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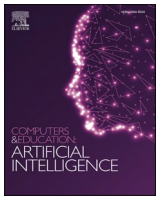

CHAT-ACTS: A pedagogical framework for personalized chatbot to enhance active learning and self-regulated learning

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ABSTRACT

The CHAT-ACTS pedagogical framework presented in this paper integrates personalized chatbots into active and self-regulated learning (SRL) to enhance student engagement, motivation, and learning outcomes. Employing three primary learning modes - Personalized Chatbot, Self-Regulated Learning, and Active Learning - the learner occupies the central position, symbolizing their active role in shaping their learning journey. Strategic actions such as Evaluation, Feedback, and Plan are crucial in the Personalized Chatbot mode, while the SRL mode emphasizes Goal Setting and Study Tactics. The Active Learning mode underscores Active-Based Learning and Teaching Strategies. Through these modes, bidirectional relationships are established, facilitating feedback, setting goals, and employing active learning techniques. By utilizing this framework, educators can maximize the impact of personalized chatbots in various educational settings.

1. Introduction

Given the increasing popularity of generative Artificial Intelligence (AI) tools, such as ChatGPT, educators are prompted to reassess their approach to designing lessons and classes (e.g., the alignment between their learning objectives and the assessment). In the past, instructors relied on face-to-face interactions with students to provide necessary guidance and promote meaningful engagement. However, the emergence of generative AI presents new possibilities for education, challenging educators to explore innovative ways to integrate these tools into their teaching practices and maximize students' full potential. Despite the various applications of AI in education, there has been a lack of theoretical understanding of AI integration and educational perspectives. Previous research on chatbots primarily emphasized improving student achievement and their perceptions of chatbots, but it often lacked clear and specific guidance on how to design chatbots to customize student learning experiences, particularly in relation to self-regulation and active learning (Lin, 2020). Lin's doctoral dissertation proposed a methodology when designing a chatbot for educational settings, such as personalized feedback and knowledge check ensuring learner understands the content. In this paper, we extend Lin's work to develop a theoretical framework that can effectively guide integration of AI tools in the classroom to help educators and researchers advance educational practices. Therefore, a comprehensive framework that addresses the theoretical underpinnings of education can provide practical guidance for educators and researchers looking to integrate personalized chatbots into their pedagogical practices.

Active learning and Self-Regulated Learning (SRL) are two important concepts in education. These two concepts guide important pedagogical decisions when educators plan their learning objectives and class activities. Active learning refers to student-centred activities requiring them to analyze, synthesize, and evaluate information rather than passively receive information through lectures or readings (Bishop et al., 2014; Bonwell & Eison, 1991, pp. 20036–21183; Prince, 2004). Hodges (2020) indicated that successful active learning strategies depend on many factors, including the design of the learning environment, the nature of the learning activities, and the level of student engagement and motivation. As a result, active learning can improve understanding of learned materials and the retention of learned knowledge (Konopka et al., 2015), providing an alternative to more passive forms of knowledge acquisition, and shifting the focus from teachers to their students (DiYanni & Borst, 2020).

SRL, on the other hand, involves students taking ownership of their learning by setting goals, monitoring their progress, and adjusting their strategies based on feedback and self-reflection (Virtanen et al., 2017; Winne & Hadwin, 1998). Taken together, active learning and SRL can

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potentially enhance student motivation, engagement, and achievement in educational settings.

The field of AI has undergone remarkable advancements, giving rise to innovative technologies like educational chatbots. These chatbots, such as Open AI's ChatGPT, have increasingly been utilized in education to enhance personalized learning experiences and support academic tasks (Lin & Chang, 2020; Okonkwo & Ade-Ibijola, 2021). It is important to note that ChatGPT, although mentioned earlier in this work, is not specifically a personalized chatbot or an intelligent tutoring system. Instead, it is a state-of-the-art large language model with immense potential to revolutionize the education sector. The integration of ChatGPT and similar chatbots into educational settings, however, lack a clear educational framework. Currently, students initiate interactions with ChatGPT to obtain directions and direct answers, using its output as a foundation to develop their own ideas. From the perspective of SRL, learners perceive chatbots, such as ChatGPT, as valuable resources to support learning, employing them to guide their actions, criteria, standards, plans, and objectives in addressing their learning tasks (Chang et al., 2023; Kılınç, 2023; Lee et al., 2020; Sáiz-Manzanares et al., 2023; Vasconcelos & Santos, 2023). However, from an educator's standpoint, the absence of pedagogical principles that effectively connect SRL and chatbots remains challenging (Kılınç, 2023; Lin, 2020).

