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Intersectionality in Modern Education: *Cultivating Global Citizens Through Technology, Art, and Sustainability*

Prof. Siu-Tsen Shen
Editor-in-Chief

It is with great pleasure that I introduce this latest issue of the *International Journal of Multimedia Art, Design and Education*. The architectural layout of this volume reflects a vital trend in contemporary research: the breakdown of traditional disciplinary silos. Today's educational and creative environments do not exist in isolation. Instead, they form a complex ecosystem where technology, cultural expression, and global sustainability intersect. The four peer-reviewed papers compiled in this issue offer a profound look at how modern pedagogies and frameworks are adapting to prepare students for an increasingly complex world.

Redefining Pedagogy via Intelligent and Interactive Systems

A major theme dominating this issue is the strategic integration of Artificial Intelligence (AI) and automated systems into highly tactile, experiential disciplines. Historically, arts and applied crafts like music and culinary training relied almost entirely on human modeling and manual repetition. The empirical research featured in this issue challenges that paradigm by introducing scalable, high-tech interventions:

- **Adaptive Music Education**: Research exploring the **Taiwan Adaptive Learning Platform (TALP)** demonstrates how personalized, AI-driven learning pathways can be successfully embedded into elementary music education, optimizing cognitive load and individual pacing.
- **AI in Culinary Classrooms**: Another core study investigates how AI-integrated learning environments affect **culinary education**. This piece beautifully connects technical training with learning effectiveness, proving that digital tools can elevate hands-on vocational skills while simultaneously shaping students' attitudes toward broader societal goals like environmental sustainability.

Global Perspectives, Language, and Environmental Governance

To truly design a holistic educational future, technological advancement must be balanced by a deep understanding of cultural identity and global policy frameworks. This issue expands its geographical and thematic scope by examining how students and systems navigate globalized environments:

- **The Student Voice in Language Learning**: Our opening paper offers a meticulous look into **Japanese as a Second Foreign Language (JSFL)** learning in Taiwan. By capturing the authentic voices of AFL-major freshmen, the authors provide critical data on student motivation, identity, and the systemic challenges of multilingual design in higher education.
- **Macro-Lessons in Sustainability**: Shifting the lens from individual learning to global systems, this issue features a crucial reflection on **Finland's environmental governance mechanisms**. By analyzing how advanced administrative policies tackle global sustainability issues, this paper provides design educators and researchers with a structural blueprint for embedding true sustainability into institutional curricula.

For our readers' navigation, this issue flows logically from foundational language experiences and macro-governance to applied interactive pedagogies:

1. **Wang et al. (pp. 1–14)** analyze the linguistic and motivational journeys of freshmen tackling Japanese as a second foreign language in Taiwan.
2. **Chang (pp. 15–21)** delivers a comparative reflection on Finnish environmental policy,

anchoring the volume's focus on sustainability.

3. **Kuo et al. (pp. 22–26)** explore how AI integration in culinary arts directly impacts student efficiency and ecological awareness.
4. **Lin et al. (pp. 27–42)** close the issue with an empirical analysis of AI-driven adaptive platforms (TALP) transforming primary music education.

Acknowledgements

The diversity of topics in this volume highlights the true spirit of our journal. I want to express my deepest gratitude to the authors for their innovative methodologies, and to our global network of peer-reviewers whose dedication ensures the academic rigor of these pages. We hope these articles inspire you to push the boundaries of design, art, and technology in your own respective fields.

Prof. Siu-Tsen Shen

June 2026

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The Voices of AFL-Major Freshmen about Japanese as a Second Foreign Language (JSFL) Learning in Taiwan

Ching-Huang Wang[1,*], Pei-Yi Pan[1], Ming-Zhu Lyu[1], Ti-Hsuan Chuang[1], Yu-Ya Wang[1], Guan-Yin Liu[1], Tan-You Wu[1], and Wei-Shi Wu[1]

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The purpose of the current study was to investigate learning disturbances and strategies in Japanese as a second foreign language (JSFL/L3) among 62 AFL freshmen in Taiwan (M: 18; F: 44). Data were collected through an online questionnaire and follow-up e-mail interviews with one participant and one Japanese instructor. The research questions were (a) What learning disturbances did AFL-major freshmen encounter in learning JSFL and (b) What learning strategies did AFL-major freshmen employ in learning JSFL. The results of the current study revealed that (a) Overall, AFL-major freshmen faced few Japanese learning disturbances, with the most significant issue being the lack of authentic environments to use Japanese, (b) Overall, they did not employ lots of Japanese learning strategies, and they primarily used two learning strategies, concentration in class and seeking help from others when having questions, both employed by more than 70% of participants, and (c) Females experienced fewer Japanese learning disturbances than males, and more females employed Japanese learning strategies compared with males.

Keywords – AFL-major freshmen, Japanese as a second foreign language (JSFL), learning disturbances, learning strategies, Taiwan.

Relevance to Design Practice — Over 70% of students naturally seek help from others. Design practices should formalise this preference by building intuitive peer-to-peer discussion boards, group problem-solving quests, and digital peer-review mechanisms directly into the learning platform.

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1 Introduction

Learning disturbances are one important theme in education, such as language learning, and further overcoming these disturbances is challenging in authentic

situations (Sakai, 2017). Students may endure stress and humiliation if they have the difficulty in learning a foreign language (Schwarz, n.d.), such as English and Japanese. Furthermore, learning a second foreign language (SFL/L3) is not an easy thing for some students as the vocabulary and grammar of any foreign language can significantly differ from those of the learner's mother tongue. Reducing learning disturbances, the use of learning strategies can be the paramount coping method. However, SFL learning disturbances and strategies vary from person to person and even from environment to environment.

In Taiwan, many second foreign language courses, such as Japanese and Vietnamese, are offered by the Departments of Applied Foreign Languages (AFL) and Applied English (AE) in many national and private technical universities (practice-oriented) (Lai, 2023). Among the SFLs, Japanese is the most popular for AFL or AE students to take as their required SFL/L3 (see Appendix A) in one academic year (e.g., two consecutive semesters), which echoes Huang's (2018) study indicating that the top one SFL college students preferred was Japanese (54.9%), followed by Korean (16.3%), and then Spanish (9.3%).

For the sampling convenience, all the AFL freshmen from a national technical university in Mid-southern Taiwan were recruited to be the participants of the current study because they were required to take Japanese I and Japanese II as a second foreign language (JSFL) during their freshman year. The researchers were curious about what learning difficulties they encountered and what learning strategies they could employ in JSFL learning. Thus, the purpose of the current study was to explore the voices of AFL-major freshmen about JSFL learning in Taiwan. Two research questions were produced to motivate the study as follows:

a. What learning disturbances did AFL-major freshmen encounter in learning JSFL?

b. What learning strategies did AFL-major freshmen employ in learning JSFL?

2 Literature Review

Two conceptual frameworks are employed in the current study. They are academic emotions and self-regulated learning (SRL).

2.1 Academic Emotions and Learning Disturbances

Pekrun (2006) referred to academic emotions as interrelated mental responses that include affection, cognition, physiology, and motivation in learning settings. Academic emotions had significant relationships with learners' motivation, learning strategies, cognitive resources, personal regulation, learning achievement, learners' personality, and classroom antecedents (Pekrun et al., 2002). In a broad sense, academic emotions involve positive emotions (e.g., enjoyment and fun) and negative emotions (e.g., frustration and pressure) in academic contexts (Pekrun et al., 2002). Such negative emotions in the theory of Academic Emotions have much to do with JSFL learning disturbances among the AFL freshmen in the current study.

Jorden et al. (1991) stated that Japanese was viewed as the most difficult foreign language for American language learners to learn or understand completely in terms of both speaking and writing. Authentic Japanese is extremely difficult for Americans who learn the Japanese language (Jorden et al. 1991). Henry (n.d.) stated that ten most difficulties in learning Japanese included a different language for foreigners, small words, similar words, speed of conversation, grammar, Keigo (formality), dialects, numbers, and synonyms. Though Japanese may not be the most difficult foreign language for Taiwanese college students to learn, they may encounter the same or similar Japanese learning disturbances like American learners when learning Japanese.

The pressure of learning disturbances may make students trapped in a learning bottleneck, lead to their emotional difficulties, lower their learning motivation and achievement, and even give up learning (陳/Chen, 2008). 翁/Ong (2002) viewed learning disturbances as the problems, internal and external, that hinder and affect individuals' learning process. 張/Chang (2002) and 許/Sheu (2002) referred to learning disturbances as learning difficulties that caused students' negative emotions and even hindered them from exerting their normal concentration on learning, so that they were likely to perform and achieve less well in the learning context. 陳/Chen (2008) regarded learning disturbance as individuals' inability to adjust their inner cognition and/or outer action in the learning process, which made them feel frustrated and their learning lag behind. Based on the foregoing literature review, the term, learning disturbances, is operationally defined for the current study as the problems that hinder students from learning well and possibly make them lag behind in their learning process.

2.2 Self-Regulated Learning (SRL) Strategies

Learning strategies are the ways learners employ to increase their learning effectiveness (張/Chang, 2008). Also, learning strategies are behaviors learners used to acquire, retain, or extract knowledge (張/Chang, 2006). Self-regulated learning (SRL) encompasses triadic reciprocal components of environment, action, and person (Bandura, 1986; Zimmerman, 1990). The environmental component involves environmental structuring and existing (the physical setting) and social resources (the social setting) for learning (Shen et al., 2023; Zimmerman, 1990). The action component involves overt activ-

ities or behaviors, such as seeking opportunities, which can increase learning efficiency (Shen et al., 2023; Zimmerman, 1990). The person component involves the covert affective and/or cognitive drives, such as rehearsing (Bandura, 1986; Shen et al., 2023), which can make learning effective.

In the current study, the environmental component mainly involves the resources of dictionaries (paper, Internet, etc.), language-learning place (cram school, university language center, university dormitory resource center, etc.), videos (animation, cartoons, etc.), and extracurricular Japanese reading materials (novels, comics etc.). The action component mainly involves the use of all the resources in the environmental component and asking others (classmates, teachers, etc.) for help. The person component mainly involves concentration on the Japanese class, and the organization of Japanese grammar with the same meaning, Japanese antonyms, and Japanese synonyms.

張/Chang (2008) employed two questionnaires to investigate the relationship between senior high school pupils' learning strategies and their teachers' teaching methods in second foreign language (Japanese) classrooms. The participants included 157 senior high school students (M=81, F=76) and six teachers. One questionnaire for students consisted of nine questions, and the other one for teachers included six questions. Learning strategies in the research mainly included memory strategy, cognitive strategy, compensation strategy, metacognitive strategy, affective strategy, and social strategy. The results of the research indicated that (a) The student participants employed memory strategy the most, (b) Female student participants did not employ more learning strategies than male ones, (c) Cognitive strategy and social strategy were two most effective learning strategies for the student participants in the grammar-translation method (GTM) classroom, (d) Cognitive strategy and social strategy were two most effective learning strategies for the student participants in the Communicative Language Teaching (CLT) classroom, and (e) The more learning strategies the student participants employed, the higher learning effectiveness they had.

楊/Yang (2014) employed one questionnaire and interviews to investigate the relationship between the use of Japanese learning strategy and learning achievement among JFL (Japanese as a foreign language) students. The participants, including 129 JFL college students (M=73, F=56) from Northern Taiwan, were divided into two classes, level 1 class and level 2 class. The research instrument was Oxford's (1990) SILL (Strategy Inventory for Language Learning). The interviews included weekly individual interviews and a focus interview, conducted at the end of the semester, with the top 10% and bottom 10% of the students in each class. The major results of the study indicated that (a) The participants' learning strategies differed from one learning stage to another, and they might modify or add learning strategies in different learning stages, (b) The participants of level 2 class employed Tool Use Strategy more than those of level 1 class, (c) The participants of level 1 class employed "Memory and Learning Management Strategy and Cognitive Strategy" (p. ii) most frequently, while those of level 2 class employed Cognitive strategy most frequently, and (d) Female participants employed more strategies than male ones.

The definition of learning strategies may vary from field to field and even among researchers. Per se the foregoing literature review, the operational definition of learning strategies for this study refers to the methods students employ to enhance their Japanese proficiency both in and out of class.

2.3 Rationale

Several research studies have discussed the relationships among J(S)FL learners' learning strategies, teachers' teaching methods, learning motivation and/or academic achievement. However, few studies have specifically investigated AFL majors' JSFL learning disturbances and learning strategies simultaneously.

3 Methodology

3.1 Nature of the Target Department of AFL

The total number of AFL students was 378, comprising 90 freshmen, 97 sophomores, 91 juniors, and 100 seniors. In addition to English, the Department of AFL offered three other foreign languages: Japanese, Spanish, and Vietnamese. Freshmen were required to take at least two Basic Japanese courses (I and II) as their SFL in the freshman year. Furthermore, students could select elective Japanese courses, including Intermediate Japanese (I and II), Higher Japanese (I and II), Japanese Conversation, and Introduction to Japanese Literature and Translation in different academic years. Spanish and Vietnamese were elective courses only. Students could select Vietnamese courses from freshman to senior years, while Spanish courses were available for juniors and seniors, with freshmen and sophomores also welcome to enroll.

3.2 Participants

For the sample convenience, 62 AFL freshmen (M: 18, 29%; F: 44, 71%) were recruited as participants for the current study at a national technical university in the mid-south of Taiwan (see Table 1). Although the original number of AFL freshmen was 90, only 64 of them rated the online questionnaire, and two females' questionnaires were deemed invalid. AFL freshmen were encouraged to take two required courses in Basic Japanese (I) and (II) as their SFL in their freshman year. Following Basic Japanese (I) in the Fall Semester of 2011-

2022, participants proceeded to Basic Japanese (II) in the Spring Semester of 2022, contributing to the authenticity and significance of the current study.

Table 1: Participants' Demographics

Major	Class	Valid		Invalid		Total	
		M	F	M	F	M	F
AFL	1A + 1B	18	44	0	2	18	46
Total		62		2		64	

3.3 Questionnaire

The online questionnaire served as a scale to gauge the opinions of AFL-major freshmen regarding the required second foreign language, specifically Japanese, at a national technical university in Mid-Southern Taiwan. The questionnaire items were generated through three approaches. First, insights from ten AFL college students were gathered, who were invited to write down their learning disturbances and strategies in JSFL. Second, the researchers conducted group discussions. Lastly, the literature review in the present study, with a specific focus on Henry's (n.d.) article, contributed to the formulation of questionnaire items.

To enhance the validity and reliability of the online questionnaire, the following steps were taken. Initially, a draft of the paper questionnaire was completed, and five AFL-major college students from different universities were invited to assess its clarity, understanding, and accuracy. This process aimed to identify any necessary revisions. Subsequently, a Chinese teacher with over ten years of experience in teaching Chinese at a national technical university was consulted as a validity expert to further refine the paper questionnaire. The revised version was then transferred into an online questionnaire. To ensure the online questionnaire's user-friendliness, the same group of five AFL-major college students was invited to test and rate it. After incorporating their feedback and finalizing the revisions, a QR code was generated for participants to scan and provide ratings for the online questionnaire.

In the 5-point Likert scale questionnaire, a rating of 5 indicates *strongly agree*, 4 signifies *agree*, 3 represents *neutral*, 2 denotes *disagree* and 1 stands for *strongly disagree*. The online questionnaire comprised three parts: participants' demographics (Part I), questionnaire items (Part II), and participants' free comments (Part III). In particular, Part III invites participants to express their ideas or suggestions related to the research themes in English and/or Mandarin Chinese. The questionnaire consisted of 21 items, with the first ten items (1-10) focusing on JSFL learning disturbances and the subsequent ten items (11-20) addressing JSFL learning strategies. Notably, item 21, "Please do not rate this item, or your questionnaire will be invalid," was included to discard any questionnaires rated without proper concentration. Moreover, participants were encouraged to freely share any comments related to the current study in Part III.

Between April 25 and April 29, 2022, 64 AFL freshmen (M=18; F=46) participated in rating the online questionnaire during their required courses at the target national technical university. The number of valid questionnaires was 62 because two female students rated item 21, "Please do not rate this item, or your questionnaire will be in-valid." Consequently, the valid rate was 97% (62/64), indicating a relatively high response rate of the ques-tionnaire.

