Fostering Sustainable Learning through AI-Supported Flipped Classrooms: A Conceptual Framework for Enhancing Self-Regulated Learning in Chinese College English Listening Instruction

Yin Zhumin[1*]   Renee Shiun Yee Chew[2]
INTI International University[1-2]
*I24027977@student.newinti.edu.my

Abstract

This study constructs a conceptual framework to integrate AI-supported flipped classrooms with self-regulated learning (SRL) in English listening teaching in Chinese universities. Referring to Zimmerman's (2000) SRL cycle theory, the framework integrates AI tools and flipped teaching to solve the problems of passive learning. AI customizes pre-class content and provides real-time feedback to help students plan and monitor their learning independently. Classroom activities promote collaborative reflection and connect individual and social learning. By cultivating self-regulated learning habits and long-term motivation, the framework meets the needs of post-epidemic education resilience. Although this integration can increase participation and relieve anxiety, its effectiveness depends on the fairness of technology access and the balance between teachers. In order to overcome infrastructure differences and avoid indicator dependence, this study advocates a mixed implementation of high- and low-tech strategies to achieve fair promotion. This study regards AI as a boost to SRL cultivation, reshapes the concept of language education, and highlights the synergy between technology, teaching methods, and learner autonomy.

1. Introduction

English listening teaching in Chinese higher education has long faced a series of challenges, which are not only due to the inherent drawbacks of the traditional teaching model, but also closely related to the changing educational needs. At present, the conventional teaching method is teacher-centred and adopts a standardized assessment system. Under such a model, students' learning behaviour is passive and foreign language listening anxiety (FLLA) is aggravated (Liu & Yuan, 2021; Zhou & Thompson, 2023). Moreover, this type of teaching method over-emphasizes listening comprehension checks, but ignores the cultivation of students' metacognitive strategies and self-regulated learning (SRL) abilities, making it difficult for learners to cope with real-time cognitive challenges in the listening process (Xu & Luo, 2022). In addition, the promotion of English-medium instruction (EMI) requires students to decode language information and understand subject content, which further increases the cognitive

burden (Zhou & Rose, 2021). Students' English proficiency varies, and a unified curriculum cannot take into account the needs of everyone. Students with poor English foundation are easily marginalized in teaching (Chen, 2024). These systemic problems indicate an urgent need to restructure the teaching framework and break through the emotional, cognitive and teaching system barriers in the process of listening skill development.

In response to the challenges mentioned above, the flipped classroom (FC) model has become a revolutionary teaching alternative. Qiu and Luo (2022) and Cevikbas and Kaiser (2022) have shown that this model cultivates learners' autonomy and reduces their learning anxiety by replanning the learning sequence, moving content delivery before the class, and focusing on collaborative practice in the classroom. A large number of empirical studies have shown that, especially when flipped classrooms are combined with digital tools, they are effective in improving learners' listening skills and promoting the use of metacognitive strategies (Fan, 2022). However, in China, the promotion and application of flipped classrooms are subject to certain constraints due to inadequate infrastructure and insufficient teacher preparation. This phenomenon reflects the contradiction and conflict between teaching innovation and the traditional education system (Feng, 2020; Miao et al., 2024). At the same time, artificial intelligence (AI) technology is booming, and adaptive learning platforms, speech recognition systems, etc. have opened up a new path for personalized teaching. Research by Crompton et al. (2024) and Alrasheedi (2025) showed that AI can provide real-time feedback and accurately diagnose students' listening problems, which is very consistent with the requirements of differentiated teaching in classrooms with varying levels of language proficiency. However, Tsang (2019) pointed out that current academic research often treats AI and flipped classrooms as independent teaching methods, ignoring the synergistic value of the two in dealing with the complex and immediate teaching needs of listening comprehension.

In the post-epidemic era, the field of education has undergone profound changes, and it has become increasingly urgent to build a sustainable learning model. This model is not a stopgap measure but focuses on long-term development. The Organization for Economic Cooperation and Development (OECD, 2021) proposed the concept of "sustainable learning", which aims to cultivate learners who can continue to improve in a changing environment and have adaptability and self-regulation. This concept is very consistent with China's Education Power Construction Plan (MOE, 2024). In this context, the AI-supported flipped classroom (AI-supported FC) model provides a feasible solution for enhancing students' learning resilience. With the help of this model, learners can effectively overcome cognitive and emotional challenges through repeated practice and timely feedback and better adapt to complex and changing learning environments.