The extraordinary text-generation capabilities of ChatGPT and its significant impact on education present an avenue for advancing pedagogy, assessment, and learning objectives (Rudolph et al., 2023). To practically integrate active learning and SRL into personalized chatbots, several strategies can be employed. One approach involves designing chatbots that provide personalized learning support to students, including timely and individualized feedback (Pérez et al., 2020). Another strategy focuses on enhancing student engagement and motivation within active learning environments by creating interactive and engaging chatbots that facilitate collaboration and peer-to-peer interactions (Fidan & Gencel, 2022; Lin, 2020; Pérez et al., 2020). Additionally, chatbots can scaffold SRL in students by offering tools and resources to monitor learning progress, set goals, and facilitate reflective practices (Chang et al., 2023; Du et al., 2021; Pérez et al., 2020; Wollny et al., 2021). Despite the positive results and potential benefits of chatbots, to our understanding and research, there is no framework to guide educators to incorporate chatbots that can tailor learning tasks (i.e., personalization) to boost active learning and self-regulation. Thus, integrating personalized chatbots into active learning environments empowers educators to enhance students' learning experiences and foster their development as self-regulated learners.

This paper introduces the CHAT-ACTS framework. The "CHAT" portion of the framework denotes our focus on chatbot integration, with "ACT" and "S" representing active learning and self-regulation, respectively. The framework is designed to be used within formal accredited learning contexts, assisting instructional designers and instructors in integrating personalized chatbots to enhance active learning and SRL. By exploring the potentials of personalized chatbots in promoting these educational approaches, our goal is to present arguments and insights on how a personalized chatbot can advance active learning and SRL, as well as effective strategies for integrating into these contexts.

The paper will review the literature on active learning and SRL and personalized chatbots to scaffold active learning and SRL. It will also discuss the theoretical framework for using personalized chatbots in active learning and SRL, its impact on active learning and SRL, and effective strategies for integrating personalized chatbots into active learning and SRL.

2. Literature review

2.1. Active learning and SRL

Active learning is a pedagogical approach that engages students in the learning process beyond traditional lecture learning (DiYanni & Borst, 2020). It is a broad term encompassing various teaching methods and promotes skill development and higher-order thinking through discussions, case studies, and peer review (Prince, 2004). Previous research has demonstrated the positive effects of active learning strategies on students' learning achievement and enthusiasm (e.g., Eustaqio et al., 2022; Nafea, 2020; Şeşen & Tarhan, 2011). For instance, Nafea (2020) found that strategies like self-study, peer review, and clickers significantly improved learning outcomes for computer science students. However, it is important to acknowledge the contextualized nature of the study and its reliance on student perceptions. Nonetheless, these findings support the use of active learning strategies in creating engaging and effective learning environments. Similarly, the findings from Eustaqio et al. (2022) indicated that student enthusiasm increased when an active learning strategy was applied in class. Active learning strategies promoted student learning outcomes with respect to enhanced short-term retention and more profound levels of understanding (Khan & Madden, 2016; Sivan et al., 2000). For example, Khan and Madden (2016) used speed learning as an active learning strategy to maximize college students' learning and engagement. Through in-depth case study analysis, results illustrated that speed learning promoted understanding of course materials within a limited amount of time. When considering these active learning strategies, it is crucial to acknowledge their potential implications for SRL. While not explicitly explored in prior research, it can be inferred that the effectiveness of these strategies may be due, in part, to students' self-regulatory behaviours. Iran-Nejad (1990) and Iran-Nejad and Chissom (1992) demonstrated that active learning and executive control are sources of self-regulation. Learners who deliberately engage in resource-searching, resource-using, or resource-making self-regulate their own strategic planning for learning. Therefore, in our proposed framework, we explicitly address the connections between active learning and SRL, so we argue that active self-regulation must be supported and accompanied by a resourced-based intelligent virtual agent - in this case, a chatbot. The inclusion of SRL within the context of active learning strategies has the potential to further enhance learners' overall learning experience and outcomes.