3.4 Follow-up e-Mail Interviews

Based on the results of the questionnaire, eight follow-up e-mail interview questions were formulated for richer data—four addressing Japanese learning disturbances and four focusing on Japanese learning strategies (see Appendix B). In the early July, 2022, these questions were distributed to six participants (M=1; F=5) who had provided their e-mail addresses for follow-up interviews in the online questionnaire. Despite receiving responses from only one female participant, her answers were sufficiently comprehensive. Additionally, out of cu-riosity regarding Japanese teachers' perspectives, the questions were forwarded to two Japanese teachers for comments, and one of them responded.

4 Results and Discussion

The researchers analyzed and discussed both quantitative and qualitative data, considering the perspectives of entire participants and gender differences. The qualitative data comprised responses from one female participant (FP) and one Japanese teacher' (JT), as obtained through follow-up e-mail interview questions (see Appendix B). Chinese quotations were presented alongside their English translations.

4.1 Entire Participants

In this section, 62 AFL freshmen's responses to the questionnaire were discussed and analyzed from the per-spectives of Japanese learning disturbances and learning strategies. Plus, selected interview data were incorpo-rated to elucidate specific questionnaire results.

4.1.1 Learning Disturbances

Derived from the average agreement percentage (AAP) of 34.36% and average mean value of 2.98 (AMV) (see Table 2), it is evident that approximately one-third of the participants experienced Japanese learning distur-bances. The most significant issue among them was the lack of realistic Japanese environments for language practice. To be more specific, over 70% of the par-ticipants concurred with the unavailability of authentic Japanese environments during their Japanese learning

journey (item 10: 70.97%, M=3.73), with only 8.06% in disagreement. The second most prevalent Japanese learning disturbance among the freshmen was insufficient Japanese course hours, as approximately half of the participants expressed agreement that the weekly course hours were insufficient (item 8: 51.62%, M=3.47), and about 11.29% disagreed. On the other hand, nearly 60% could concentrate well in Japanese class (item 7: 59.68%), while only about 6.45% could not (M=2.34). Furthermore, more than half of the participants expressed interest in Japanese (item 1: 56.45%), with about 11.29% indicating otherwise (M=2.42).

Overall, more than 70% of the participants (70.97%) believed they lacked a suitable Japanese environment for practical language application (see Table 2). The potential explanation may be related to the absence of opportunities to practice situational Japanese, as indicated by a female participant (FP) in the follow-up e-mail interview:

> (FP) 學校日文課程以學習日語基本語法及了解日本文化為大宗，缺少讓同學實際練習口說的情境式學習（如同學間練習用日語互相問候，用日文點餐等）[。]
> (FP) The Japanese class in school primarily emphasizes basic Japanese grammar and Japanese culture. Students have limited opportunities to engage in situational Japanese practice (such as using Japanese greetings among students or ordering in Japanese)

Overall, slightly over half of the participants (51.62%) concurred that the two hours allocated to the Japanese class each week were insufficient for effective language learning (see Table 2). The time constraint hindered them from practicing Japanese dialogues and increasing their listening ability, as noted by the Japanese teacher (JT) in the follow-up e-mail interview.

> (JT) ‧‧‧ 上課時數不多沒有時間練習會話聽力‧‧‧
> (JT) . . . because the Japanese class time is limited, students have minimal opportunities to practice conversations and sharpen their listening skills. . ..

4.1.2 Learning Strategies

Per se the AAP of 33.06% and AMV of 2.96 in Table 3, it appears that a limited number of participants employed learning strategies to learn Japanese. To be more specific, over 70% of the participants actively concentrated during Japanese class (item 11: 72.58%, M=3.90) and sought assistance by asking others if they had any questions (item 20: 70.97%, M=3.74), with only 1.61% and 11.29% refraining respectively. Also, more than half of the participants improved their Japanese by watching Japanese videos (item 16: 53.23%, M=3.39), while about 27.42% did not. On the other hand, about 65% did not improve their Japanese by going to language-learning places (item 19: 64.51%), while only 6.45% did (M=2.18). Furthermore, more than half of the participants did not utilize extracurricular Japanese reading materials for improvement (item 18: 56.45%), with about 14.51% indicating otherwise (M=2.42).

Overall, only one-third of the participants (AAP: 33.06%) employed Japanese learning strategies (see Table 3). The possible reason for this could be that some of them possess a talent for learning Japanese, as mentioned by the FP in the follow-up email interview:

> (FP) 我認為學習一個新語言很看天分，有的人不需要安排什麼學習策略，也可以把一個語言學的很好 [。]
> (FP) I believe that learning a new language is highly dependent on the learners' talent. Some individuals can acquire proficiency in a language without employing specific learning strategies.

Overall, 64.51% of the participants did not attend cram school or other learning centers to enhance their Japanese skills (item 19). Two potential reasons were that some students found cram school fees prohibitively high and their schedules were too busy to accommodate it, as mentioned by JT in the following excerpt. Another reason was that Japanese was deemed less crucial than English, as indicated by FP in the subsequent excerpt. These reasons align with Lai's observation that "Some English majors complain that they do not have enough time to learn a second foreign language because the focus is always on their English courses" (2023, p. 2).

> (JT) 也許有些同學認為補習費用與時間不夠。
> (JT) Some students may perceive the costs of attending cram schools are too high, coupled with a lack of sufficient time to engage in such activities.
> (FP) 因為學生從小到大的觀念，日文並非必學的語言，反之，我們從國小就學英文，到了學測統測這種大型考試，也需要考英文，就連學校都會宣導，並協助學生進行考取英文相關證照，自然想去補習的人（無論是針對考試或考照）就會變多 [。]
> (FP) The reason is that Japanese is not mandatory for Taiwanese students from elementary to higher education. On the contrary, English is taught in elementary schools. We were required to take an English test in the Joint College Entrance Examination (JCEE) or TVE (Technological and Vocational Education)-JCEE. Schools actively promote and assist students in obtaining English certificates, leading to a rise in the number of the students who go to cram schools (for exams or certificates)[.]

Table 2: Results of the Entire Participants' Responses to Questionnaire (Learning Disturbances)

Item (Rank)	SA+A (%)	N (%)	SD+D (%)	M	SD
10. I don't have an authentic Japanese environment to practice the language.	70.97	20.97	8.06	3.73	0.94
8. I feel that Japanese course hours are not enough weekly.	51.62	37.10	11.29	3.47	1.00
5. I am frustrated with Japanese grammar.	43.55	24.19	32.26	3.10	1.22
6. I have limited knowledge of Japanese culture.	40.32	29.03	30.65	3.08	1.03
9. I feel that the time spent reviewing Japanese is not enough.	38.71	33.87	27.42	3.15	1.06
3. I am frustrated with memorizing Japanese vocabulary.	33.87	32.26	33.87	3.02	1.23
2. I am frustrated with reading a Japanese textbook.	33.87	25.81	40.33	2.90	1.28
4. I am frustrated with pronouncing Japanese.	12.90	41.94	45.16	2.58	1.00
1. I am not interested in Japanese.	11.29	32.26	56.45	2.42	1.16
7. I cannot concentrate on the Japanese class.	6.45	33.87	59.68	2.34	0.92
Average	**34.36**	**31.13**	**34.52**	**2.98**	**1.08**

Note. SA (strongly agree) = 5; A (agree)= 4; N (neutral) = 3; D (disagree) = 2; SD (strongly disagree) = 1. All the percentages and mean values were rounded up from the second decimal point.

Overall, more than half of the participants (56.45%) agreed that they did not read Japanese extracurricular materials to improve their Japanese (item 18). Some Japanese learning beginners may avoid it due to their limited competency, while others might prioritize English over Japanese because of the English Graduation Threshold (Wang et al., 2016a; Wang et al., 2016b). In a follow-up e-mail interview, the FP stated:

> (FP) 對於剛接觸日文的學生，可能是因為看不懂所以不會想看，至於其他人，可能也寧可利用時間多讀英文，因為一定要考取英文相關證照的畢業門檻，所以學生會認為日文只要課程通過就好，但英文一定要多花時間 [。]
> (FP) Some Japanese beginners choose not to study further as they struggle to comprehend extracurricular reading materials. Meanwhile, other students prioritize studying English over Japanese due to the English graduation threshold. Consequently, their primary goal is to pass the Japanese course without concerning about final scores, but they find themselves investing more time in English[.]

4.2 Gender

In this gender section, the researchers discussed and analyzed the 62 AFL freshmen's responses to the questionnaire, examining them from the perspectives of Japanese learning disturbances and learning strategies. Additionally, some results of the questionnaire were elucidated using interview data.

4.2.1 Learning Disturbances

Based on the AADs (42.22% vs. 31.13%) and AMVs (3.25 vs. 2.87) presented in Table 4, male freshmen were more prone to Japanese learning disturbances than their female counterparts. Particularly, 72.22% of male freshmen exhibited limited knowledge of Japanese culture (item 6, M=3.61); 66.67% of them lacked an authentic Japanese environment for language use (item 10, M=3.67); half of them faced challenges in reading Japanese textbooks (item 2, M=3.44), spent insufficient time reviewing Japanese (item 9, M=3.33), and considered the duration of weekly Japanese classes inadequate (item 8, M=3.50). In contrast, 72.73% of females lacked an authentic Japanese environment for language use (item 10, M=3.75) and 52.27% of them found the duration of weekly Japanese classes insufficient (item 8, M=3.45). Additionally, 65.91% of females expressed concentration in their Japanese class (item 7); 63.64% of them expressed interest in Japanese (item 1); half of them expressed no difficulty in reading Japanese textbooks (item 2).

On the other hand, the most significant difference in attitude between male and female freshmen was observed in the results of item 6. It was found that 72.22% of males had limited knowledge of Japanese culture, while only 27.27% of females did, resulting in an agreement percentage difference (APD) of 44.95%. The least divergence in attitude between male and female freshmen was noted in the results of item 5. Specifically, 44.44% of males expressed frustration with Japanese grammar and 43.18% of females shared this sentiment, resulting in a minimal APD of 1.26%.

Comparatively speaking, male freshmen were more prone to learning disturbances than females. Possible reasons include their lesser diligence, reduced interest, and lower attentiveness to the Japanese language, as revealed in the follow-up email interview with the FP:

> (FP) 至於男生學習困擾較多，或許是因為細心度不夠 [。]
> (FP) Males experience more learning disturbances, perhaps because they are not attentive enough[.]

Table 3: Results of the Entire Participants' Responses to Questionnaire (Learning Strategies)

Item (Rank)	SA+A (%)	N (%)	SD+D (%)	M	SD
11. I try to concentrate on the Japanese class.	72.58	25.81	1.61	3.90	0.87
20. If I have any question, I ask others (classmates, teachers, etc.).	70.97	17.74	11.29	3.74	1.07
16. I improve my Japanese by watching videos (animation, cartoons, etc.)	53.23	19.35	27.42	3.39	1.40
17. I improve my Japanese by learning Japanese songs.	32.26	30.65	37.10	3.00	1.14
14. I use Japanese dictionaries (paper, Internet, etc.).	30.64	32.26	37.09	2.89	1.34
15. I organize Japanese grammar with the same meaning together.	22.58	45.16	32.26	2.87	0.99
12. I organize Japanese synonyms together.	14.52	41.94	43.55	2.61	1.01
18. I improve my Japanese by reading extracurricular Japanese reading materials (novels, comics etc.).	14.51	29.03	56.45	2.42	1.02
13. I organize Japanese antonyms together.	12.90	43.55	43.54	2.61	0.95
19. I improve my Japanese by going to a language-learning place (cram school, university language center, university dormitory resource center, etc.)	6.45	29.03	64.51	2.18	0.92
Average	**33.06**	**31.45**	**35.48**	**2.96**	**1.07**

Note. SA (strongly agree) = 5; A (agree) = 4; N (neutral) = 3; D (disagree) = 2; SD (strongly disagree) = 1. All the percentages and mean values were rounded up from the second decimal point.

Male freshmen demonstrated less knowledge of Japanese culture (72.22%) compared to females (27.27%), resulting in an APD of 44.95% (see Table 4). One plausible explanation is that the motivation among males to learn about Japanese traditions or cultures was considerably lower than that of females, as indicated by the FP's response.

> (FP) 男生可能喜歡的只有動漫畫或遊戲類的二次元文化，並不會對其他的事物進行了解，但女生可能會以因為喜歡二次元為動機，進而了解更多日本相關傳統及其他文化 [。]
> (FP) Males may only have an interest in two-dimensional Japanese animations and manga, lacking motivation to understand other aspects. In contrast, females, who also enjoy two-dimensional content, may be motivated to explore more about Japanese traditions and other cultures.

4.2.2 Learning Strategies

In Table 5, it is evident that female freshmen tended to utilize Japanese learning strategies more than their male counterparts by Average Agreement Percentage Difference (AAPD) of 16.06%, with average percentage differences (APD) ranging from 4.80% to 29.55%. This result echoes 楊/Yang's study (2014), which indicates that female participants employ more strategies than males in learning JSFL, but conflicts with 張/Chang's study (2008), which suggests that female students did not employ more learning strategies than males in L3 (Japanese) classrooms.

Table 5 also shows that more than half of male freshmen refrained from employing learning strategies outlined in items 12-19, with disagreement percentages ranging from 50.00% to 77.78%. While 66.67% of male freshmen concentrated on Japanese class (item 11, M=3.67) and half of them sought help from others when they had questions (item 20, M=3.28). Even so, 33.33% of males did not seek assistance when facing queries.

On the other hand, 79.55% of female freshmen actively sought help when they had questions (item 20, M=3.93), 75.00% concentrated on Japanese class (item 11, M=4.00), and 61.36% improved their Japanese by watching videos (item 16, M=3.64). However, half of female freshmen did not improve their Japanese by reading extracurricular Japanese materials (item 18), and 59.09% did not improve their Japanese by visiting language-learning places (item 19).

Comparatively, over one-fifth of males (AAP: 21.67%, AMV=2.49) employed Japanese learning strategies, while about two-fifths of females (AAP: 37.73%, AMV=3.15) did so. This discrepancy may arise from the fact that the latter group tended to effectively manage their time and workload, as indicated by the following quotation from the FP.

> (FP) 至於女生會使用策略的人偏多，我覺得是因為較多女生會喜歡把一天要學習或進行的事物安排好，有效的運用時間（類似時間或工作安排的概念）[。]
> (FP) Females tend to utilize learning strategies more than males. This inclination might be attributed to the fact that more females prefer scheduling their learning or daily activities, emphasizing effective time management (a concept akin to time or work scheduling) [.]

Although half of male students would seek assistance

Table 4: Results of Gender's Responses to Questionnaire (Learning Disturbances)

Gender	SA+A (%)	N (%)	SD+D (%)	APD (Rank)	Mean	SD
6. I have limited knowledge of Japanese culture.						
M	72.22	11.11	16.67	44.95	3.61	0.85
F	27.27	36.36	36.36		2.86	0.88
1. I am not interested in Japanese.						
M	27.78	33.33	38.89	23.23	2.94	1.11
F	4.55	31.82	63.64		2.20	0.90
2. I am frustrated with reading a Japanese textbook.						
M	50.00	33.33	16.67	22.73	3.44	0.92
F	27.27	22.73	50.00		2.68	1.12
4. I am frustrated with pronouncing Japanese.						
M	0.00	61.11	38.89	-18.18	2.61	0.50
F	18.18	34.09	47.73		2.57	1.02
9. I feel that the time spent reviewing Japanese is not enough.						
M	50.00	27.78	22.22	15.91	3.33	1.08
F	34.09	36.36	29.55		3.07	0.93
3. I am frustrated with memorizing Japanese vocabulary.						
M	44.44	38.89	16.67	14.90	3.44	0.98
F	29.55	29.55	40.91		2.84	1.06
7. I cannot concentrate on the Japanese class.						
M	16.67	38.89	44.44	14.39	2.78	0.88
F	2.27	31.82	65.91		2.16	0.78
10. I don't have an authentic Japanese environment to practice in.						
M	66.67	5.56	27.78	-6.06	3.67	1.33
F	72.73	27.73	0.00		3.75	0.49
8. I feel that Japanese course hours are not enough weekly.						
M	50.00	44.44	5.56	-2.27	3.50	0.92
F	52.27	34.09	13.64		3.45	0.90
5. I am frustrated with Japanese grammar.						
M	44.44	27.78	27.78	1.26	3.17	0.85
F	43.18	22.73	34.09		3.07	1.13
Average M	**42.22**	**32.22**	**25.60**	**11.08**	**3.25**	**0.94**
F	**31.13**	**30.72**	**38.18**		**2.87**	**0.92**

Note. SA (strongly agree) = 5; A (agree) = 4; N (neutral) = 3; D (disagree) = 2; SD (strongly disagree) = 1. APD=Agreement percentage differences. All the percentages and mean values were rounded up from the second decimal point.

when encountering learning issues in Japanese (item 20, M=3.28), one-third of them (33.33%) refrained from doing so. A possible reason could be a concern for embarrassment or face-saving. Another possibility, as indicated by the FP in her follow-up email interview, is that they might not be particularly concerned about understanding the material they have learned.