This study builds a conceptual framework that integrates artificial intelligence and flipped classroom (FC), aiming to overcome the key theoretical and practical difficulties in English listening teaching in Chinese universities and improve students' self-regulated learning (SRL) ability. The framework is based on the self-determination theory proposed by Ryan and Deci (2020) and the SRL model of Zimmerman (2002). In the framework, artificial intelligence is positioned as a tool to promote metacognition development. With the help of adaptive algorithms, pre-class and classroom learning content is tailored according to the actual level of

learners. The research conducted by Chen (2024) and Zhou and Rose (2024) focuses on the regulatory role of language ability in learning. They oppose the homogeneous use of educational technology and advocate narrowing the achievement gap between different students through tiered support. The results of this study provide a set of scalable strategies for sustainable teaching methods, which are in line with the policy requirements of China's digital transformation and the actual situation of Chinese education. Through in-depth exploration from multiple dimensions, this study incorporates discussions on global fair artificial intelligence integration and educational resilience in the post-epidemic era, and innovatively proposes a new learner-centred dynamic listening teaching model.

The nature of this study should be clarified: this paper is a conceptual exploration, not an empirical study. This paper proposes a theoretical framework that combines AI-supported flipped teaching with autonomous learning principles, aiming to provide guidance for teaching innovation. It is recommended that future research empirically validate this framework by using a longitudinal mixed-method design in real educational settings.

2. Theoretical Foundations

2.1 Self-Regulated Learning (SRL) and Zimmerman's Three-Phase Model

The conceptual framework of this study is based on the self-regulated learning model (SRL) proposed by Zimmerman, (2000). The model divides the learning process into three stages, involving forethought, performance control, and self-reflection. In the forethought phase, learners set learning goals and develop learning strategies based on their self-efficacy and analysis of learning tasks. Pintrich (2000) pointed out that this process is extremely critical to language acquisition, among which metacognitive planning directly affects the choice of listening comprehension strategies. During performance control, learners use self-observation and flexibly use adaptive strategies to monitor their learning progress. For example, when encountering unfamiliar accents or fast speaking speed, learners will adjust their listening skills. However, Boekaerts (1999) believes that in the traditional teacher-centered teaching model, learners' abilities in this area are often not fully developed. Entering the self-reflection stage, learners analyze the causes of learning outcomes through self-evaluation, thereby optimizing subsequent learning strategies. Although Zimmerman's model provides important theoretical support for understanding self-regulated learning, it has also been criticized. Winne and Perry (2000) and Zhou and Thompson (2023) pointed out that the model pays relatively little attention to emotion regulation. In the process of language learning, anxiety often interferes with learners' cognitive engagement and is an important factor that cannot be ignored.

2.2 Sustainable Learning: Bridging SRL and Lifelong Adaptability

As an extension of self-regulated learning (SRL), sustainable learning emphasizes the cultivation of adaptive lifelong learning capabilities that go beyond short-term academic goals (OECD, 2021). Rooted in the educational priorities of the post-pandemic era, sustainable learning focuses on cultivating learners' resilience and autonomy to help them cope with the ever-changing language and technology environment (Adam, n.d.). This concept advocates process-oriented development, prompting learners to internalize strategies for autonomous knowledge construction rather than simply pursuing established standards, thus challenging the traditional result-oriented model. However, in an environment dominated by standardized tests, there is still controversy about the implementation of curriculum sustainability, and

institutional accountability often obscures personalized learning paths (Caspersen, 2005). Integrating SRL principles into the sustainable learning framework requires teaching innovation and balancing structured guidance with learners' subjective initiative - this is also the core contradiction in the process of technology-enabled language education.