SRL is guided by two processes: metacognition and strategic actions of study, such as planning, monitoring, and evaluating (Winne & Hadwin, 1998). Learners are required to monitor and adapt learning processes based on goal setting, feedback, and study tactics, thus being more active and engaging. As suggested by Iran-Nejad's work, when a learner encounters a problem-solving task, they mentally search for the best strategic plan that solves the problem at hand. The word 'active' thus implies learners' initiation of resources that assists with solving the problem they encounter in learning (James et al., 2002). Consequently, SRL is an essential aspect of active learning and can be fostered through various methods (Bell & Kozlowski, 2009; Lord et al., 2012; Manganello et al., 2019). A review conducted by Panadero (2017) compares the dominant six SRL models based on their current state and new empirical data available. One of the primary insights gained from Panadero's review is the significance of adopting multiple perspectives on SRL in a learning scenario. In the context of active learning, while various studies have demonstrated a positive impact on student motivation, it remains unclear what factors contribute to this increased level of enthusiasm and why active learning is effective in promoting student engagement. Furthermore, it is essential to examine students' decisions during the preparatory, learning, and post-learning stages once they are motivated and ready to take further learning actions when interacting with or guided by chatbots. Currently, available evidence lacks documentation of this type of learning process. Ultimately, an important question to consider is how educators and researchers can leverage SRL models to design effective interventions (i.e., with personalized chatbots) that promote student motivation and engagement in active learning contexts.

2.2. Effects of personalized chatbots in educational context

Personalized learning is often the goal of computer-assisted education, as educators can tailor their instructions to the needs of diverse student populations (Hwang et al., 2020; Murphy, 2019). Intelligent Tutoring Systems are developed to "mimic personalized human tutoring in a computer-based environment" (Kochmar et al., 2022, p. 324). Personalized chatbots, considered part of an AI tutoring system in this paper, can deliver personalized feedback during student learning and impact achievement. Several research has shown chatbots' positive effects in the educational context (e.g., Kerly et al., 2007; Pérez et al., 2020; Tsivitanidou & Ioannou, 2021). Baskara (2023) indicated that chatbots could provide personalized support and feedback, facilitate group discussions, support self-directed learning, and enhance student engagement and motivation. Similarly, Kohnke (2022) developed a personalized chatbot that can offer differentiated instructions to support language learners. Lin and Chang (2020) designed a chatbot to tailor writing instructions on argumentative essay outlines and peer feedback. Additionally, chatbots can supplement class activities and promote active learning. Despite positive effects reported in research and literature, it remains unclear whether these effects solely result from the chatbot's personalized guidance or learners' strategic decisions. Therefore, it is necessary to investigate the specific actions and perceptions of assessment standards elicited from learners during their interactions with chatbots. By gaining a deeper understanding of these dynamics, we can advance our knowledge regarding the impact and effectiveness of chatbot sessions in enhancing student learning. Therefore, our proposal here reviews previous research in SRL and active learning practice to advance our understanding of utilizing personalized chatbots. Drawing upon this inter-connected knowledge, we develop a pedagogical framework that positions a personalized chatbot along with active learning and SRL. We hope that our framework helps teachers to design instructions, so learners can better interact with personalized chatbots along with the focus on active learning and SRL. Through this framework, we also hope that we can guide future theory development and empirical work. This framework provides valuable insights into the role of chatbots in promoting effective learning outcomes and experiences.