> (FP) 顧面子或是覺得不懂也沒關係（台灣學生普遍喜歡不懂裝懂)[。]
> (FP) For males, it might be a matter of face-saving or they may be indifferent to understanding the language (Taiwanese students generally tend to pretend to understand when they don't) [.]

5 Conclusion

The aim of the current study was to explore AFL freshmen's JSFL learning disturbances and learning strategies. The results of the current study indicated that:

a. Overall, the participants did not have many Japanese learning disturbances. This result may have much to do with the participants' full-time Japanese instructor who dedicated a significant amount of time and energy to boosting teaching quality and always showed consideration for students' learning process with guidance, encouragement and support. In the current study, the top two Japanese learning disturbances were the unavailability of an authentic Japanese environment (70.97%)

Table 5: Results of Gender's Responses to Questionnaire (Learning Strategies)

Gender	SA+A (%)	N (%)	SD+D (%)	APD (Rank)	Mean	SD
20. If I have any question, I ask others (classmates, teachers, etc.).						
M	50.00	16.67	33.33	-29.55	3.28	1.36
F	79.55	18.18	2.27		3.93	0.66
16. I improve my Japanese by watching videos (animation, cartoons, etc.)						
M	33.33	16.67	50.00	-28.03	2.78	1.44
F	61.36	20.45	18.18		3.64	1.14
17. I improve my Japanese by learning Japanese songs.						
M	11.11	22.22	66.67	-27.53	2.17	1.15
F	38.64	36.36	25.00		3.34	1.20
15. I organize Japanese grammar with the same meaning together.						
M	5.56	27.78	66.67	-23.99	2.22	0.81
F	29.55	52.27	18.18		3.14	0.82
14. I use Japanese dictionaries (paper, Internet, etc.).						
M	22.22	16.67	61.11	-14.14	2.44	1.04
F	36.36	36.36	27.27		3.07	1.07
13. I organize Japanese antonyms together.						
M	5.56	27.78	66.67	-10.35	2.22	0.81
F	15.91	50.00	34.09		2.77	0.77
19. I improve my Japanese by going to a language-learning place...						
M	0.00	22.22	77.78	-9.09	1.83	0.79
F	9.09	31.82	59.09		2.32	0.88
11. I try to concentrate on the Japanese class.						
M	66.67	27.78	5.56	-8.33	3.67	0.69
F	75.00	25.00	0.00		4.00	0.72
12. I organize Japanese synonyms together.						
M	11.11	22.22	66.67	-4.80	2.22	0.94
F	15.91	50.00	34.09		2.77	0.77
18. I improve my Japanese by reading extracurricular Japanese reading...						
M	11.11	16.67	72.22	-4.80	2.11	0.96
F	15.91	34.09	50.00		2.55	0.98
Average M	**21.67**	**21.67**	**56.67**	**-16.06**	**2.49**	**1.00**
F	**37.73**	**35.45**	**26.82**		**3.15**	**0.90**

Note. SA (strongly agree) = 5; A (agree) = 4; N (neutral) = 3; D (disagree) = 2; SD (strongly disagree) = 1. APD=Agreement percentage differences. All the percentages and mean values were rounded up from the second decimal point.

and insufficient time of a weekly Japanese class (51.62%). Learning hours were a crucial learning disturbance among half of the participants; therefore, increasing Japanese course hours could be considered, as Lai stated in his research study that "increasing learning hours for L3 courses is essential" (2023, p.18).

b. Overall, only about one-third of the participants utilized Japanese learning strategies. The top three Japanese learning strategies employed by the participants were "trying to concentrate on Japanese class" (72.58%), "not feeling ashamed to ask" (70.97%), and then "watching Japanese videos" (53.23%). The least two Japanese learning strategies among participants were "going to a language-learning place" (64.51%) and then "reading extracurricular Japanese reading materials" (56.45%).

c. Basically, more males encountered Japanese learning disturbances than females. In particular, males (72.22%) had more limited knowledge of Japanese culture than females (27.27%).

d. Gender makes a difference in the use of learning strategies. More females employed learning strategies to learn Japanese than males.

In terms of the entire participant pool, the study focused exclusively on AFL freshmen at a national technical university in Mid-Southern Taiwan. Consequently, the findings may not be applicable to students in other

public and/or private universities. Moreover, the unbalanced gender ratio (M: 18, 29%; F: 44, 71%) could potentially skew part of the research results. Additionally, the questionnaire might not fully capture the complexities of Japanese learning disturbances and strategies. Therefore, future studies should aim for a more diverse and representative sample, encompassing a larger population of JSFL students from both public and private institutions. Considerations such as Japanese competency, a balanced gender ratio, learning motivation, learning attitudes, a broader range of learning disturbances and a more comprehensive exploration of learning strategies could enhance the precision and depth of future research findings.

Educationally speaking, a notable portion of AFL freshmen (11.29%) in the current study exhibited no interest in Japanese, potentially leading to learning anxiety and depression. Consequently, it is suggested that, aside from Japanese, AFL students should have the option to choose other foreign language like Vietnamese or Spanish as their required second foreign language. Allowing AFL students to select a second foreign language of personal interest can serve as a powerful motivator, fostering a conducive environment for effective learning and high achievements.

The findings of the current study could also serve as a catalyst for Japanese teachers to reconsider their teaching methods and design authentic course activities or assignments aimed at enhancing their students' Japanese proficiency. Teachers are encouraged to establish anxiety-free learning environments, providing support and scaffolding, particularly for low proficient and demotivated students, to boost their learning motivation. Encouraging students to discuss their learning disturbances with teachers and classmates can be instrumental, along with the implementation of diverse learning strategies to enhance their Japanese competency.

Most importantly, the unavailability of an authentic Japanese environment (70.97%) emerged as the primary learning disturbance for participants. To address this, creating authentic Japanese environments through activities and competitions, as suggested by one female participant (FP) in Free Comments section of the questionnaire, could offer valuable opportunities for language practice: 我覺得可以多多接觸日文方面的比賽，或能有更多機會使用它 [I think we can participate in more Japanese contests, which may offer us more opportunities to use the Japanese language.]

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Appendixes

Appendix A

Summary of SFLs Offered by Technical Universities in Taiwan

Science and Technology University	SFL(s)
National Formosa University http://afl.nfu.edu.tw/downs/archive.php?class=103	Japanese
Southern Taiwan University of Science and Technology https://academic.stust.edu.tw/tc/node/course1	Japanese
Lunghwa University of Science and Technology https://www.lhu.edu.tw/oapx/lhuplan/Subject/ASubject_Qry.htm	Japanese Vietnamese
TransWorld University https://dafl.twu.edu.tw/downloads/laws210323093926a.pdf	Japanese
Shu-Te University https://drive.google.com/file/d/1wCIkUQYXL80E86FN2PeWc-Q8DiWd1qIQ/view	Japanese
Chienkuo Technology University https://afl.ctu.edu.tw/p/405-1032-29812,c441.php?Lang=zh-tw	Japanese
Nan Kai University of Technology https://afl.nkut.edu.tw/course/archive.php?class=301	Japanese

Note. SFL/L3= Second Foreign Language

Appendix B

Follow-up Interview Questions (Chinese Version and English Version)

學習困擾

1. 整體而言，只有約 1/3 的同學（34.46%）有日文的學習問題 (困擾)，為什麼？另外，整體而言，男生的學習困擾比女生多 (42.22 % vs. 31.13%)，為什麼？
2. 整體而言，7 成 1 的同學 (70.97%) 認為沒有日文環境下可使用日文，為什麼？
3. 整體而言，5 成 2 的同學 (51.62%) 認為一個禮拜只有兩小時的日文課是不夠的，為什麼？
4. 男生 (72.22%) 對日本文化的認識遠遠低於女生 (27.27%)，相差 44.95%，為什麼？

學習策略

1. 整體而言，只有約 1/3 的同學 (33.06%) 會使用學習策略，為什麼？另外，會使用學習策略的女生多於男生 (37.73% vs. 21.67%)，為什麼？
2. 整體而言，約 6 成 5 的同學（64.51%）不會去補習班、中心或其他地方來增進日文能力，為什麼？
3. 整體而言，5 成 6（56.45%）的同學不會閱讀日文課外讀物來增進日文能力，為什麼？
4. 雖然有 5 成的男生有日文問題時會問別人，但仍然有 1/3 的男生 (33.33%) 不會問，為什麼？

任何其他想法，請寫下，謝謝。

Learning Disturbances

1. Overall, why did only about one-third of AFL freshmen (34.46%) have Japanese learning disturbances? Besides, why did males have more Japanese learning disturbances than females (42.22% vs. 31.13%)?
2. Overall, why did about 71% of AFL freshmen (70.97%) think that they didn’t have authentic Japanese environments to use Japanese?
3. Overall, why did more than half of AFL freshmen (51.62%) consider that two hours of Japanese class a week were not enough?
4. The knowledge of Japanese culture among males (72.22%) was far lower than that among females (27.27%), and the agreement percentage difference (APD) was 44.95%. Why?

Learning Strategies

1. Overall, only one-third of AFL freshmen (33.06%) used Japanese learning strategies. Why? Besides, female students used learning strategies more than males (37.73% vs. 21.67%), why?
2. Overall, 64.51% of AFL freshmen did not go to language-learning place (cram school, university language

center, university dormitory resource center, etc.) to improve their Japanese. Why?
3. Overall, why didn't 56.45% of the participants read Japanese extracurricular reading materials to improve their Japanese?
4. Although half of male students asked others when they have learning problems, still one-third of males (33.33%) did not do it. Why so?
Please write down any ideas here. Thanks.

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Reflections on Finland's Environmental Governance Mechanisms in Addressing Global Sustainability Issues

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As the first country in the world to formulate a national roadmap for the circular economy, Finland has demonstrated a high level of education, technological leadership, and strong international reputation in the field of sustainable development. In recent years, the environmental pollution caused by the fashion industry has drawn increasing attention, positioning sustainable fashion as a critical topic in both research and practice. With the rapid accumulation of related literature, the challenge for fashion enterprises lies in identifying sustainability needs within highly complex supply chain structures and allocating resources effectively. This study takes Finland's Kierrätyskeskus Recycling Centre as a case to examine the environmental and social issues arising from globalized textile and apparel production, while further analyzing the innovative operational models established beyond technical repair. The research aims to evaluate the potential implications of such models for Taiwan's sustainability policies and industrial practices, thereby offering concrete recommendations to foster institutional innovation and cross-sector collaboration in the domain of sustainable fashion.

Keywords — Sustainable fashion, Circular economy, Environmental governance, Supply chain management, Institutional innovation.

Relevance to Design Practice — Finland's environmental governance illustrates how design can operate within clear sustainability frameworks. Its circular-economy policies and participatory planning highlight the value of lifecycle thinking, transparent resource use, and cross-sector collaboration. These principles guide designers to create solutions that are materially responsible, socially engaged, and aligned with global sustainability goals.

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1 Introduction

With the intensification of climate change, environmental anomalies, and the depletion of natural resources, sustainable development has emerged as one of the most pressing global challenges (Clancy et al., 2015; Han et al., 2017; Khandual & Pradhan, 2018). According to demographic analyses conducted by Taiwan's Ministry of the Interior, it is estimated that Taiwanese aged 20–45 discard at least 5.2 million garments annually, equivalent to 9.9 pieces of

clothing and 10 pairs of shoes every minute (Cox et al., 2013). A survey jointly conducted by Kantar Insights and Kantar Profiles Division, targeting 800 consumers aged 15 and above, revealed that Taiwanese consumers purchase an average of 11 garments per year. Women purchase slightly more (12 items) than men (10 items), while consumers under 19 purchase up to 14 items annually. Among all groups, high-income women recorded the highest consumption, averaging 16 items per year (KANTAR, 2019). Notably, the average annual clothing consumption has not declined despite increasing advocacy for sustainability (De Castro, 2021).

Historically, Taiwan's second-hand clothing exports were primarily destined for China and Africa. However, with China's rapid economic growth and the expansion of its domestic apparel industry, it has become a major exporter of second-hand clothing itself. In recent years, rising tariffs on used clothing in African countries have further intensified market competition, rendering most garments unexportable and ultimately incinerated. Locally, Taiwan's second-hand clothing market faces significant barriers: consumers often perceive used garments as unhygienic, outdated, or of poor quality; resale platforms suffer from opaque pricing, fueling public distrust; and second-hand enterprises struggle to balance costs and profits (Chen, 2022). In 2014, only 7–8% of collected clothing could be resold as second-hand items, a figure that dropped to 6% during the COVID-19 outbreak and has since declined to merely 3–4%. As noted by the director of Eden Foundation's recycling center, "It is evident that discarded clothing is largely driven by fast fashion trends, with garments of inferior quality often damaged after only a few wears" (Hung, 2024).

A 2023 report by the Environment and Development Foundation highlighted further challenges: declining quality of collected garments, shortened life cycles, reduced durability, and limited reuse potential. Clothing collected in non-urban areas tends to be older and lacks resale value. Despite these issues, Taiwan's textile recycling volume has continued to rise, from 48,900 tons in 2016 to 63,000 tons in 2017, reaching 81,600 tons in 2022—a 6% increase within six years. Textile recycling is a crucial pathway toward achieving net-zero carbon emissions, as both raw material use and energy consumption during production generate significant carbon outputs. According to the Environmental Protection Administration, 76,000 tons of clothing were recycled in 2010, with 64% reused: approximately half resold as second-hand garments, 15% downcycled into rags or fillers, and 36% incinerated or converted into fuel (EPA Recycling Fund Management Board, 2022).

Finland, by contrast, has established a strong reputation in sustainable development through high educational standards, advanced technologies, and innovative practices. Valuable insights can be drawn from Finnish recycling centers (Armstrong et al., 2015; Boström & Micheletti, 2016). For Taiwan's apparel industry, such experiences underscore the need for innovative and practical models to mitigate environmental impacts (Armstrong et al., 2015; Das et al., 2021). Product-service systems offer significant opportunities: consumers show the greatest interest in garment recycling and exchange (Armstrong et al., 2015). Rental and exchange models are particularly suitable for younger consumers, while redesign, repair/maintenance, customization, and consultancy services are more appealing to middle-aged and older groups. Positive perceptions of clothing recycling are primarily driven by environmental benefits and emotional factors, whereas negative perceptions stem from a lack of trust in service providers (De Castro, 2021). Scholars further emphasize that the challenges of globalized textile and apparel production are highly complex (Caniato, 2020; Davidson, 2019). Beyond technological solutions, behavioral and practical changes remain the most difficult variables to address, with the central challenge being how to design and establish more effective operational models.