2.3 AI-Supported Flipped Classrooms: A Synergistic Model for SRL Activation

There is a synergistic effect between the flipped classroom supported by artificial intelligence and the activation of self-regulated learning (SRL), and the two complement each other in terms of personalized learning path design and metacognitive development support. Although both artificial intelligence and flipped classrooms aim to enhance learners' autonomy, their core functions are different: artificial intelligence provides personalized scaffolding and real-time feedback through data-driven algorithms, while flipped teaching shifts the focus of the classroom to active strategy training by restructuring the teaching sequence. The synergistic value of the two lies in integrating the adaptability of artificial intelligence with the collaborative reflection mechanism of flipped classrooms. Cevikbas and Kaiser (2022) pointed out that flipped classrooms use carefully selected digital resources to pre-stage knowledge absorption, freeing up time for interactive high-level tasks in class, which naturally fits the pre-thinking and executive control stages of SRL. On this basis, Alrasheedi (2025) and Crompton et al. (2024) believe that AI uses adaptive algorithms to diagnose individual listening challenges, recommend personalized practice materials, and provide real-time feedback on speech accuracy to meet the needs of learners at different levels. For example, AI-driven speech recognition systems help learners improve their pronunciation before class, and classroom collaborative activities promote reflective communication among peers, which is consistent with the self-reflection stage of SRL proposed by Zimmerman (Saks & Leijen, 2014). Qiu and Luo (2022) proposed that this integrated model provides a low-risk, self-paced practice environment, thereby effectively reducing learners' cognitive burden and alleviating foreign language listening anxiety.

It should be emphasized that the effectiveness of the AI-flipped classroom does not rely solely on the surface form of technology application. Rovers et al. (2019) believe that although artificial intelligence relies on fine-grained data analysis to better measure student behavioral participation, such as task completion time, error types, etc., it often ignores the emotional and motivational aspects., there is a risk of over-reliance on quantitative indicators. Moreover, the model assumes that students have equal access to digital infrastructure and are familiar with the autonomous learning process. However, research by Miao et al. (2024) shows that this assumption is difficult to hold in rural colleges in China due to resource gaps. In addition, Ardasheva et al. (2017) and Cheng and Chau (2013) warned through empirical research that without clear metacognitive strategy training, students are likely to rely solely on artificial intelligence tools to improve the efficiency of the learning process and find it difficult to achieve deep learning. This highlights the importance of teachers playing a guiding role, which is the only way to ensure that technological applications are consistent with self-regulated learning (SRL) goals. Overall, the AI flipped framework has been able to achieve results thanks to its dual functions of both technical support and teaching concept guidance. With this framework, listening teaching is redefined as a dynamic interactive process between learner autonomy, adaptive support, and sustainable skill transfer.

3. Proposed Framework

Building on Zimmerman's SRL model and sustainable learning principles, this framework

operationalizes the synergy between AI and flipped pedagogy through three phases: input, process, and output (see Figure 1 for details). The goal is to promote students' self-Regulated learning (SRL) and cultivate their sustainable learning ability. Alrasheedi (2025) and Cevikbas and Kaiser (2022) found that in the input stage, intelligent listening platforms, such as speech recognition systems, adaptive diagnostic modules, and flipped classroom resources, such as pre-class video lectures, interactive tasks and other artificial intelligence-driven tools, play a key role. These technologies can provide personalized learning content and give real-time feedback based on the actual situation of students to meet the needs of students at different levels, as shown by Han et al. (2025), mobile AI chatbots can provide self-regulated learning (SRL) scaffolding for goal setting and reflection. At the same time, by building a learning preparation link, students' cognitive pressure can be reduced. pointed out that this function plays an extremely important role in alleviating students' anxiety when learning foreign language listening. Furthermore, flipped videos that incorporate metacognitive prompts (such as guided note templates and reflection questions) guide students to participate in classroom activities with strategic thinking, which is consistent with the SRL pre-thinking stage proposed by Zimmerman (2000).