2.3. Personalized chatbots for active learning and SRL

A significant research gap regarding utilizing AI chatbots to foster SRL within active learning contexts has been identified. This observation highlights the need for further investigation because (1) the integration of chatbots in classrooms can be viewed as a learner-driven active learning and teaching strategy that enhances motivation (Baskara, 2023; Fidan & Gencel, 2022; Wollny et al., 2021); (2) limited exploration (e.g., Kohnke, 2022; Lin & Chang, 2020; Vasconcelos & Santos, 2023) has been undertaken to understand the specific strategies learners acquire following interactions with AI chatbots; (3) there is a dearth of knowledge regarding the metacognitive awareness and SRL strategies developed by students in their respective disciplines through conversations with chatbots (Kılınç, 2023; Sáiz-Manzanares et al., 2023; Vasconcelos & Santos, 2023). We believe that addressing these areas of inquiry will contribute to a more comprehensive understanding of the potential impact and implications of incorporating AI chatbots in educational settings.

Considering the positive effects of personalized chatbots highlighted in the literature, chatbots have the potential to support active learning and SRL by encouraging or prompting students to take an active role and providing personalized feedback (Kerly et al., 2007; Lin & Chang, 2020; Vanichvasin, 2021). Lee et al. (2022) also found that the chatbot improved students' learning performance, self-efficacy, and motivation, indirectly leading to more active learning. However, the effectiveness of chatbots in education is influenced by various factors, such as students' personality traits, educational background, social and technological skills, self-efficacy, self-regulated skills, and instructors' attitudes toward chatbots (Tsivitanidou & Ioannou, 2021; Winkler & Söllner, 2018). Despite these considerations, creating a customized chatbot has the potential to enhance active learning and SRL by providing tailored feedback and personalized learning experiences (Du et al., 2021; Kuhail et al., 2023).

Through a rigorous examination of the extant theoretical and empirical literature surrounding SRL, active learning, and personalized AI chatbots, we have formulated a comprehensive framework that provides guiding pedagogical principles. This framework aims to clarify how personalized AI chatbots can augment students' SRL and active engagement, considering their increasing use in education to provide personalized learning support, enhance student engagement, and scaffold SRL. Our review also emphasizes the need for effective strategies to integrate personalized chatbots into active learning and SRL environments. By addressing the research questions, this paper contributes to understanding the potential of personalized chatbots in enhancing active learning and SRL in educational settings.

3. CHAT-ACTS: theoretical framework for personalized chatbots in active learning and SRL

The theoretical framework presented in Fig. 1 consists of a taxonomy that differentiates three modes of learning that learners navigate when they encounter a learning task on hand. This framework is designed to guide the integration of personalized chatbots in SRL and active learning in a formal accredited learning context. The framework comprises three primary modes of learning: Personalized Chatbot, Self-Regulated Learning, and Active Learning, with the learner situated in the centre, symbolizing learners taking independent control of their learning under the three modes of learning. Each learning mode corresponds to several strategic actions that a learner can take when they learn. In this model, we assume that learner characteristics and motivation are inherent within a learner that may indirectly or directly affect each mode of learning.

The Personalized Chatbot mode of learning includes three strategic and dispositional components: Evaluation, Feedback, and Plan. When students chose to engage in the mode of the chatbot, they strategically provide information to the chatbot to obtain information. These components give the chatbot the necessary information to personalize its responses and support the learner's needs (Lin & Chang, 2020; Okonkwo & Ade-Ibijola, 2021; Pérez et al., 2020).

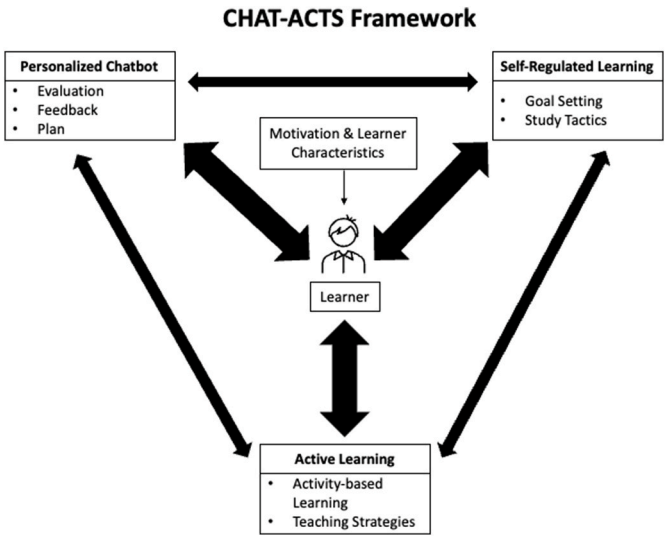

Fig. 1. The theoretical framework of a personalized chatbot engaging with a learner in active learning and SRL context.