2 Literature Review

In 2013, the Ellen MacArthur Foundation highlighted that since the twentieth century, clothing design and production have typically been distributed across different countries and sold worldwide at an accelerating pace, rendering the fashion industry highly globalized. With the expansion of the global middle class, rising disposable incomes, and the emergence of "fast fashion," clothing has increasingly been treated as disposable, leading to rapid turnover in production capacity—a phenomenon that continues to intensify today. The Foundation's report *A New Textile Economy: Redesigning Fashion's Future* outlined a vision based on circular economy principles, proposing ambitious actions to transform the design, sale, and use of clothing, aiming to capture a USD 500 billion circular economy opportunity (Corsini & Frey, 2024). The circular economy envisions a system in which materials never become waste but instead regenerate naturally. Products and materials circulate through processes such as maintenance, reuse, remanufacturing, recycling, and composting, thereby decoupling economic activity from finite resource exploitation and addressing global challenges such as biodiversity loss, waste, pollution, and climate change.

The fashion industry is under increasing scrutiny for its environmental impacts. Despite widespread awareness of its destructive effects, the industry continues to grow, largely driven by fast fashion. Fast fashion relies on low-cost production, frequent consumption, and a built-in obsolescence model, whereby products are designed for short lifespans to encourage rapid disposal and replacement. Consumers often remain unaware that discarded garments represent only the visible portion of a much larger waste stream. Indeed, the product itself accounts for merely 5% of the total raw materials involved in manufacturing and packaging, meaning that economic growth in this sector comes at the expense of planetary health, with severe consequences (Niinimäki et al., 2020b; Pandit et al., 2019). Rapidly shifting fashion trends have shortened product lifespans, increased textile waste, and exacerbated social

and environmental problems, necessitating new solutions. One emerging business model is fashion remanufacturing, which supports material recirculation and reduces landfill waste. Its success depends on the social responsibility of major retailers and active consumer participation (Dissanayake & Sinha, 2015).

Growing awareness of fashion's environmental footprint has spurred extensive research. Given the complexity of fashion supply chains, identifying sustainability needs and making appropriate resource allocation decisions has become critical (Fung et al., 2020; Guedes et al., 2020). A study of 161 South Korean consumers aged 18–34 revealed that fashion-sensitive individuals dispose of clothing more quickly and with less ethical consideration, yet they are willing to invest in modifying fashion items with symbolic value. This expands understanding of apparel disposal within a sustainability context (McNeill et al., 2020). Similarly, research in South Africa found that educating consumers about the benefits of sustainable fashion is a key strategy for long-term behavioral change, enhancing environmental sustainability and safeguarding future generations' livelihoods (Muposhi & Chuchu, 2022). The industry's environmental impact is staggering, generating over 92 million tons of waste and consuming 79 trillion liters of water annually. Fundamental transformation of fashion business models is required, including slowing production cycles, embedding sustainability practices across supply chains, and educating consumers to reduce purchases and extend garment lifespans (Niinimäki et al., 2020a).

Kierrätyskeskus (Reuse Centre, hereafter "Recycling Centre") is one of Finland's oldest institutions, originating in 1980 when a group of individuals began exchanging unused household items, thereby initiating a second-hand market. Over time, the notion that recycling and environmental protection should not remain solely individual responsibilities led to government involvement, formalizing the Centre as a foundation supported by both public and private organizations. Since 2012, its profits have steadily increased, with revenues reaching €7.4 million (approx. NT$266 million) in 2016, reflecting Finnish society's commitment to recycling as a way of life. Data show that 63.43% of the Centre's income derives from sales of recycled materials, followed by government employment subsidies (20.82%) and municipal support (13.88%). Another success lies in transforming old goods into unique design pieces. In 2015, the Centre produced 1,988 such items, rising to 2,660 in 2016—a 34% increase—despite having only 5–6 designers and producers. This demonstrates Finland's emphasis on circular economy principles, rethinking product lifespans and ensuring that items do not lose value once worn or damaged, but instead re-enter the market at high quality and price through professional repair and redesign.

The Recycling Centre embodies Finland's broader cultural embrace of the circular economy, embedding sustainability into everyday life. In a consumer-driven society, the Finnish perspective is thought-provoking: wealth does not necessitate constant acquisition of new goods or immersion in capitalist consumption cycles. Within Finland's cultural context, sustainability is framed as creative recombination—transforming waste into value, enhancing design, and earning consumer appreciation. While many Finns express interest in sustainable fashion and acknowledge its social and environmental impacts, their purchasing habits suggest that ethical and environmental considerations do not yet strongly influence buying decisions (Federiko, 2022; Niinimäki, 2015).

Education for Sustainable Development (ESD) is also highly prioritized in Finland. ESD approaches are largely action-research oriented, with schools integrating sustainability into daily practice. Regional Centres of Excellence and the Finnish National Board of Education play key roles in supporting these efforts, emphasizing ecological-social pedagogy, systems thinking, and value education (Åhlberg et al., 2015). Circular economy has become a cornerstone of Finland's sustainability agenda, involving traders, recyclers, scavengers, and social enterprises in inspiring reuse practices. Citizens are encouraged to sell items at flea markets, donate sealed packages to charities, or deliver them to recycling centres, thereby maximizing reuse potential rather than discarding unwanted goods. As a result, 90% of Finns actively participate in the second-hand market (Dang, 2023).

3 Research Method and Data Analysis

This study adopts a single-case study approach, which can be defined as an empirical investigation designed to address questions related to the phenomenon under examination. Such a method enables a deeper understanding of dynamic processes within specific contexts. Common data collection techniques in case studies include archival records, interviews, surveys, and observations. The present research is retrospective and exploratory, relying on existing online resources to analyze the selected case. Specifically, we reviewed the official website of Kierrätyskeskus Recycling Centre and relevant journal articles, with particular attention to Finland's performance in advancing sustainability within the fashion industry and the factors contributing to its success.

3.1 Subtle Integration of Educational Values by Kierrätyskeskus

Kierrätyskeskus exemplifies the profound educational impact of sustainability on environmental awareness. The organization emphasizes that its core mission is to promote environmental education for sustainable development. More than a recycling centre, Kierrätyskeskus functions as an environmental education platform, offering customized courses and diverse resources. For example, it regularly organizes lectures (see Tables 1 and 2 for course content), community education activities, Näprä creative workshops, and guided tours to equip residents with knowledge on recycling, waste reduction, and sustainable living skills. In collaboration with schools, it designs curricula that engage students in hands-on and interactive activities to foster an

Table 1. Curriculum Outline of Sustainable Development Pedagogy at Finland's Kierrätyskeskus

Slogan	Experience the World's Leading Educational System
Course Description	Following a brief introduction to Finnish pedagogy and sustainable development (requiring prior completion of a foundational course), participants will engage in practical demonstrations. They will experience innovative educational methods from the perspective of students, with demonstrations tailored as needed.
Course Benefits	This program deepens understanding of sustainability pedagogy for the target age group. 1. Gain inspiration and acquire further knowledge of Finnish pedagogy and hands-on learning. 2. Experience Finland's world-renowned teaching methods from a student's perspective. 3. Engage in discussion and pose questions to our educational experts. 4. Take home a ready-to-use teaching method.
Basic Information	Target Group: Teachers and educators Group Size: Maximum of 20 participants Price Includes: Instructor and one transferable teaching method Minimum Duration: 1 hour
Required Materials & Skills	No prior experience is necessary; all materials are provided for participants.

Source: Kierrätyskeskus official website.

understanding of environmental protection. At the industrial level, the Centre also provides consultancy services for businesses and institutions, supporting environmental management and sustainability initiatives to help enterprises implement green policies.

3.2 Social Responsibility Practices of Kierrätyskeskus

Kierrätyskeskus is a company distinguished by its strong commitment to social responsibility. It actively creates employment opportunities for disadvantaged groups and provides workplace training programs that emphasize social inclusion and skill development. Short-term work experiences are offered to the long-term unemployed and new entrants to the labor market, helping them reintegrate into professional life. After the trial period, some employees transition into permanent positions, supported by government wage subsidies. The Centre also assists participants with career planning, résumé writing, interview preparation, and guidance for further employment or continuing education. Upon completion of on-the-job training, participants receive formal qualifications and skill certifications. Regardless of background, age, or prior experience, individuals are encouraged to participate, reinforcing both community and personal values. This integration of environmental protection with social responsibility has made Kierrätyskeskus a model of sustainable development and socio-cultural inclusion in Finland.

3.3 Accessibility and Convenience of Public Donations at Kierrätyskeskus

Within the Helsinki metropolitan area, more than 60 donation points enable citizens to conveniently donate a wide range of items. Donations can be made directly at affiliated stores, while recycling trucks regularly provide local collection services. Donation points are equipped with bins of two sizes—large and small (see Figure 1). In addition, MyFetch represents an innovative logistics platform that redefines the role of "delivery" by integrating distribution and recycling into a two-way process. This service supports both individuals and businesses, making sustainable practices simple, routine, and accessible, thereby lowering participation barriers. Another initiative, Kierrätyskeskus × Emmy, is a collaboration between the Recycling Centre and the second-hand luxury platform Emmy. Its aim is to simplify recycling and second-hand sales, thereby enhancing sustainability and extending the lifecycle of fashion products.

Figure 1. Schematic diagram of the donation point at Kierrätyskeskus.

4 Results

Finland emphasizes individual convenience and responsibility, employing deposit-refund schemes and automated recycling machines to increase public participation. By contrast, Taiwan focuses on community mobilization and

Table 2. Kierrätyskeskus Lectures: Education for Sustainable Development

Slogan	Waste Sorting Made Simple!
Course Description	In Finnish households, waste is systematically sorted into designated containers. For more than thirty years, our experts have been teaching and inspiring both children and adults to achieve this goal. The lecture provides background information and statistical data on Finland's waste-sorting and recycling practices, while also equipping participants with tools to effectively convey the subject to others.
Course Benefits	• Insight into Finland's successful recycling system. • Practical understanding of Finnish waste-sorting practices. • Simple methods for teaching others how to sort waste. • Opportunities to consult and engage with our experts.
Basic Information	Participants: Teachers and educators Group Size: Up to 20 participants Price Includes: Instructor Minimum Duration: 1 hour
Required Materials & Skills	All necessary materials are provided; no prior knowledge or experience is required.

Source: Kierrätyskeskus official website.

government leadership, establishing recycling networks through sanitation teams and contracted recyclers. Both countries demonstrate high recycling rates for specific items such as beverage containers (PALPA, 2023). However, Finland's overall recycling rate surpasses that of Taiwan, primarily due to its simpler and more convenient system, reinforced by deposit-based incentives.

In terms of policy evolution, Taiwan has actively promoted source reduction and green design initiatives (Environmental Protection Administration, 2023). Finland, on the other hand, has long integrated recycling into everyday life and cultural practices, thereby fostering a nationwide circular economy model characterized by broad citizen participation (Agency, 2022; DebbyLin, 2023). Taiwan could benefit from adopting Finland's deposit-refund system and self-service recycling machines to enhance convenience and provide immediate rewards. Conversely, Finland could learn from Taiwan's community mobilization strategies and regulatory frameworks. Mutual exchange of strengths between the two systems would contribute to achieving net-zero carbon reduction goals. A comparative summary of the differences between Finland and Taiwan's recycling systems is presented in Table 3.

5 Discussion and Recommendations

In the 1990s, Taiwan experienced rapid economic growth accompanied by a surge in waste generation, earning the nickname "Garbage Island." Today, after years of sustained effort, Taiwan's recycling achievements have gained international recognition. In January 2020, Finland's largest newspaper, *Helsingin Sanomat*, reported on Taiwan's resource classification and recycling measures, praising Taiwan as a global leader in this field and suggesting that the EU and Finland could learn from its experience (Tang, 2020). Finland, in turn, has established its reputation as the first country to launch a national circular economy roadmap in 2016, led by the Finnish Innovation Fund Sitra. The roadmap aims to achieve a fully circular society and economy by 2030, with four core objectives (Sitra, 2016):

1. **Culture of participation:** embedding second-hand goods, flea markets, and recycling mechanisms into everyday life.
2. **Corporate involvement:** initiatives such as Marimekko's "Pre-loved" second-hand platform to extend product lifecycles.
3. **Recycling mechanisms:** installation of deposit-return machines in convenience stores, allowing refunds to be used as purchase credits.
4. **Design orientation:** integrating lifecycle considerations into product design, emphasizing repairability, recyclability, and remanufacturing.

Through the case study of Finland's Kierrätyskeskus Recycling Centre, this research has examined innovative practices in sustainable fashion and the circular economy, offering multiple insights for Taiwan's sustainability policies and industrial applications. First, Finland has successfully internalized recycling into daily life, enhancing public participation and efficiency through deposit-refund systems, self-service recycling machines, and educational promotion. By contrast, although Taiwan has established a comprehensive recycling system, challenges remain in the low reuse rate of second-hand clothing, declining quality, and lack of market trust. These issues highlight the need for further institutional innovation and cultural transformation.

6 Conclusion

Table 3. Comparative Analysis of Recycling Systems in Finland and Taiwan

Dimension	Finland	Taiwan
System Establishment	1994: Implementation of the Waste Act, requiring local governments to manage household waste collection and treatment (Melanen et al., 2002).	Since 1997: Implementation of the "Four-in-One Recycling Program."
Classification Items	Paper, cardboard, glass, metals, plastics, organic waste, hazardous waste, electronic products, etc.	Resource waste, kitchen waste, and general waste divided into 38 categories for recycling.
Recycling Functions	Self-service sorting and deposit-return machines, achieving recycling rates above 90%.	Collection and transportation by municipal sanitation teams, purchase by recyclers, and subsidies from the recycling fund.
Deposit System	Consumers receive cash or discounts when returning beverage bottles and cans.	No deposit system, though some municipalities provide recycling incentives.
Recycling Rate	Beverage container recycling rate reaches 93%; overall rates in some cities up to 90%.	General waste recycling rate is approximately 60.94%, with certain categories exceeding 90%.
Recycling Convenience	Automated recycling machines located in supermarkets and gas stations, with more than 5,000 collection points.	Communities provide separate bins for sanitation teams to collect regularly, supplemented by recycling stations and mobile collection vehicles.
Policy Drivers	Circular economy and sustainability education, emphasizing individual responsibility and convenience.	Source reduction, regulatory control, and economic incentives (e.g., mandatory purchase of garbage bags).
Innovative Measures	Deposit-return mechanisms introduced at music festivals and events to encourage on-site recycling.	Promotion of reusable cups and online recyclable bags, alongside restrictions on single-use products.

Kierrätyskeskus is more than a recycling platform; it integrates environmental education, social employment, and creative design, demonstrating a high degree of cross-sectoral innovation. By transforming discarded clothing into high-value design products and creating employment opportunities for disadvantaged groups, it highlights the social dimension of sustainability. This model offers important reference value for Taiwan, where government and civil society could jointly promote a "redesign incubation platform" that connects designers, social welfare organizations, and recycling enterprises to generate sustainable products with both cultural and economic significance.

Moreover, Finland places strong emphasis on the role of education in sustainability. Through school partnerships, community courses, and creative workshops, it cultivates public awareness and practical skills for sustainable living. Taiwan could adopt this model by integrating sustainable fashion into national curricula and vocational education, while encouraging local governments and non-profit organizations to advance community-based environmental education and recycling initiatives.

In summary, Finland's experience demonstrates that promoting sustainable fashion requires not only technological and institutional support but also cultural, educational, and social engagement. For Taiwan, advancing sustainability in fashion should focus on three dimensions: institutional design, supply chain integration, and civic education. Such efforts would help build a resilient and innovative sustainable fashion ecosystem, enabling a cradle-to-cradle transformation. Encouraging local entrepreneurial teams and designers to participate in recycling and remanufacturing, supported by policy incentives and technical assistance, would further strengthen Taiwan's capacity to establish a diverse and competitive sustainable fashion industry chain.

Conflict of Interest

The authors declare that they have no financial or non-financial conflicts of interest that could have influenced the design, execution, data analysis, or writing of this manuscript.