The process stage activates self-regulated learning (SRL) strategies through orderly interactions between learners, technology, and instructional design. Ardasheva et al. (2017) pointed out that in the pre-class interaction, AI tools can diagnose individual listening shortcomings, recommend targeted exercises, and help learners set goals; while flipped tasks can closely link pre-class preparation content with class goals by building an outline, stimulating learners to plan tasks. This is consistent with the conclusions of related studies: trajectory analysis based on natural language processing (NLP) has objectively reflected learners' autonomous learning strategies when watching video lectures (such as self-questioning, Winne, 2017), and the prompt words generated by ChatGPT provide scaffolding support for learning plan formulation and process monitoring in pre-class activities (Li, 2023). In the classroom, peer-led discussions, problem-solving simulations, and other activities are carried out to encourage learners to explain the use of strategies and adjust their learning methods based on feedback from peers and teachers. Pintrich (2000) believes that this interactive process fully reflects the performance control stage proposed by Zimmerman. However, studies by Rovers et al. (2019) and Saks and Leijen (2014) also pointed out that this model has potential problems. If learners rely too much on the algorithmic suggestions of artificial intelligence, they may unconsciously narrow their own strategy selection range; a phenomenon observed when high-SRL students exhibited decreased autonomy after over-relying on chatbot guidance (Han et al., 2025). Similarly, if there is a lack of guidance in flipped tasks, learners may only participate superficially. Therefore, the framework emphasizes the guiding value of teachers, and while carrying out strategy training, it also makes reasonable use of the autonomous assistance function of artificial intelligence. This is to ensure that learners can truly understand and practice the principles of self-regulated learning (SRL) and avoid simply learning mechanically according to tool prompts.

The output level covers key elements such as improving learning autonomy, maintaining learning motivation, and cultivating sustainable learning ability. Cheng and Chau (2013) pointed out that learners can gradually develop the habit of autonomous listening practice by continuously participating in artificial intelligence feedback activities and completing collaborative flipped tasks, such as independently selecting appropriate learning resources according to their own level, or reflecting on the types of errors. Such habits were fostered through AI-driven reflection prompts that help promote strategy transfer and emotional self-

regulation. (Li, 2023; Yılmaz et al., 2017). When students have a stronger sense of control over their learning process, they will reduce their dependence on external rewards such as test scores. More importantly, Prøitz (2010) emphasized that the framework integrates transferable self-regulated learning (SRL) strategies such as adaptive goal adjustment and emotional self-regulation into daily learning, focusing on cultivating learners' sustainable learning ability and helping them cope with various challenges in future language learning after the end of formal teaching. However, Miao et al. (2024) and Chen (2024) point out that there are still systemic challenges. Rural colleges may not be able to fully utilize advanced AI tools due to relatively weak infrastructure; at the same time, the exam-oriented education culture often focuses more on students' short-term performance and neglects the cultivation of sustainable skills. Therefore, to ensure that the framework can be widely and equitably implemented, a hybrid implementation approach is recommended, combining AI-driven personalized teaching with low-tech SRL support methods such as reflection journals and peer guidance.

Figure 1
Visual Representation of the Framework via a Linear Flow
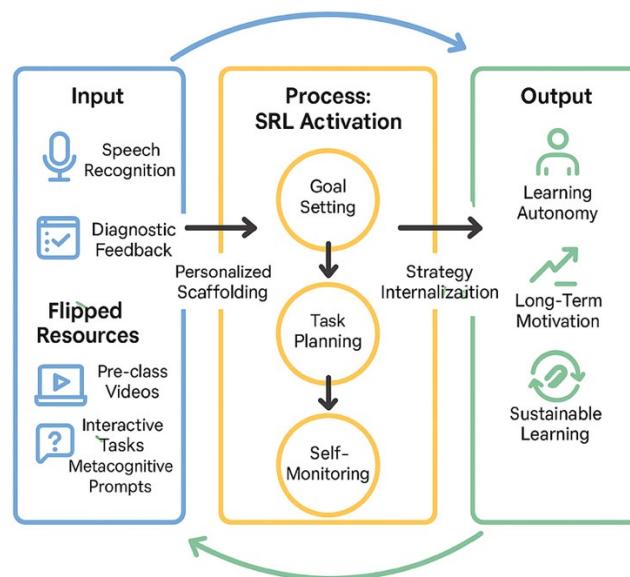
Noted: This figure is generated by researchers