3.1. Evaluation, feedback, and plan

These components can be achieved by integrating peer activities in class (i.e., peer review) (Fidan & Gencel, 2022; Lee & Fu, 2019; Liaqat et al., 2021; Lin & Chang, 2020; Lin; 2020), learning analytics for personalized feedback and progress reports (Baskara, 2023; González-González et al., 2023; Kaiss et al., 2023; Okonkwo & Ade-Ibijola, 2021; Pérez et al., 2020; Vanichvasin, 2021; Vijayakumar et al., 2019), and plan for learning support (Carayannopoulos, 2018; Deng & Yu, 2023; Deveci Topal et al., 2021).

In the mode of SRL, learners take control of their learning, set goals, monitor their progress, and adjust their strategies as needed. Our model is based on Winne and Hadwin's (1998) SRL model because it focuses more on the metacognitive aspects of SRL than the other SRL models when learners initiate a study session (Panadero, 2017). Building upon Winne and Hadwin's work, the SRL mode of learning comprises two key components: Goal Setting and Study Tactics. These components are critical for learners to engage in metacognitive SRL practices, enabling them to set and achieve their learning goals, select appropriate study tactics, adapt to changing contexts or feedback they receive, monitor their motivation levels, and actively engage in the learning process by reflecting on their progress and adjusting their approach accordingly (Chang et al., 2023).

3.2. Goal setting

In the SRL scholarship, the prevailing assumption is that SRL is inherently driven by student self-set goals (Latham & Locke, 1991; Wong et al., 2021). However, the impact of goals on SRL remains inconclusive in the literature, prompting substantial attention to exploring the fundamental nature of goals. Cleary and Zimmerman (2001) have contributed to this exploration by identifying distinct goal features, such as process goals versus outcome goals and general goals versus specific goals. Nevertheless, these goal classifications may not adequately encompass learners' agency. In pursuing academic endeavours, learners determine their goals based on their motivational beliefs and goal orientations, including mastery and performance goals. While some learners aspire to master a skill, others prioritize attaining high grades (Kaplan & Maehr, 2007).

According to Zimmerman et al.'s SRL model (2011), the forethought stage is pivotal for shaping learners' goals. Here, self-regulated learners define their motivational beliefs, gauge interest and self-efficacy for tasks, and assess their knowledge and desired outcomes. In the task analysis phase, they set specific goals and plans. Page-Voth and Graham (1999) studied the impact of goal-setting strategies on writing proficiency among seventh- and eighth-graders. Through instructional interventions, students coordinated cognitive processes like idea generation, content evaluation, and targeted element integration. The study found that students using goal-setting strategies outperformed their peers, producing longer, more detailed, and higher-quality essays. Such a result highlighted the essential role of goal setting in enhancing writing performance.

Currently, there is limited empirical evidence regarding using chatbots by SRL individuals for educational purposes and how they employ these AI-based tools. A recent perspective from Chang et al. (2023) argues that the self-set goals established by learners can effectively serve as prompts for chatbots. When learners set goals, they articulate the goals, frame them as prompts, and feed them into a chatbot. Within their conceptual framework, when learners engage with chatbots, they are inherently engaging in SRL activities. This engagement entails the deliberate application of cognitive and metacognitive strategies, the formulation of comprehensive evaluation plans, and the cultivation of explicit learning objectives for each interactive session with the chatbot.

3.3. Study tactics

Study tactics are defined as learning actions that learners enact to advance their learning (Winne & Marzouk, 2019). Skilled self-regulated learners, therefore, apply productive study tactics (Hadwin et al., 2007; Winne & Hadwin, 1998). Study tactics have been operationalized as a series of observable operations and learning events recorded as trace data in a computerized system (Fan et al., 2022). For example, a learner may engage in a series of time-stamped learning actions to construct knowledge, from conducting a Google search for the definition of a concept, clicking a link to a video introducing that concept, and opening up the note-taking software (Microsoft Notes) to take notes.

