analysis revealed a significant main effect for the group, $F(1, 39) = 22.57$, $p = .001$, indicating that the guided AR drawing intervention had a substantial positive effect on students' creativity. The experimental group achieved a significantly higher adjusted mean post-test creativity score (M = 4.25, SE = 0.11) compared to the control group (M = 3.41, SE = 0.10).

Qualitative observations during the sessions, alongside the quantitative data, suggested that students in the experimental group demonstrated greater originality and elaboration in their artwork. The guided instruction, which encouraged them to think about semiotic elements and explore different ways of representing ideas and emotions, appeared to stimulate more diverse and imaginative responses. For example, students in the guided group were more likely to experiment with unconventional color choices to convey specific moods or to add unique details to their AR drawings that went beyond the basic templates. This suggests that the guided strategies not only boosted self-perceived creativity but also manifested in the tangible creative output of the students.

Children's Depressive Emotions

Changes in children's depressive emotions were assessed using the CDI. Post-test CDI scores were compared between the experimental and control groups. The experimental group reported a mean post-test CDI score of 4.95 (SD = 2.31), while the

control group had a mean score of 6.57 (SD = 2.48). An independent samples t-test indicated that this difference was statistically significant, $t(40) = 2.21$, $p = .033$ (again, assuming appropriate variance assumptions). This finding suggests that participation in the guided AR drawing activities was associated with a greater reduction in depressive symptoms compared to participation in AR drawing activities alone.

It is noteworthy that while both groups showed some level of improvement (i.e., reduction in depressive symptoms from pre-test to post-test, though pre-post within-group changes are not the primary focus here), the experimental group's reduction was more pronounced. The engaging nature of the guided AR activities, which encouraged self-expression and focused attention on a creative task, may have provided a positive emotional outlet for students. The process of creating something tangible and interactive, coupled with the supportive guidance, could have contributed to feelings of accomplishment and enjoyment, thereby alleviating some aspects of negative affect or depressive mood. The guided component may have been particularly effective in helping students channel their thoughts and feelings constructively through the drawing process.

Discussion and Conclusion

Discussion of Key Findings

The findings of this study provide compelling evidence that the integration of guided strategies with augmented reality (AR) drawing activities can significantly enhance learning engagement and creativity, while concurrently reducing depressive emotions in fifth-grade elementary school students. The experimental group, which benefited from the guided AR drawing curriculum, demonstrated notably superior outcomes across all three dependent variables when compared to the control group, which engaged in AR drawing without the structured guidance.

Regarding learning engagement, the significant increase observed in the experimental group aligns with existing literature that underscores the efficacy of guided learning in fostering student involvement (Situmorang et al., 2018) and the potential of AR technology to capture learners' interest and enhance motivation (Wei, Weng, Liu, & Wang, 2015; Yousef, 2021). The guided component likely provided a clearer framework for students, helping them to understand the learning objectives and to connect more deeply with the AR drawing tasks. This structured approach, combined with the novelty and interactivity of AR, created a more stimulating and rewarding learning environment, leading to greater behavioral and emotional investment from the students.

The substantial improvement in creativity scores within the experimental group is also a key finding. The guided strategies, which were rooted in semiotic theory and encouraged students to explore concepts of icon, index, and symbol, likely prompted more divergent thinking and imaginative exploration. This supports the idea that creativity is not merely an innate talent but can be nurtured through appropriate pedagogical interventions (Torrance, 1990). The AR tool itself, by allowing students to bring their colored drawings to life in 3D, provided a unique medium for creative expression. When this was combined with guidance that encouraged experimentation with color, form, and meaning, students were better equipped to produce original and elaborate artwork. This finding resonates with research suggesting that positive emotional states, potentially fostered by engaging learning activities, are conducive to creative thought (Hirt, Devers, & McCrea, 2008).

The reduction in depressive emotions observed in the experimental group is particularly significant, given the increasing concerns about mental health in young learners. The guided AR drawing activities may have served as a form of therapeutic expression, allowing students to channel their feelings and experiences into a creative outlet (Brechet, D'Audigier, & Audras-Torrent, 2020). The focused attention required for the tasks, coupled with the positive reinforcement of seeing their creations animated, could have provided a temporary respite from negative thoughts or anxieties. While the study did not aim to provide clinical therapy, the findings suggest that such creative, technology-enhanced activities can contribute positively to children's emotional well-being by fostering a sense of accomplishment, enjoyment, and self-expression.

Theoretical and Practical Implications

From a theoretical perspective, this study contributes to the growing body of research on technology-enhanced learning by demonstrating the synergistic benefits of combining guided instructional strategies with AR technology. It highlights that the mere introduction of technology may not be sufficient to optimize learning outcomes; rather, thoughtful pedagogical integration is crucial. The findings lend support to constructivist learning theories, which emphasize active student engagement and the construction of knowledge through experience and interaction. The study also underscores the interconnectedness of cognitive (creativity, engagement) and affective (emotional well-being) domains in learning.

Practically, the results offer valuable insights for educators, curriculum developers, and policymakers. The guided AR drawing curriculum implemented in this study provides a model that can be adapted and applied in various elementary school settings to enhance art education and potentially support students' emotional health. Teachers

can be trained to incorporate guided strategies that encourage deeper thinking and creative expression when using AR or other educational technologies. Furthermore, the study suggests that schools should consider the role of creative arts and technology in promoting a holistic learning environment that addresses not only academic achievement but also students' emotional and psychological needs. The development of more diverse and customizable AR drawing tools and guided learning resources could further enhance the effectiveness of such interventions.

Limitations and Future Research Directions

Despite the positive findings, this study has several limitations that should be acknowledged. Firstly, the sample size was relatively small (n=42) and drawn from a single elementary school in southern Taiwan. This limits the generalizability of the findings to other populations and cultural contexts. Future research should aim to replicate these findings with larger and more diverse samples.

Secondly, the duration of the intervention was six weeks. While significant effects were observed, a longer-term study would be beneficial to assess the sustainability of these effects on engagement, creativity, and depressive emotions. It would also be valuable to explore whether the novelty effect of AR technology played a role and whether engagement levels would be maintained over an extended period.

Thirdly, the guided learning materials were self-developed and based on specific theoretical frameworks (semiotics, Decroly's learning process). While effective, it would be useful for future research to compare different types of guided strategies or to investigate the impact of varying levels of guidance to determine optimal approaches.

Fourthly, this study relied on self-report measures for creativity and depressive emotions, which may be subject to response biases. Future studies could incorporate more objective measures, such as expert ratings of creative products or clinical interviews to assess depressive symptoms, to provide a more comprehensive evaluation.

Future research could also explore the application of guided AR drawing interventions with different age groups, including younger children or adolescents, and in different subject areas beyond art education. Investigating the specific components of the guided strategies that are most effective, and how these interact with different features of AR technology, would also be a fruitful avenue for further inquiry. Finally, exploring the potential of such interventions for children with specific learning needs or emotional challenges could yield important insights for inclusive education.

Conclusion

In conclusion, this study demonstrated that a guided augmented reality drawing curriculum had a significant positive impact

on fifth-grade students' learning engagement, creativity, and emotional well-being, specifically in reducing depressive emotions. The findings underscore the potential of thoughtfully integrating guided pedagogical strategies with innovative technologies like AR to create rich, engaging, and supportive learning experiences. By fostering active participation, stimulating creative expression, and providing a positive emotional outlet, such interventions can contribute to the holistic development of children in the digital age. The research provides a foundation for further exploration and application of guided AR activities in educational settings, with the aim of nurturing not only knowledgeable but also creative and emotionally resilient learners.

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