4. Implications for English Listening Instruction

4.1 Pedagogical Implications: Task Design and AI Integration

For educators, the framework requires a paradigm shift: from content imparters to strategic coordinators of multiple roles that mediate between technology, pedagogy, and equity. Teachers need to act as designers of pre-class self-regulated learning (SRL) by embedding metacognitive prompts in pre-class materials and strategically integrating AI tools and flipped learning resources to scaffold learners' pre-thinking phase and relieve anxiety (Liu & Yuan, 2021). When selecting pre-class materials, teachers should consider both language difficulty and metacognitive guidance (Cevikbas & Kaiser, 2022), such as incorporating reflective questions into flipped videos to help students anticipate listening challenges or assess comprehension gaps. In addition, as facilitators of self-regulated learning in the classroom, teachers need to prioritize the design of collaborative activities (such as peer discussions) to encourage students

to express and adjust strategies based on feedback, ensuring that they go beyond algorithmic suggestions to achieve deep cognitive engagement (Ardasheva et al., 2017; Pintrich, 2000). In this process, AI platforms are not only diagnostic tools, but also adaptive partners that generate personalized exercises through real-time error analysis, allowing teachers to focus on high-impact interventions such as collaborative problem solving (Alrasheedi, 2024). However, we need to be wary of over-reliance on AI automation, which may weaken teachers' teaching guidance role - algorithms often prioritize efficiency rather than deep cognitive engagement (Rovers et al., 2019). To this end, teachers also need to act as hybrid designers with fairness at the core, combining the personalized advantages of AI with low-tech strategies (such as reflective journals) to bridge infrastructure differences and test-taking bias (Chen, 2024; Miao et al., 2024). Therefore, professional development should empower teachers to critically interpret AI analysis data and design hybrid tasks (such as using AI error reports to conduct strategy workshops) to balance technical feedback with humanistic guidance (Wang, 2023). Finally, as a catalyst for autonomous learning transfer, teachers need to design targeted activities (such as peer analysis of AI-identified errors) to extend adaptive skills beyond the curriculum and cultivate sustainable learning capabilities that are consistent with the goal of resilience in the post-epidemic era (Cheng & Chau, 2013; OECD, 2021).

4.2 Student Implications: Cultivating Self-Regulated Learners

Students need to receive systematic tool literacy and metacognitive awareness training w hen transitioning to the AI flipped classroom model. Saks and Leijen (2014) suggested that in the initial guidance stage, students should be made aware of the unfamiliarity of AI functions, such as showing how the speech recognition system can give constructive feedback on pronu nciation, and at the same time make it clear to students that AI is only an auxiliary tool and ca nnot replace critical thinking. To help students develop the habit of self-regulated learning (S RL), Cheng and Chau, (2013) suggested that teachers can introduce reflection logs, allowing s tudents to record goal setting, such as "This week, I will focus on identifying key words in rap id speech", and use AI-generated indicators to evaluate learning progress. However, there are still challenges in practice. Chen (2024) and Zhou & Rose (2024) found that learners with poo r English foundation may over-rely on AI correction and neglect the cultivation of comprehen sive strategies, while students with excellent grades may find automatic feedback lacking valu e. Ardasheva et al. (2017) pointed out that this problem can be solved by constructing "strateg y transfer" activities, such as discussing problems identified by AI in peer teaching sessions, t o ensure that students' learning skills can be transferred to different scenarios.

4.3 Educational Sustainability: Aligning with Post-Pandemic Innovation

The Organization for Economic Cooperation and Development (OECD, 2021) pointed out that in the post-epidemic era, it is crucial to build a resilient lifelong learning ecosystem, and this framework just meets this need. Through AI-based flipped hybrid teaching, teaching activities are no longer overly dependent on physical classrooms. This model is not only an important measure to deal with the crisis, but also effectively cultivates learners' autonomy and helps them continue to learn beyond the scope of formal education. Prøitz (2010) proposed that when students internalize self-regulated learning (SRL) strategies into habits, they can achieve sustainable learning results. For example, they can use AI tools to conduct independent learning in informal scenarios such as work or daily life long after the course ends. However, the research of and Feng (2020) warns that systemic inequality poses a challenge to the promotion of this framework. There is a gap in technology use between urban and rural areas, which may prevent learners in remote areas from benefiting from AI; at the

same time, the exam-oriented education culture may reduce flipped classrooms to "digital cramming" and fail to truly promote deep learning. Therefore, to resolve this problem, policymakers should proactively promote inclusive hybrid teaching models, combining low-bandwidth artificial intelligence tools such as offline voice applications with community-based peer-to-peer networks to promote the widespread dissemination of sustainable education concepts and ensure that more learners can benefit from this teaching model.