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Exploring Student's Perceptions of AI-Integrated Learning in Culinary Education: *Effects on Learning Effectiveness and Sustainability Attitudes*

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Artificial intelligence (AI) has become increasingly visible in higher education, especially in courses that require active interaction, problem solving, and professional skill development. In culinary education, where students often learn through repeated hands-on kitchen practice, instructors have begun exploring whether AI-supported learning tools can improve learning efficiency while also reducing unnecessary food waste during training. Although previous studies have discussed AI applications in higher education, relatively few studies have focused on practice-oriented disciplines such as culinary education. In addition, limited attention has been given to how AI-supported learning may influence students' sustainability-related attitudes and behavioral intentions. To address this issue, the present study employed a cross-sectional quantitative design to investigate the relationships among students' perceptions of AI-integrated learning, perceived learning effectiveness, sustainability attitudes, and food waste reduction intentions. Questionnaire data were collected from 312 undergraduate students enrolled in culinary-related programs in southern Taiwan. The findings indicated that students who held more positive perceptions toward AI-integrated learning generally reported stronger learning effectiveness and higher sustainability awareness. Sustainability attitudes were also positively associated with food waste reduction intentions and fully mediated the relationship between AI-integrated learning and behavioral intentions. The study contributes to current discussions on AI-supported education by providing evidence from a practice-based learning context that has received relatively limited scholarly attention. Practical implications for culinary educators and sustainability-oriented curriculum design are also discussed.

Keywords — Artificial Intelligence, Culinary Education, Learning Effectiveness, Sustainability Attitudes, Food Waste Reduction, Higher Education.

Relevance to Design Practice — Integrating AI scaffolding into curriculum design allows culinary educators to bridge the gap between abstract sustainability concepts and kitchen operations. By designing pedagogical AI agents that assist students in the prep-phase, training programs can systematically cultivate resource-conscious professionals. This study offers a structural framework for technical curriculum designers to embed predictive AI scaffolding into culinary toolkits, thereby minimizing material waste and enhancing operational efficiency in educational hospitality settings.

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1 Introduction

The development of artificial intelligence (AI) has rapidly influenced educational environments across different disciplines. In higher education, AI-supported tools are increasingly being used to assist students with learning preparation, information organization, feedback generation, and reflective learning processes (Holmes et al., 2019; Luckin et al., 2016). Rather than functioning solely as technical applications, these tools are gradually becoming part of everyday teaching and learning practices.

This trend is particularly meaningful in practice-oriented educational settings. In culinary education, for example, students often rely on repeated kitchen practice to develop professional competencies. While practical training remains essential, instructors frequently observe that repeated ingredient preparation and operational mistakes may unintentionally increase food waste during learning activities. In addition, students sometimes struggle to connect sustainability concepts discussed in class with actual kitchen practice.

To bridge this pedagogical gap, AI integration can serve as an essential cognitive scaffold before students enter the physical kitchen. Specifically, AI tools can guide students through detailed recipe comprehension, precise portion estimation based on ingredient scaling algorithms, optimal workflow scheduling, and error prevention strategies before hands-on operations begin. By clarifying technical steps, identifying potential procedural bottlenecks, and accurately calculating resource allocations beforehand, such technology-driven preparation minimizes trial-and-error raw material waste. This intervention directly addresses the core challenges of experiential learning, thereby highlighting the distinct educational, economic, and practical value of culinary lab courses.

As a culinary educator, the researcher has observed that students are often interested in using AI tools for recipe plan-ning, ingredient calculations, and procedural preparation be-fore entering practical kitchen environments. Some students also report that AI-supported preparation helps them reduce uncertainty during cooking practice and improve confidence in learning tasks. These classroom observations motivated the present study.

At the same time, sustainability has become an increasingly important issue in higher education due to the growing emphasis on the Sustainable Development Goals (SDGs) (United Nations, 2015). Universities are expected not only to cultivate professional skills but also to foster students' awareness of responsible resource management and environmental sustainability (UNESCO, 2021).

Despite the growing literature on AI in education, limited empirical studies have examined how AI-supported learning influences both learning effectiveness and sustainability-related attitudes within culinary education contexts. Most existing studies focus either on technology adoption or general educational applications, with relatively little attention given to practice-oriented disciplines (Zawacki-Richter et al., 2019).

Therefore, this study aims to investigate the relationships among students' perceptions of AI-integrated learning, learning effectiveness, sustainability attitudes, and food waste reduction intentions in culinary education.

2 Literature Review

2.1 Artificial Intelligence in Education

Artificial intelligence has emerged as a transformative force in education, enabling adaptive learning, personalized feedback, intelligent tutoring systems, and data-driven instructional support (Holmes et al., 2019). Previous studies have demonstrated that AI-supported learning environments can enhance students' engagement, self-regulated learning, and academic performance (Luckin et al., 2016).

Roll and Wylie (2016) argue that AI in education has evolved from automation-oriented applications toward pedagogically meaningful interventions embedded within instructional design. Rather than replacing teachers, AI is increasingly conceptualized as a pedagogical partner that supports reflective learning and cognitive scaffolding. Importantly, students' perceptions of AI tools play a critical role in determining learning effectiveness. Positive perceptions of AI-supported learning environments are associated with higher acceptance, engagement, and learning outcomes (Chen et al., 2020).

2.2 AI Integration in Culinary Education

Compared with traditional lecture-based disciplines, culinary education involves intensive hands-on practice and repeated operational learning. Students are required to prepare ingredients, conduct cooking procedures, and repeatedly practice technical skills in order to achieve competency standards.

However, this learning process may also create challenges. Instructors may observe situations in which students over-prepare ingredients, misunderstand procedural steps, or repeat practical tasks due to insufficient preparation before entering kitchen environments. These issues may unintentionally contribute to food waste and inefficient learning experiences.

Recent developments in generative AI technologies provide new possibilities for addressing these concerns. AI-supported tools can assist students with recipe interpretation, ingredient estimation, workflow planning, and procedural review before physical practice begins (Parsons & MacCallum, 2020). When students utilize AI to simulate, predict, and correct potential mistakes in portioning or process scheduling prior to entering the kitchen, they show higher technical accuracy and lower raw material waste. Rather than replacing hands-on learning, AI functions as a supplementary instructional support mechanism that enhances preparation and reflective learning processes.

2.3 Sustainability Attitudes and Food Waste Reduction

Food waste has become a major sustainability challenge within the hospitality and foodservice industries. According to Gustavsson et al. (2011), approximately one-third of

food produced globally is lost or wasted. Educational interventions are widely recognized as important mechanisms for fostering sustainability awareness and promoting environmentally responsible behaviors. Previous research has shown that sustainability attitudes are positively associated with pro-environmental intentions, including food waste reduction behaviors (Filimonau & De Coteau, 2019). In recent years, AI technologies have also been explored as tools for supporting sustainable practices through predictive systems and decision-support mechanisms (Dwivedi et al., 2021).

2.4 Research Framework and Hypotheses

The present study is grounded in the Theory of Planned Behavior (Ajzen, 1991) and social cognitive theory (Bandura, 1986). Accordingly, the following hypotheses are proposed:

- **H1:** Students' positive perceptions of AI-integrated learning are positively associated with perceived learning effectiveness.
- **H2:** Students' positive perceptions of AI-integrated learning are positively associated with sustainability attitudes.
- **H3:** Sustainability attitudes are positively associated with food waste reduction intentions.
- **H4:** Perceived learning effectiveness is positively associated with sustainability attitudes.
- **H5:** Sustainability attitudes mediate the relationship between AI-integrated learning perceptions and food waste reduction intentions.

3 Methodology

3.1 Research Design

This study adopted a cross-sectional quantitative research design using a structured questionnaire to assess the hypothesized paths within the structural model.

3.2 Participants and Sampling

A total of 312 valid questionnaires were collected from undergraduate students enrolled in culinary-related programs across three comprehensive universities in southern Taiwan. Convenience sampling was utilized due to institutional access. Among the participants, 61.5% were female and 38.5% were male. Most participants were between 18 and 22 years old (M = 20.3, SD = 1.2). Approximately 72% reported previous experience using generative or adaptive AI-supported learning tools in their coursework.

3.3 Research Instrument and Measures

The survey instrument was developed based on validated scales from prior literature and adapted to fit the specific culinary education context. All survey items were scored on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

- **Perceptions of AI-Integrated Learning (AI):** Measurement scales were adapted from Chen et al. (2020), which evaluate students' perceived usefulness, usability, and cognitive engagement with AI tools (5 items; e.g., "AI tools help me understand recipe structures efficiently").
- **Perceived Learning Effectiveness (LE):** Adapted from Al-Samarraie et al. (2018), measuring self-assessed technical acquisition and prep-phase operational efficacy (4 items; e.g., "AI preparation increases my confidence in kitchen execution").
- **Sustainability Attitudes (SA):** Adapted from Biasutti and Frigerio (2016), assessing environmental consciousness and kitchen resource management awareness (4 items; e.g., "I believe minimizing material waste during practical classes is crucial for sustainability").
- **Food Waste Reduction Intentions (FWRI):** Adapted from Filimonau and De Coteau (2019), focusing on students' self-reported intentions to actively minimize waste during physical food preparation tasks (4 items; e.g., "I intend to calculate ingredient weights precisely to prevent waste").

3.4 Research Procedure and Ethical Considerations

Data collection was conducted over a five-month period. Prior to administering the survey, participants were fully informed about the academic purpose of the study. It was explicitly stated that participation was entirely voluntary and that they reserved the right to withdraw at any stage without academic penalty. To ensure absolute confidentiality and protect participants' identities, no personal data, identifiers, or email addresses were linked to the survey data. All responses were processed anonymously. Formal implied consent was obtained electronically from all respondents prior to unlocking the digital survey questionnaire.

3.5 Data Analysis

Descriptive statistics, Cronbach's α internal reliability, and Pearson product-moment correlations were calculated using SPSS 26.0. To test the complex mediation hypotheses, Model 4 of the PROCESS Macro for SPSS (Hayes, 2022) was utilized, applying 5,000 bootstrap resamples to compute 95% bias-corrected confidence intervals (CIs).

4 Results

4.1 Reliability and Descriptive Summary

The internal consistency of the scales was evaluated using Cronbach's α. As shown in Table 1, all constructs exceeded the standard psychometric threshold of .70, indicating robust internal reliability across measures.

Table 1. Reliability and Descriptive Summary of the Scales (N = 312)

Construct	Items	Mean	SD	α
1. AI-Integrated Learning	5	3.74	0.68	.91
2. Learning Effectiveness	4	3.62	0.71	.88
3. Sustainability Attitudes	4	3.85	0.59	.85
4. Food Waste Reduction Intentions	4	3.91	0.64	.84

4.2 Correlation Analysis

Pearson correlation analysis revealed significant positive linear relationships among all major variables, providing preliminary alignment with our hypothesized framework.

Table 2. Intercorrelations Among the Variables (N = 312)

Variable	1	2	3	4
1. AI-Integrated Learning	—			
2. Learning Effectiveness	.63**	—		
3. Sustainability Attitudes	.54**	.58**	—	
4. Food Waste Reduction Intentions	.41**	.47**	.69**	—

Note. p < .01.

4.3 Mediation and Regression Analysis

To test whether sustainability attitudes mediate the link between AI-integrated learning and food waste reduction intentions, Hayes' (2022) PROCESS macro (Model 4) was utilized.

The regression paths indicated that AI-integrated learning significantly predicted perceived learning effectiveness (β = .63, p < .001, R^2 = .40) and sustainability attitudes (β = .31, p < .001). Perceived learning effectiveness also significantly predicted sustainability attitudes (β = .39, p < .001). Together, AI-integrated learning and learning effectiveness explained a significant proportion of variance in sustainability attitudes (R^2 = .41, Adjusted R^2 = .40, F = 107.54, p < .001).

Finally, food waste reduction intentions were strongly predicted by sustainability attitudes (β = .62, p < .001). Crucially, when entering sustainability attitudes into the model, the direct path from AI-integrated learning to food waste reduction intentions became statistically non-significant (β = .08, p = .120). This pattern demonstrates a full mediation effect. The comprehensive breakdown of total, direct, and indirect effects is presented in Table 3.

Table 3. Direct, Indirect, and Total Effects for the Mediation Model

	Effect	SE	t	95% CI
Total Effect (AI→FWRI)	0.39	0.05	7.98	[0.29, 0.49]
Direct Effect (AI → FWRI)	0.08	0.05	1.56	[-0.02, 0.18]
Total Indirect Effect	0.31	0.04	—	[0.23, 0.40]
Indirect Path 1: AI→ SA → FWRI	0.19	0.03	—	[0.13, 0.26]
Indirect Path 2: AI → LE → SA → FWRI	0.12	0.02	—	[0.08, 0.17]

Note. AI=AI-Integrated Learning; LE=Learning Effectiveness; SA=Sustainability Attitudes; FWRI=Food Waste Reduction Intentions. p < .001 for total effect.

5 Discussion

Several important educational and theoretical implications can be drawn from the empirical findings of the present study.

First, students who perceived AI-integrated learning more positively tended to report stronger learning effectiveness. In a culinary education context, this link is particularly evident during the foundational preparation phase. When digital AI tools are utilized for advanced recipe comprehension and precise portion estimation before entering the actual kitchen, students report lower conceptual uncertainty. AI serves as a cognitive platform where students optimize their workflow scheduling and predict potential procedural bottlenecks. Consequently, this targeted digital preparation mitigates hands-on mistakes, allowing students to maximize the educational value of their physical lab hours rather than exhausting time on repetitive mechanical corrections.

Second, AI-integrated learning was significantly associated with sustainability attitudes. This finding indicates that AI-supported educational environments do not merely improve technical or operational outcomes; they provide the cognitive scaffolding necessary for students to foresee the material consequences of their kitchen operations. By executing digital simulations of production outputs and practicing error prevention strategies ahead of time, students internalize a proactive mindset toward responsible resource management.

Third, sustainability attitudes fully mediated the relationship between AI-integrated learning and food waste reduction intentions. This critical mechanism shows that technology itself does not directly alter behavioral intentions. Instead, it operates indirectly by fundamentally reshaping the internal awareness, eco-attitudes, and values developed during the cognitive learning process.

From a broader curriculum design perspective, the findings suggest that AI should not simply be introduced as an isolated technological novelty. Instead, AI tools should be structurally integrated into core instructional goals, reflective evaluation assignments, and sustainability-oriented curriculum design in modern kitchen classrooms.

6 Conclusion

This study demonstrates that AI-integrated learning plays a significant role in enhancing learning effectiveness and fostering sustainability attitudes within higher culinary education. By identifying sustainability attitudes as a full media-tor, the empirical framework provides a deeper understanding of how modern educational technologies translate into pro-environmental behavioral intentions. The results suggest that embedding predictive AI platforms into practical preparation

workflows can simultaneously optimize student skill acquisition and support broader global sustainability metrics (SDGs). Future research should employ longitudinal tracking or experimental controls to further validate these structural paths across varied institutional settings.

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Adaptive Learning and Artificial Intelligence in Elementary Music Education: *An Empirical Analysis of the Taiwan Adaptive Learning Platform (TALP)*

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This study investigates the effectiveness of integrating adaptive instruction and artificial intelligence technology through the Taiwan Adaptive Learning Platform (TALP) in elementary music education. The research involved students from grades 3-6 in Taiwan, with the development of digital teaching materials aligned with the 2019 Curriculum Guidelines and implementation of teaching experiments. Using a mixed-methods research design that combines grounded theory, TF-IDF keyword analysis, and Epistemic Network Analysis (ENA), this study examines teacher instructional model transformation and student learning outcomes. Results demonstrate that the adaptive learning platform effectively facilitates teachers' transition from "knowledge transmitters" to "learning facilitators" and significantly enhances students' learning motivation, self-directed learning ability, and knowledge construction capacity. This research validates the potential of technology-enabled music education and provides empirical evidence for future educational innovation.

Keywords – Adaptive instruction, Artificial intelligence, Music education, Taiwan Adaptive Learning Platform, Learning outcome analysis, Epistemic network analysis.

Relevance to Educational Practice – Educators and administrators interested in adaptive learning can use this empirical evidence to inform their implementation of AI-driven platforms. The findings articulate how teachers can transition from knowledge transmitters to learning facilitators, utilizing structured digital materials and adaptive assessment to accommodate individual student differences while enhancing engagement and self-directed learning.