More broadly, the framework supports the cutting-edge discussion on sustainable learning by linking self-regulated learning (SRL) with long-term learner adaptability and national digital transformation policies (OECD, 2021). It challenges the teaching model centred on short-term test-taking by emphasizing metacognitive development, learner agency and emotional resilience. These teaching transformations are particularly critical in the post-pandemic recovery phase, in which technology-enabled flexible teaching needs to coexist with fair and people-centered learning environments.

5. Conclusion

Integrating AI-supported flipped classroom into English listening teaching is a revolutionary teaching practice. This teaching method promotes students to achieve sustainable learning by activating self-regulated learning (SRL) strategies through the system. In this model, the adaptive nature of AI and the flipped teaching method's emphasis on students' active participation work together to successfully overcome the long-standing problems of passive learning, cognitive overload, and foreign language learning anxiety in the field of language education. At the same time, this model can effectively cultivate learners' autonomous learning ability and help them master lifelong skills. This study constructs a corresponding conceptual framework based on the three-stage theory of self-regulated learning proposed by Zimmerman (2000), namely, pre-thinking, executive control, and self-reflection. The framework shows that when AI tools are strategically integrated with flipped classroom resources, a virtuous cycle will be formed. In the cycle, students' learning motivation and autonomous learning ability continue to improve, which in turn encourages them to participate more deeply in teaching activities. The Organization for Economic Cooperation and Development (OECD, 2021) pointed out that this synergistic effect can not only improve students' current listening skills, but also help students master metacognitive strategies, which can be transferred to different language learning and academic scenarios, in line with the needs of cultivating learners with resilience and autonomous learning ability in the post-epidemic era.

Wang (2023) pointed out that this framework provides important theoretical support for future teaching innovation in balancing technology integration and people-centered teaching methods. It prompts educators and policymakers to rethink AI and regard it as a catalyst for the development of self-regulated learning (SRL) rather than a substitute for traditional teaching, while highlighting the irreplaceable role of teachers in cultivating students' reflection and critical thinking. However, the framework is still theoretical and needs to be validated through empirical research to quantify its impact in different educational scenarios. It should be noted that there are several potential limitations: First, the premise of implementation is the availability of standardized digital infrastructure, which may be difficult to meet in resource-poor environments (Miao et al., 2024). Therefore, a hybrid approach combining high-tech and low-tech tools is needed to ensure equitable access. Second, if not properly regulated, the integration of AI tools may weaken teachers' subjective initiative (Rovers et al., 2019). Educators need to receive targeted training to interpret AI feedback and maintain teaching dominance (Wang, 2023). Third, learners with low self-regulated learning ability (SRL) may

over-rely on automated suggestions and even deviate from the reflective learning process. These risks highlight the importance of teacher-led strategy scaffolding and differentiated instructional design.

Future research should give priority to conducting longitudinal mixed-method surveys to evaluate the effectiveness of the framework in actual teaching environments. In particular, it is necessary to explore the interaction between AI's personalized functions and factors such as culture and infrastructure, for example, whether students in rural areas with limited technological resources can benefit from a combination of low-tech and high-tech teaching models. In addition, comparative studies across English course types, such as academic listening and conversational English, will help to clarify the contextual adaptation strategies needed to optimize the generalizability of the framework. Finally, it is critical for AI developers and educators to engage in interdisciplinary collaboration to improve tool design so that it prioritizes teaching goals rather than simply pursuing algorithmic efficiency, ensuring that AI-enhanced instruction not only improves immediate learning outcomes but also contributes to a more sustainable, inclusive, and learner-centered educational ecosystem.

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