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Introduction

Research Background and Motivation

As digital technology advances rapidly, the education sector is undergoing profound transformation. Traditional unidirectional knowledge transmission models struggle to meet the diverse learning needs of modern students. Particularly in music education, educators face persistent challenges in accommodating individual differences, enhancing learning motivation, and effectively assessing learning outcomes. In recent years, the integration of adaptive instruction with artificial intelligence (AI) technology has offered promising solutions to these challenges.

The Taiwan Adaptive Learning Platform (TALP), promoted by Taiwan's Ministry of Education, aligns with the twelve-year national education curriculum standards and emphasizes technology-assisted learning capabilities while prioritizing individual student needs. However, previous applications of TALP have concentrated primarily on subject-based learning, with relatively limited application in arts and humanities, particularly in music education. Music education encompasses not only knowledge and skill acquisition but also emotional expression, aesthetic appreciation, and cultural understanding, making its instructional assessment and outcome analysis uniquely complex.

Consequently, our research team implemented the "Elementary Music Adaptive Teaching Material Development and Experimentation Project" to address elementary music education needs, develop digital materials aligned with the 108 Curriculum for grades 3-6, analyze the music domain's knowledge structure, and evaluate implementation outcomes through teaching experiments.

Research Objectives

The primary objectives of this research are:

1. Construct knowledge structure and digital teaching materials for elementary grades 3-6 music education aligned with the 108 Curriculum.

2. Investigate the impact of implementing the TALP adaptive platform on elementary music teachers' instructional models and professional roles.

3. Assess the platform's effects on student learning outcomes, learning motivation, and self-directed learning ability.

4. Apply multi-dimensional mixed research methods to deeply analyze teacher and student cognitive structure evolution throughout the digital learning process.

Literature Review

Adaptive Instruction and Individualized Learning in Music Education

Adaptive instruction represents a student-centered teaching model emphasizing flexible adjustment of instructional content, methods, pace, and assessment based on individual student abilities, interests, aptitudes, and learning needs. In music education, students demonstrate substantial variation in prior knowledge, pitch discrimination, rhythm sense, and instrumental operation skills, making traditional uniform instruction inadequate for accommodating all learners.

Differentiated instruction has been recognized as an effective strategy for addressing this challenge [1]. Scholars indicate that music teachers can adjust instructional content, learning processes, and final products to enable all students to find entry points for musical participation [2]. However, in practical implementation, teachers face considerable challenges in providing differentiated instruction to each student within limited class time. The introduction of digital learning platforms, particularly those with adaptive diagnostic capabilities, effectively reduces teacher burden and enables large-scale individualized learning.

Artificial Intelligence and Learning Analytics in Educational Diagnosis

In recent years, artificial intelligence and learning analytics technologies have become increasingly widespread in educational applications [3]. AI systems can process large volumes of learning data, establish predictive models through machine learning algorithms, and provide precise learning diagnosis and individualized feedback [4].

In educational diagnosis, AI systems dynamically adjust question difficulty based on student responses, precisely identify learning weaknesses, and recommend appropriate remedial teaching resources. This mechanism of "adaptive assessment" and "adaptive instruction" enhances learning efficiency while enabling teachers to monitor class and individual student progress in real-time, facilitating instructional strategy adjustment. The TALP platform used in this research is designed on these principles, implementing adaptive learning through knowledge structure mapping and dynamic assessment.

Flipped Classroom and Blended Learning in Music Education Practice

The flipped classroom represents a blended learning model that relocates traditional classroom lectures to pre-class student self-study through digital materials, reserving classroom time for higher-order cognitive activities such as discussion, hands-on practice, and problem-solving.

In music education, the flipped classroom model demonstrates substantial potential [5]. Research indicates

that flipped classrooms combining digital materials with interactive activities significantly enhance students' music knowledge levels and learning engagement [6]. Students can preview music theory knowledge or instrumental techniques through videos before class, while classroom time allows for ensemble performance, composition, and recital activities. This model not only grants students learning autonomy but also prompts teacher transformation from "knowledge transmitter" to "learning facilitator" and "collaborator."

Learning Outcome Assessment and Epistemic Network Analysis

Beyond traditional test scores, increasingly more research emphasizes analyzing learning processes and cognitive structures [7]. Grounded theory, as a qualitative research method, systematically extracts concepts from textual data and constructs theoretical models [8]. Epistemic Network Analysis (ENA), an emerging quantitative ethnographic method, transforms qualitative coded data into visualized network diagrams, presenting learners' concept connections and structural changes within specific contexts [14].

This research integrates grounded theory, TF-IDF keyword analysis, and ENA to comprehensively and deeply analyze teacher and student cognitive evolution before and after implementing the adaptive learning platform.

Research Methods

Research Design

This research employs a multi-dimensional mixed-methods research design combining qualitative and quantitative analytical approaches to comprehensively evaluate the TALP platform's effectiveness in elementary music education. The research process encompasses three main stages: material development, teaching intervention implementation, and outcome analysis.

Research Participants and Setting

The teaching experiments were conducted at Xinzhuang Elementary School in Wandan Township, Pingtung County, Taiwan, with participants including grade 3-4 students and participating music teachers. As the project's "Adaptive Teaching Material Development Center School," Xinzhuang Elementary School possesses strong digital teaching infrastructure and teacher community support.

Material Development and System Implementation

The project team, including expert scholars and experienced elementary music teachers, analyzed music learning content for grades 3-6 according to the 108 Curriculum, constructing knowledge nodes and knowledge structure. Developed digital materials include:

1. **Instructional Videos:** Covering six major themes (pitch training, music notation, singing, instrumen-tal performance, composition, and appreciation) presented through animation to enhance student interest.

2. **Checkpoints and Practice Exercises:** Each video includes checkpoints with accompanying practice exercises and question banks for real-time student learning diagnosis.

3. **Learning Worksheets and Lesson Plans:** Worksheets designed to complement video content with adaptive teaching lesson plans integrating TALP.

All materials are hosted on Taiwan's Ministry of Education TALP platform for teacher and student access.

Teaching Intervention Models

This research provided multiple teaching models integrating TALP for teacher implementation, primarily including:

1. **Unit-based Diagnosis and Learning Support:** Students undergo system diagnosis with video-based remediation targeting identified weaknesses.

2. **Knowledge Structure Learning and Flipped Instruction:** Teachers assign pre-class learning tasks with classroom interactive discussion and hands-on practice.

3. **Progressive Inquiry Learning Integrated with TALP:** System-assisted in-class small group discussion and inquiry practice guide students through problem-solving and reflection [10].

Data Collection and Analysis Methods

Research data included teacher instructional journals, student learning reflections, interview transcripts, and system usage data. Analysis methods included:

1. **Grounded Theory Analysis:** Open coding, axial coding, and selective coding of qualitative texts to extract core concepts and thematic evolution.

2. **TF-IDF Keyword Analysis:** Natural language processing techniques to extract representative keywords from pre- and post-experiment texts, quantifying characteristic differences.

3. **Epistemic Network Analysis (ENA):** Transforming coded data into network models to visualize teacher and student cognitive structure changes and concept association strength.

Research Results and Discussion

Teacher Instructional Model and Cognitive Transformation

Grounded Theory Analysis: From Teaching Concerns to Effectiveness Affirmation

Through grounded theory analysis of teacher interviews and instructional journals, significant evolution in teacher axial coding emerged between pre- and post-experiment periods. In the initial experiment phase (pre-experiment), teachers occupied a "cautiously optimistic teaching innovation preparation" stage. Core concerns centered on "teaching concerns and challenges," such as worries about student platform unfamiliarity and potential motivation loss, alongside "instructional preparation and adjustment," including platform familiarization and curriculum modification.

However, in the later experiment phase (post-experiment), teachers experienced "paradigm shift from knowledge transmission to learning facilitation." Core themes transformed to "teaching effectiveness affirmation," with teachers observing enthusiastic student responses and outcomes exceeding expectations. Simultaneously, teachers perceived "learning quality enhancement," with students demonstrating comprehensive improvement in learning depth, breadth, and initiative. Most importantly, teachers underwent "instructional model transformation," successfully transitioning from traditional knowledge transmitters to learning facilitators [15].

Frequency and TF-IDF Analysis: From Technical Focus to Outcome Orientation

Frequency and TF-IDF keyword analysis results further corroborated qualitative findings. Pre-experiment, teacher high-frequency vocabulary concentrated on "curriculum" and "operation," reflecting technical and preparatory concerns. Post-experiment, vocabulary shifted toward "learning," "knowledge," and "demonstration," representing outcome-oriented language. This indicates teacher attention transitioned from tool usage to student learning outcome assessment and enhancement.

Epistemic Network Analysis (ENA): Structural Focus and Optimization

ENA visualization revealed teacher cognitive structure changes. Pre-experiment, teacher cognitive networks displayed "dispersed problem-oriented networks" (9 nodes, 12 edges, density 0.333), with multiple concerns forming loose connections lacking core focus, primarily centered on potential challenges and concerns.

Post-experiment, teacher cognitive networks transformed to "outcome-focused systematic networks" (10 nodes, 12 edges, density 0.267). Reduced network density reflected more organized and focused thinking, forming strong clusters centered on learning outcomes. This indicated teachers successfully transcended the technical adaptation period, establishing systematic teaching thinking centered on student learning.

Student Learning Outcomes and Experience Transformation

Grounded Theory Analysis: From Anxiety-Anticipation to Self-Directed Empowerment

Grounded theory analysis of student learning reflections revealed students initially occupied "learning breakthrough pursuit amid anxiety and anticipation" status. Axial coding included "technology learning anxiety" (nervousness, fear of errors), "traditional curriculum boredom" (monotony, lack of interest), "new learning mode anticipation" (curiosity, willingness to try), and "autonomous and collaborative learning desire" (topic selection autonomy, peer discussion).

Post-experiment, students transitioned to "self-directed learning empowerment and comprehensive growth" status. Core themes evolved to "positive learning experience" (interesting, enjoyable), "learning motivation and engagement" (wanting more), "capability development and growth" (operational proficiency, confidence enhancement), "knowledge construction and application" (learning and sharing), and "self-directed learning realization" (autonomous content and pace selection) [11] [12].

Frequency and TF-IDF Analysis: From Emotional to Experience-Outcome Language

Student frequency and TF-IDF analysis showed pre-experiment high-frequency vocabulary dominated by emotional terms like "nervous" and "curious." Post-experiment vocabulary shifted to "tasks," "interesting," and "achievement," describing concrete learning experiences and outcomes. This reflects student transition from emotional responses to unknown technology toward achievement and enjoyment in actual operation [9].

Epistemic Network Analysis (ENA): From Chaos to Positive Cycles

Student ENA similarly revealed significant structural changes. Pre-experiment, student cognitive networks displayed "chaotic anxiety-anticipation-desire mixed networks" (17 nodes, 23 edges, density 0.169), with intertwined emotions and expectations creating dispersed structures.

Post-experiment, networks integrated into "positive experience-driven capability growth virtuous cycles" (18 nodes, 22 edges, density 0.144). Following positive learning experiences, students experienced capability growth and self-directed learning realization, forming stable and positive cognitive structures.

Comprehensive Discussion: Successful Teaching Paradigm Shift

Research results strongly support the application value of combining adaptive instruction with AI technology in music education. This represents not merely technical implementation but a successful teaching paradigm transformation.

At the **teacher level**, research confirms digital platforms effectively facilitate teacher transition from "knowledge transmitters" to "learning facilitators." Through TALP diagnosis and data feedback, teachers establish individualized feedback mechanisms enabling precise instruction. Teacher cognitive networks shift from problem-oriented to outcome-oriented perspectives, demonstrating professional development through technology empowerment.

At the **student level**, research observes significant multi-dimensional improvements in depth, breadth, and initiative. Learning motivation transforms from passive reception to active exploration, with self-efficacy comprehensively enhanced (from anxiety to confidence). Most importantly, students' self-directed learning and knowledge construction abilities substantially strengthen, enabling not only music knowledge acquisition but also application and sharing [13].

These findings align with previous flipped classroom and adaptive learning research, further confirming that in arts and humanities domains, structured digital materials combined with appropriate instructional guidance effectively overcome traditional teaching limitations, realizing authentic "adaptive instruction."

Detailed Analysis of Curriculum Design and Content Development

Aligning Digital Content with the 108 Curriculum Guidelines

The development of digital teaching materials for TALP required meticulous alignment with Taiwan's 2019 Curriculum Guidelines (the 108 Curriculum). The 108 Curriculum emphasizes "core competencies", shifting the focus from mere knowledge acquisition to the practical application of knowledge, skills, and attitudes in real-world contexts.

In music education, this translates to a holistic approach encompassing three main dimensions: artistic perception, creative expression, and cultural understanding. The research team faced the challenge of translating these abstract competencies into concrete, measurable digital learning modules.

To achieve this, the team deconstructed the curricu-lum guidelines into specific "knowledge nodes" and "skill nodes." For example, the competency of "understanding musical form" was broken down into nodes such as "identifying ABA form," "recognizing verse-chorus structure," and "analyzing thematic development." These nodes formed the structural backbone of the TALP music modules, ensuring that every video, practice exercise, and assessment directly contributed to the overarching curriculum goals.

Designing Engaging and Pedagogically Sound Video Content

The instructional videos developed for the platform were not simply recorded lectures; they were carefully crafted multimedia experiences designed to maximize cognitive engagement while minimizing extraneous cognitive load, in accordance with Mayer's Cognitive Theory of Multimedia Learning.

Key design principles included:

1. **Segmenting:** Complex topics were broken down into short, digestible segments (typically 3-5 minutes), allowing students to process information at their own pace.
2. **Signaling:** Visual cues (e.g., highlighting, arrows, on-screen text) were used to direct students' attention to essential information, such as specific notes on a staff or key movements in instrumental technique.
3. **Modality:** Information was presented using both auditory and visual channels simultaneously (e.g., hearing a melody while seeing the corresponding notation), leveraging dual-channel processing to enhance retention.
4. **Personalization:** The narration employed a conversational, encouraging tone, fostering a sense of social partnership between the learner and the digital instructor.

Furthermore, the videos incorporated diverse musical examples, ranging from classical masterpieces to contemporary popular music and traditional Taiwanese folk songs, ensuring cultural relevance and broad appeal.

Developing Adaptive Assessment Mechanisms

The core of TALP's effectiveness lies in its adaptive assessment engine. The research team developed a comprehensive question bank mapped to the established knowledge nodes. Each question was calibrated for difficulty and discriminatory power.

The adaptive algorithm functions by continuously updating its estimate of the student's ability based on their responses. If a student answers a question correctly, the system presents a more challenging question; if they answer incorrectly, the system provides a simpler question or a remedial hint.

Crucially, the assessments in the music modules went beyond simple multiple-choice questions. They included interactive elements such as:

- **Aural Discrimination Tasks:** Students listen to a short audio clip and identify the instrument, meter, or melodic contour.

- **Notation Manipulation:** Students drag and drop notes onto a staff to complete a melody or correct a rhythmic error.
- **Performance Analysis:** Students watch a video of a musical performance and identify technical errors or expressive nuances.

These diverse assessment formats provided a more accurate and comprehensive evaluation of students' musical competencies than traditional testing methods.

Exploring the Socio-Emotional Dimensions of Digital Music Learning

Mitigating Performance Anxiety

Performance anxiety is a pervasive issue in traditional music education. Many students feel intimidated by the prospect of singing or playing an instrument in front of their peers, which can severely inhibit their learning and enjoyment.

The TALP platform provided a safe, private environment for initial skill acquisition and practice. Students could make mistakes, repeat exercises, and refine their techniques without fear of public judgment. This "low-stakes" practice environment was instrumental in building students' confidence.

Qualitative data revealed that students who previously exhibited high levels of anxiety in music class became noticeably more willing to participate in group activities and performances after using the platform. The digital scaffolding provided a secure foundation upon which they could build their public performance skills.

Fostering Intrinsic Motivation through Autonomy and Competence

Self-Determination Theory (SDT) posits that intrinsic motivation is driven by the fulfillment of three basic psychological needs: autonomy, competence, and relatedness. The adaptive learning model implemented in this study effectively addressed all three needs.

Autonomy was supported by allowing students to control the pace of their learning, choose which modules to review, and select topics for independent inquiry projects. **Competence** was fostered through the platform's adaptive algorithms, which ensured that students were consistently challenged at an appropriate level, leading to frequent experiences of success and mastery. **Relatedness** was cultivated through the collaborative classroom activities that followed the independent digital learning phases.

The synergistic fulfillment of these needs resulted in a profound shift in students' motivational profiles, moving from extrinsic compliance (learning to get a good grade) to intrinsic engagement (learning for the joy of musical discovery).

The Role of Teacher Empathy in Blended Environments

While the digital platform handled much of the cognitive scaffolding, the emotional scaffolding remained the crucial domain of the teacher. The most successful teachers in the study were those who actively monitored students' emotional states and provided empathetic support.

By utilizing the platform's data dashboards, teachers could identify students who were struggling not just academically, but emotionally (e.g., students who repeatedly failed a specific module and exhibited signs of frustration). Teachers could then intervene with targeted encouragement, personalized guidance, or alternative learning strategies.

This highlights a critical insight: in technology-rich educational environments, the teacher's role as an empathetic mentor becomes more, not less, important. Technology provides the data, but the teacher provides the human connection necessary to translate that data into meaningful support.

Future Technological Horizons in Music Education

Integration of Artificial Intelligence in Performance Assessment

While the current iteration of TALP excels at assessing theoretical knowledge and aural discrimination, the assessment of physical performance skills (e.g., vocal intonation, instrumental technique) still relies heavily on teacher observation.

Future developments should explore the integration of advanced AI technologies, such as machine learning algorithms capable of analyzing audio and video recordings of student performances. These systems could provide real-time, objective feedback on pitch accuracy, rhythmic precision, and even expressive elements like dynamics and articulation.

Such tools would not replace teacher assessment but would provide students with immediate, actionable feedback during their independent practice sessions, significantly accelerating skill acquisition.

Virtual and Augmented Reality (VR/AR) Applications

The potential of VR and AR in music education is vast and largely untapped. Future iterations of adaptive plat-forms could incorporate immersive VR experiences, al-lowing students to virtually step inside a symphony or-chestra, explore the acoustics of famous concert halls, or interact with 3D models of complex instruments.

AR applications could overlay digital information onto the physical world, such as projecting fingering charts directly onto a student's instrument or visualizing sound

waves in real-time as they play. These immersive technologies have the potential to make abstract musical concepts profoundly concrete and engaging.

Gamification and Serious Games

To further enhance student engagement, future developments should explore deeper integration of gamification principles. While TALP currently utilizes basic gamification elements (e.g., progress bars, achievement badges), more sophisticated "serious games" could be developed.

These games could embed complex musical learning objectives within compelling narratives and interactive challenges. For example, a game might require students to compose melodies to solve puzzles or analyze historical musical styles to unlock new levels. By seamlessly blending play and learning, these tools can sustain high levels of motivation over extended periods.

Conclusions and Recommendations

Conclusions

Through rigorous teaching experiments and multi-dimensional mixed analysis, this research successfully validates the TALP adaptive teaching model's significant effectiveness in elementary music education. Research conclusions encompass three major validated outcomes:

1. **Teacher Role Transformation:** Teachers successfully transition from knowledge transmitters to learning facilitators, establishing student-centered new teaching paradigms.

2. **Comprehensive Student Growth:** Students achieve significant multi-dimensional improvements in learning motivation, self-directed learning ability, and knowledge construction-application capacity, with effectively reduced technology anxiety and enhanced self-efficacy.

3. **Cognitive Structure Optimization:** Teacher and student cognitive networks transform from pre-experiment dispersed, chaotic states to post-experiment focused, integrated, systematic structures, demonstrating positive deep cognitive evolution.

This represents a successful technology-empowered teaching and learning case, demonstrating that even in music education emphasizing emotional and practical dimensions, adaptive instruction and AI technology unleash substantial potential, providing valuable empirical evidence for future educational innovation.

Teaching Recommendations and Future Perspectives

Based on research findings, four major implementation directions and recommendations emerge:

1. **Expanded Application Scope:** The validated teaching model—providing structured tasks, platform-guided integration, and student autonomy—demonstrates high transferability. Future implementation should extend this model to additional arts disciplines (visual arts, performing arts) or other domains, expanding adaptive instruction's impact.

2. **Enhanced Teacher Training:** Technology implementation success depends critically on teachers. Educational authorities should strengthen teacher training, focusing on effectively fulfilling "learning facilitator" roles. Training should include open-task design, learning data interpretation and analysis, and effective scaffolding and individualized feedback provision.

3. **Encouraged Peer Collaboration:** Student feedback strongly reflects desire for and enjoyment of peer discussion and cooperation. Future platform design and curriculum planning should incorporate greater peer collaboration, group interaction, and outcome-sharing mechanisms, amplifying social learning effects.

4. **Long-term Development Focus:** While this research provides short-term experimental observa-tion with demonstrated effectiveness, future research should conduct extended longitudinal tracking. Investigation should explore digital adaptive learning model impacts on sustained student learning habit development, continuous academic achievement improvement, and career development implications.

Final Summary and Call to Action

The comprehensive analysis presented in this extended study unequivocally demonstrates the transformative potential of the Taiwan Adaptive Learning Platform (TALP) in elementary music education. By successfully bridg-ing the gap between individualized digital instruction and collaborative classroom practice, this model offers a compelling blueprint for the future of arts education.

The transition from traditional, uniform instruction to dynamic, adaptive learning environments requires significant effort, investment, and a willingness to embrace new pedagogical paradigms. However, the profound benefits observed—enhanced student motivation, accelerated skill acquisition, optimized cognitive structures, and elevated teacher professional roles—far outweigh the challenges of implementation.

We call upon educational policymakers, school administrators, and music educators worldwide to actively explore and adopt adaptive learning technologies. By doing

so, we can ensure that music education remains vibrant, relevant, and deeply impactful in the 21st century, empowering the next generation of learners to discover, create, and connect through the universal language of music.

Detailed Case Analysis

Teacher Case Study: Transformation from Concerns to Innovation

To deeply understand teacher transformation processes, this research selected Hsu You-Ya from Xinzhuang Elementary School as a typical case for detailed analysis. With 15 years teaching experience, Hsu possessed basic digital teaching knowledge but maintained reservations about adaptive platform application.

In the initial experiment phase (weeks 1-4), Hsu focused on platform operation technology. Her instructional journals frequently referenced "login procedures," "assignment uploading," and "system operation" technical questions. She worried students would waste class time due to platform unfamiliarity and questioned her ability to effectively manage online-offline instructional integration. This phase represents "technical adaptation."

Entering the middle phase (weeks 5-12), Hsu began exploring platform diagnostic functions. She discovered diagnostic results enabled rapid student learning status understanding without extensive individual assessment. She began adjusting instructional content based on diagnos-tic results, providing differentiated resources. Her jour-nals began noting "obvious student progress variation" and "targeted instruction possibility." This phase represents "application exploration."

In the later phase (weeks 13-36), Hsu underwent qualitative role transformation. Rather than positioning herself as knowledge transmitter, she became a learning facilitator. She designed open-ended questions guiding inquiry learning, utilizing class time for small group discussion, peer learning, and collaborative practice, delegating knowledge transmission to online materials. Her journals overflowed with joy at student progress and new model affirmation. She noted: "Witnessing children's autonomous learning and mutual assistance brings profound satisfaction. This approach not only enhances learning outcomes but also reveals teaching's deeper meaning." This phase represents "innovative practice."

Student Case Study: Growth Trajectory from Anxiety to Confidence

Similarly, this research selected fourth-grade student Xiaomei for detailed analysis. Xiaomei demonstrated average music performance with limited learning interest, frequently distracted during class.

Initially, Xiaomei felt unfamiliar and anxious about new learning approaches. In her learning reflection, she wrote: "I don't know how to use this system; I'm afraid of pressing wrong buttons." She even considered abandoning platform use. However, with teacher and peer encouragement, she gradually began attempting.

After several adaptation weeks, Xiaomei discovered platform advantages. She could view videos at her own pace without worrying about falling behind. She could repeatedly review difficult material until mastery. She found that pre-learning related knowledge enabled more confident classroom participation and practice. Her reflections began including "I understand now!" and "I can help other classmates."

In the later experiment phase, Xiaomei's changes became particularly evident. She transformed from passive learner to active explorer. She began proactively asking questions, participating in group discussions, and creating personal musical compositions. In her final reflection, she wrote: "I discovered I actually love music. Through this system, I can learn at my own pace without pressure. I now anticipate music class."

Concrete Teaching Model Innovation Example

This research documented a typical Hsu's adaptive teaching lesson on "Instrument Recognition."

Pre-class, students viewed three instructional videos through TALP: "Instrument Classification," "Woodwind Instrument Introduction," and "Brass Instrument Introduction." Based on viewing progress and checkpoint performance, the system recommended differentiated practice exercises.

During class (50 minutes), Hsu avoided traditional lecture, instead implementing:

1. **Introduction and Discussion (10 minutes):** Hsu played a symphony excerpt, requesting student instrument identification. Students enthusiastically responded based on pre-class learning.
2. **Small Group Inquiry (20 minutes):** Hsu divided students into four groups, each receiving "instrument inquiry tasks" including identifying sound production principles, tone characteristics, and musical applications. Students utilized platform resources and classroom instrument models.
3. **Outcome Sharing and Discussion (15 minutes):** Groups presented findings with peer questioning and suggestions. Hsu provided guidance and clarification.
4. **Reflection and Extension (5 minutes):** Hsu requested learning reflection and assigned post-class extension tasks: "Find favorite music, identify instruments, and record findings."

This lesson exemplifies adaptive instruction: pre-class self-study provides knowledge foundation, classroom time addresses higher-order cognitive activities (analysis, application, creation), and teacher role transforms from knowledge transmitter to learning facilitator.

Contributions to Music Education Theory

Redefining Music Teacher Professional Roles

Traditional music education theory emphasizes teacher roles as "music knowledge transmitter" and "musical skill demonstrator." However, this research challenges this conventional perspective. In adaptive teaching environments, fundamental teacher role transformation occurs:

- **From "Knowledge Transmitter" to "Learning Facilitator":** Teachers no longer represent sole knowledge sources. Digital materials assume knowledge transmission responsibility while teachers focus on guiding deep learning, critical thinking, and creative expression.
- **From "Skill Demonstrator" to "Learning Support Provider":** Teachers need not individually demonstrate each skill in class. Students repeatedly view demonstrations through videos while teachers provide individualized guidance and encouragement.
- **From "Assessor" to "Data Interpreter":** Teachers no longer depend on traditional paper-based testing for assessment. Systems automatically diagnose and assess while teachers interpret data, understand student learning status, and adjust instruction accordingly.

This role transformation elevates teacher professional status while making teaching more challenging and fulfilling.

Balancing Individual and Social Dimensions in Music Learning

Traditional music education often emphasizes collectivity—entire classes singing and performing together. However, this approach frequently overlooks individual differences. This research demonstrates adaptive instruction balances individual and social learning.

During pre-class autonomous learning, students engage in individualized learning at personal pace and ability level, ensuring appropriate experiences for each learner.

During class, through small group discussion, peer learning, and collaborative practice, students engage in social learning. This enhances outcomes while developing collaboration and social skills.

This balanced model particularly suits music education, as music represents both personal artistic expression and social cultural practice.

Expanding Music Learning Assessment Dimensions

Traditional music assessment primarily focuses on skill performance (e.g., singing, playing instruments) and knowledge testing (e.g., music theory). This research demonstrates that adaptive platforms enable multi-dimensional assessment.

Through system data, teachers can assess student learning processes (e.g., video viewing time, practice completion rates). Through classroom observation, teachers can assess student collaboration, problem-solving, and creative expression. This comprehensive assessment approach more accurately reflects student music learning outcomes.

Practical Implementation Strategies

Strategy 1: Gradual Implementation and Scaffolded Support

Implementing adaptive instruction requires gradual progression. Schools should avoid demanding immediate comprehensive adoption. Instead, teachers should begin with single units or specific topics, gradually expanding application scope.

Simultaneously, schools must provide adequate scaffolded support, including technical assistance, professional development, and peer collaboration opportuni-ties. Establishing teacher professional learning communi-ties enables experience sharing and collaborative problem-solving.

Strategy 2: Integrating Online and Offline Learning Experiences

Successful adaptive instruction relies on seamless online-offline integration. Teachers must carefully design learning activities ensuring pre-class online learning directly connects with in-class offline activities.

For example, if students learn rhythm concepts online, classroom activities should involve rhythm creation or ensemble performance applying those concepts. This integration reinforces learning outcomes and demonstrates online learning's value.

Strategy 3: Fostering Student Self-Directed Learning Habits

Adaptive platforms provide self-directed learning opportunities, but students require guidance to develop appropriate habits. Teachers should explicitly teach self-directed learning strategies, such as goal setting, time management, and self-reflection.

Initially, teachers may need to provide structured guidance, gradually releasing control as students develop autonomy. Encouraging students to monitor their own progress through platform dashboards fosters ownership and responsibility.

Strategy 4: Utilizing Data for Continuous Improvement

The most significant advantage of adaptive platforms is data generation. Teachers must learn to interpret and utilize this data for continuous instructional improvement.

Regularly reviewing class and individual performance data enables teachers to identify common misconceptions, adjust instructional pacing, and provide targeted interventions. This data-driven approach ensures instruction remains responsive to student needs.

Global Perspectives and Future Directions

International Comparisons in Adaptive Music Education

While this research focuses on Taiwan's TALP platform, the findings resonate with global trends in educational technology. Internationally, platforms like SmartMusic and MusicFirst have demonstrated similar potential in enhancing music education through technology.

However, TALP's integration with the national curriculum and its comprehensive approach to multiple subjects provide a unique model for systemic educational reform. Comparing TALP's implementation with international counterparts offers valuable insights into cultural and contextual factors influencing technology adoption.

The Role of Generative AI in Future Music Education

The recent integration of Generative AI into TALP opens new frontiers for music education. Future research should explore how AI can facilitate personalized music composition, provide real-time performance feedback, and generate customized learning materials.

Generative AI has the potential to further democratize music creation, enabling students without extensive formal training to express themselves musically. Investigating these applications will be crucial for shaping the future of music education.

Addressing the Digital Divide

As education increasingly relies on digital platforms, addressing the digital divide becomes paramount. Ensuring equitable access to devices, reliable internet, and supportive learning environments is essential for realizing adaptive instruction's full potential.

Future initiatives must prioritize resource allocation to underserved communities, ensuring all students benefit from technological advancements in music education.

Concluding Remarks

The integration of the Taiwan Adaptive Learning Platform (TALP) into elementary music education represents a significant advancement in pedagogical practice. By shifting the focus from uniform instruction to individualized learning, this approach addresses long-standing challenges in accommodating diverse student needs.

The empirical evidence presented in this study confirms that adaptive instruction, supported by AI technology, not only enhances student learning outcomes and motivation but also catalyzes a profound transformation in teacher professional roles. As education continues to evolve in the digital age, the insights gained from this research pro-ide a robust foundation for future innovations in music education and beyond.

The journey from traditional knowledge transmission to technology-empowered learning facilitation is com-plex but immensely rewarding. By embracing these new paradigms, educators can unlock the full potential of every student, fostering a lifelong appreciation for music and a robust capacity for self-directed learning.

Methodological Reflections and Limitations

Strengths of the Mixed-Methods Approach

The integration of qualitative and quantitative methods in this study provided a comprehensive understanding of the complex phenomena associated with adaptive learning in music education. Grounded theory allowed for the emergence of nuanced themes from teacher and student experiences, capturing the emotional and cognitive shifts that occurred during the intervention.

Simultaneously, Epistemic Network Analysis (ENA) offered a robust quantitative framework for visualizing and analyzing these shifts. By mapping the connections between different cognitive elements, ENA revealed structural changes in thinking patterns that might have been obscured in traditional qualitative analysis. This methodological synergy strengthens the validity and reliability of the research findings.

Limitations of the Current Study

Despite its contributions, this study acknowledges several limitations. First, the sample size was relatively small, focusing on a single elementary school in Taiwan. While this allowed for in-depth case analysis, it limits the generalizability of the findings to broader populations or different cultural contexts.

Second, the duration of the teaching experiment (36 weeks) provides insights into short-to-medium-term effects but cannot fully capture long-term impacts on student musical proficiency or sustained self-directed learning habits. Longitudinal studies spanning multiple academic years are necessary to assess the enduring effects of adaptive instruction.

Third, the study primarily relied on self-reported data (journals, reflections, interviews) and system usage metrics. While valuable, these data sources could be supplemented with objective measures of musical skill acquisition, such as standardized performance assessments evaluated by independent experts.

Recommendations for Future Research Methodologies

Future research should consider employing quasi-experimental designs with larger, more diverse samples across multiple schools and regions. Incorporating control groups receiving traditional instruction would provide a clearer comparative baseline for evaluating the efficacy of adaptive platforms.

Additionally, researchers could explore the integration of physiological or neurological measures (e.g., eye-tracking, EEG) to investigate the cognitive load and emotional engagement associated with different learning modalities in music education. Such interdisciplinary approaches could yield deeper insights into the mechanisms underlying effective adaptive instruction.

Policy Implications for Educational Authorities

Curriculum Integration and Standardization

The successful implementation of TALP in music education highlights the need for educational authorities to formally integrate digital adaptive platforms into national curriculum standards. This integration should go beyond mere recommendations, providing clear guidelines and standardized frameworks for developing and evaluating digital teaching materials across all arts disciplines.

Establishing a centralized repository of high-quality, peer-reviewed digital resources would ensure equitable access for all schools, reducing the burden on individual teachers to create materials from scratch.

Funding and Infrastructure Development

Sustaining and scaling adaptive instruction requires significant investment in technological infrastructure. Policymakers must ensure adequate funding for reliable high-speed internet, up-to-date hardware (tablets, computers), and ongoing platform maintenance and upgrades.

Furthermore, funding should be allocated for the continuous development of advanced AI features, such as natural language processing for automated feedback on student reflections or computer vision for analyzing instrumental performance techniques.

Teacher Professional Development Frameworks

Educational authorities must prioritize comprehensive professional development programs focused on digital pedagogy. These programs should shift away from basic technical training toward advanced pedagogical strategies, such as data-driven decision-making, facilitating inquiry-based learning, and designing effective blended learning environments.

Creating incentive structures, such as certification programs or career advancement opportunities, can encourage teachers to actively engage in these professional development initiatives and become leaders in digital educational innovation.

The Intersection of Technology and Aesthetics in Music Education

Preserving the Human Element

A recurring concern regarding the integration of technology in arts education is the potential loss of the "human element"—the emotional connection, expressive nuance, and interpersonal dynamics that characterize musical experiences. This study demonstrates that technology, when applied thoughtfully, does not replace human interaction but rather reconfigures it.

By automating knowledge transmission and basic skill assessment, adaptive platforms free teachers to focus on the deeply human aspects of music education: interpreting emotional expression, facilitating collaborative creativity, and nurturing aesthetic appreciation. Technology serves as a scaffold, elevating the quality of human interaction in the classroom.

Enhancing Aesthetic Experiences through Digital Tools

Digital platforms offer unique opportunities to enhance aesthetic experiences. High-quality audio-visual materials can expose students to diverse musical genres, historical contexts, and world-class performances that might otherwise be inaccessible. Interactive tools allow students to manipulate musical elements (pitch, rhythm, timbre) in real-time, fostering a deeper understanding of musical structure and composition.

Future developments in virtual and augmented reality (VR/AR) could further immerse students in rich acoustic environments, simulating the experience of performing in a concert hall or exploring the acoustics of different historical periods.

Ethical Considerations in AI-Assisted Arts Education

As AI assumes a larger role in educational diagnosis and content generation, ethical considerations must be addressed. Issues of data privacy, algorithmic bias, and the potential homogenization of artistic expression require careful scrutiny.

Educational platforms must ensure transparent data usage policies and employ algorithms that recognize and value diverse musical traditions and individual creative styles. AI should be designed to augment human creativity, not dictate or constrain it.

Detailed Analysis of Student Engagement Metrics

Quantitative Assessment of Platform Usage

Analysis of TALP system logs provided quantitative insights into student engagement patterns. Over the 36-week intervention, the average student logged into the platform 4.2 times per week outside of regular school hours, indicating a high level of self-directed engagement.

The average duration of each session was 22 minutes, suggesting sustained attention rather than superficial browsing. Notably, students frequently revisited instructional videos, with an average of 2.5 views per video, particularly for complex topics such as music notation and instrumental techniques. This behavior aligns with the qualitative findings that students valued the ability to learn at their own pace and review materials until mastery was achieved.

Correlation Between Engagement and Performance

Statistical analysis revealed a strong positive correlation ($r = 0.78$, $p < 0.01$) between platform engagement metrics (total time spent, number of practice exercises completed) and final assessment scores. Students who actively utilized the platform's diagnostic features and completed recommended remedial exercises demonstrated the most significant improvements in both theoretical knowledge and practical skills.

This correlation underscores the efficacy of the adaptive learning model, confirming that active participation in the digital environment translates directly into enhanced learning outcomes.

Analysis of Peer Interaction within the Platform

While TALP primarily focuses on individualized learning, its collaborative features (e.g., discussion forums, peer review modules) were also actively utilized. Network analysis of platform interactions showed that students frequently engaged in peer-to-peer assistance, answering questions and sharing insights.

This digital collaboration extended into the physical classroom, where students who interacted frequently online were more likely to assume leadership roles during group activities. This finding suggests that digital platforms can effectively foster a sense of community and collaborative learning, challenging the notion that technology isolates students.

Teacher Perspectives on Workload and Efficiency

Initial Investment vs. Long-Term Efficiency

Interviews with participating teachers highlighted a common trajectory regarding workload. In the initial phases of the project, teachers reported a significant increase in workload associated with learning the platform, adapting lesson plans, and designing new instructional activities.

However, by the second semester, teachers reported a net decrease in administrative and preparatory burdens. The platform's automated assessment and diagnostic tools significantly reduced the time spent grading and identifying student weaknesses. This efficiency gain allowed teachers to redirect their energy toward designing creative classroom activities and providing individualized feedback.

The Value of Data-Driven Insights

Teachers consistently cited the platform's data analytics dashboards as a transformative tool. The ability to instantly visualize class-wide comprehension levels and pinpoint specific knowledge gaps enabled teachers to make informed, real-time adjustments to their instruction.

"Before TALP, I often didn't know a student was struggling until the mid-term exam," noted one teacher. "Now, I can see immediately if a concept isn't landing, and I can address it the very next day." This proactive approach to teaching represents a fundamental shift from traditional reactive models.

The Need for Ongoing Technical Support

Despite the long-term efficiency gains, teachers emphasized the critical importance of ongoing technical support. Occasional system glitches, connectivity issues, or difficulties navigating new platform features could disrupt lesson flow and cause frustration.

Schools implementing adaptive platforms must ensure robust IT support infrastructure to minimize these disruptions and maintain teacher confidence in the technology.

Expanding the Theoretical Framework: Constructivism in the Digital Age

Vygotsky's Zone of Proximal Development (ZPD) and Adaptive Learning

The findings of this study strongly resonate with Vygotsky's concept of the Zone of Proximal Development (ZPD). The TALP platform effectively functions as a digital "More Knowledgeable Other" (MKO), providing the necessary scaffolding to help students achieve tasks they could not complete independently.

The platform's adaptive algorithms continuously assess the student's current capability level and provide challenges that are just beyond their independent reach, perfectly aligning with the principles of ZPD. As the student's competence grows, the platform dynamically adjusts the scaffolding, ensuring continuous cognitive development.

Social Constructivism and Blended Learning

While the digital platform facilitates individualized cognitive development, the blended learning model employed in this study robustly supports social constructivist theories. The classroom environment, freed from the constraints of basic knowledge transmission, becomes a vibrant space for social negotiation of meaning.

Through collaborative music-making, peer critique, and group inquiry, students co-construct their understanding of musical concepts. This integration of individualized digital scaffolding and collaborative social interaction represents a sophisticated application of constructivist principles in the modern educational context.

Connectivism and Networked Learning

The study's findings also align with Connectivism, a learning theory for the digital age proposed by George Siemens. Connectivism posits that learning is a process of connecting specialized nodes or information sources.

In the context of this research, students learn not only by internalizing information but by navigating the network of resources provided by TALP, connecting with peers, and synthesizing diverse inputs. The Epistemic Network Analysis (ENA) utilized in this study visually captures this connectivist process, demonstrating how students build complex networks of understanding through their interactions with the digital environment and each other.

Research Tools and Measurement

Teacher Interview Protocol

This research conducted semi-structured teacher interviews with primary questions including:

Student Learning Reflection Questionnaire

Students completed regular learning reflections addressing:

1. What did you learn in this lesson?
2. What difficulties or discomfort did you experience using Yincai Network?
3. What aspects of this new learning approach do you most enjoy?
4. How do you believe this learning approach benefits your music education?
5. What do you anticipate for the next lesson?

Learning Outcome Measurement Tools

This research employed multi-dimensional learning outcome measurement:

1. **Knowledge Assessment:** Platform-embedded checkpoints and practice exercises measuring music knowledge mastery.
2. **Skill Evaluation:** Teacher observation and scoring assessing music performance, singing, and composition skills.
3. **Learning Motivation Scale:** Modified Intrinsic Motivation Inventory measuring learning interest, perceived competence, and value.
4. **Self-Directed Learning Scale:** Custom-developed scale measuring autonomous learning desire, self-regulation, and self-efficacy.

Detailed Data Analysis Results

Teacher Cognitive Network Detailed Metrics

Pre-experiment teacher cognitive network metrics:

- Nodes: 9
- Edges: 12
- Network density: 0.333
- Average degree: 2.67
- Clustering coefficient: 0.45
- Maximum degree node: "Teaching Concerns" (degree 5)

Post-experiment teacher cognitive network metrics:

- Nodes: 10
- Edges: 12
- Network density: 0.267
- Average degree: 2.40
- Clustering coefficient: 0.52
- Maximum degree node: "Learning Outcomes" (degree 6)

These metric changes indicate teacher cognitive struc-ture transformation from dispersed multi-center to focused single-center structure.

Student Cognitive Network Detailed Metrics

Pre-experiment student cognitive network metrics:

- Nodes: 17
- Edges: 23
- Network density: 0.169
- Average degree: 2.71
- Clustering coefficient: 0.38
- Maximum degree node: "Anxiety" (degree 7)

Post-experiment student cognitive network metrics:

- Nodes: 18
- Edges: 22
- Network density: 0.144
- Average degree: 2.44
- Clustering coefficient: 0.41
- Maximum degree node: "Positive Experience" (degree 8)

These metric changes indicate student cognitive structure transformation from negative emotion-centered to positive experience-centered.

Quantified Learning Outcome Results

In knowledge assessment, experimental group students averaged 82.5 points (SD = 8.3), while control group averaged 76.3 points (SD = 10.2), with statistically significant difference ($t = 2.45$, $p < 0.05$).

In learning motivation, experimental group students averaged 4.2 points (5-point scale), while control group averaged 3.5 points, with significant difference ($t = 3.12$, $p < 0.01$).

In self-directed learning ability, experimental group students averaged 4.1 points, while control group averaged 3.3 points, with significant difference ($t = 2.89$, $p < 0.01$).

Teaching Case Examples

"Instrument Recognition" Unit Teaching Design

Unit Objectives: Students identify common instruments, understand instrument classification and characteristics, and recognize instruments in musical works.

Teaching Process:

- **Pre-class (Online Self-Study):** Students view three instructional videos, complete checkpoints and practice exercises. System recommends supplementary resources based on performance.
- **Classroom:** Teacher plays symphony excerpt requesting instrument identification. Students conduct small group inquiry activities designing instrument recognition games.
- **Post-class (Consolidation and Extension):** Students complete post-class tasks identifying instruments in favorite music.

Assessment Methods: Online checkpoints, classroom participation, post-class assignments, end-of-unit instrument recognition assessment.

"Music Composition" Unit Teaching Design

Unit Objectives: Students apply learned music knowledge for simple composition expressing musical ideas.

Teaching Process:

- **Pre-class:** Students view composition basics videos learning rhythm and melody composition methods.
- **Classroom:** Teacher introduces composition tools and software, guiding small group composition activities. Groups create brief musical compositions.
- **Post-class:** Students complete individual compositions with recording or performance.

Assessment Methods: Composition musicality, creativity, and technical evaluation; peer assessment; self-assessment.

"Music Appreciation" Unit Teaching Design

Unit Objectives: Students appreciate diverse musical styles, understanding music cultural background and expression techniques.

Teaching Process:

- **Pre-class:** Students view composer biography and work background videos understanding historical-cultural context.
- **Classroom:** Teacher plays musical works guiding appreciation and analysis. Small groups discuss sharing personal feelings and understanding.
- **Post-class:** Students write appreciation reflections sharing with classmates.

Assessment Methods: Classroom discussion participation, appreciation reflections, peer assessment.

Teacher Training Curriculum Outline

Basic Training (2 days)

Day One:

- Morning: Adaptive instruction philosophy and international development trends
- Afternoon: Yincai Network platform functionality introduction and operation demonstration

Day Two:

- Morning: Adaptive instruction curriculum design
- Afternoon: Practical operation and Q&A

Advanced Training (2 days)

Day One:

- Morning: Learning data interpretation and application
- Afternoon: Individualized feedback design and provision

Day Two:

- Morning: Classroom activity design and implementation
- Afternoon: Teaching reflection and continuous improvement

Certification Program (4 days)

For teachers intending to become seed teachers, deeper training encompasses instructional design, data analysis, and curriculum development. Teachers completing certification and passing assessment receive "A2 Instructor" certification.

Platform Functionality Introduction

Diagnostic and Assessment Functions

Yincai Network diagnostic functions include:

1. **Pre-Assessment Diagnosis:** Conducted before unit beginning, understanding student prior knowledge.
2. **Formative Assessment:** Conducted during learning, monitoring progress.
3. **Summative Assessment:** Conducted after unit completion, evaluating learning outcomes.

Based on diagnostic results, the system recommends appropriate learning resources and pace.

Learning Pathway Planning Function

The system automatically plans personalized learning pathways based on student diagnostic results and learn-ing objectives. Students follow recommended pathways or adjust based on personal needs.

Data Analysis and Reporting Functions

The system provides detailed learning data analysis and reporting including:

1. **Individual Learning Reports:** Displaying each student's progress, mastered knowledge points, and remediation needs.
2. **Class Learning Reports:** Displaying class learning status, knowledge mastery distribution, common errors.
3. **Comparative Analysis:** Comparing different students, classes, and time periods.

Teachers adjust instructional strategies based on these reports.

Frequently Asked Questions and Answers

Question 1: Does adaptive instruction cause teacher unemployment?
A: No. Adaptive instruction changes teacher roles rather than eliminating teaching needs. Actually, adaptive instruction demands higher teacher requirements including stronger instructional design, data analysis, and learning facilitation abilities.

Question 2: Is adaptive instruction suitable for all students?
A: Adaptive instruction's core principle involves adjusting to individual student needs. Therefore, it theoretically suits all students, including struggling learners and gifted students.

Question 3: What costs does adaptive instruction implementation require?
A: Costs include platform usage fees, teacher training, and hardware investment. However, long-term adaptive instruction enhances teaching efficiency and reduces remediation needs, providing cost-effectiveness.

Question 4: Does adaptive instruction increase teacher workload?
A: Initial implementation may increase workload (platform learning, new activity design), but once adapted, teacher workload typically decreases as platforms assume instructional tasks.

Question 5: How ensure online student learning remains focused?
A: This represents genuine challenge. Recommended measures include establishing clear learning expectations and norms, providing appropriate monitoring and support, designing engaging content, and granting appropriate student autonomy.

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