Furthermore, the integration of chatbots into self-regulated has been a growing area for research (Chang et al., 2023). Chatbots have the potential to serve as a mediator tool in instructional processes by offering personalized and timely guidance that can align with learners' specific study tactics. For instance, a chatbot can recommend specific study tactics for students when they have viewed a page for a long time, such as highlighting or taking notes. In the classroom, teachers can specifically teach students effective ways of highlighting or introducing note templates for students to take effective notes (Winne et al., 2019). These AI-driven functions could foster metacognitive awareness by aligning chatbot interactions with established study tactics and instructions (Chang et al., 2023), enabling learners to reflect on their learning strategies. This symbiosis between active learning strategies, study tactics, and chatbot-mediated instructions offers a new frontier in educational technology that can empower learners to navigate the complex landscape of SRL with greater efficacy and autonomy.

The Active Learning mode includes two contextual clues for learning: Active-Based Learning and Teaching Strategies. Our primary focus lies on teaching strategies, specifically activity-based learning, due to its significant implications for the integration of AI by educators within the learning and teaching environment. These clues aim to provide learners with a diverse range of active learning experiences, negotiation for meaning, and resources, enabling them to actively engage with the content, apply strategies and problem-solving skills, interact with others, and access relevant resources and contents (Bishop et al., 2014; Bonwell & Eison, 1991; Prince, 2004; Sivan et al., 2000).

3.4. Activity-based learning & teaching strategies

Within the traditional education system, students receive instructions, and educators anticipate developing skills, acquiring concepts, and cultivating specific capacities. Pedagogical practices rooted in *x-based approaches or X-BL* often prompt researchers to seek validation and legitimacy by measuring their impact on student achievement. For instance, inquiry-based learning, originating in the Socratic method, encourages students to explore topics of interest while teachers facilitate learning through follow-up questions. The work of John Dewey further underscores that learning thrives when students actively engage in their thinking and are empowered to exert control over their learning trajectory. However, current education research tends to define "active" in finite or indefinite terms, often revolving around student agency, motivation, or the value students place on learning. This has led to challenges in isolating the specific effects of pedagogy amid the entanglement of motivational elements.

The domain of 'active learning' encompasses diverse teaching approaches, each with many possibilities. Here, 'x' represents any activity-based modality employed in the educational context (Albadi & David, 2019; Anwer, 2019). As an example, our framework tailored for AI introduces the concept of AI-based learning, wherein teachers integrate AI technologies within classrooms to captivate students through engaging and enjoyable experiences. Additionally, educators may incorporate games into game-based learning to foster student enjoyment and motivation. We would like to call for advancing our theoretical comprehension of AI and its application in the classroom setting. This goes

beyond merely labelling it as AI-based learning or AI-based pedagogy, urging redefining and re-examining students' roles when interacting with AI and probing whether AI assumes a central role in their learning or remains subservient as a supplementary resource. By exploring these dimensions, we endeavour to shed a new light on the relationship between students and AI in the learning process, reimagining the potential impact of AI technologies in educational contexts.

As shown in Fig. 1, the bidirectional relationships between the Personalized Chatbot and SRL modes of learning, Personalized Chatbot and Active Learning modes of learning, and SRL and Active Learning modes of learning are critical in promoting effective learning. These bidirectional relationships guide educators and instructional designers when incorporating chatbots into active learning and SRL environments. The Personalized Chatbot mode can facilitate learners' self-regulated and active learning practices by providing timely and personalized feedback, support, and guidance. For instance, Lin and Chang (2020) designed a personalized chatbot to guide undergraduate students in developing argumentative essay outlines and refining peer feedback. Furthermore, Lin's doctoral dissertation (2020) recommended several principles for designing personalized chatbots to maximize the learning experience. Such personalized chatbots can offer individualized feedback to enhance learners' SRL and active learning. On the other hand, previous research and theorization have not established a direct empirical connection between Active Learning and SRL. As Pintrich and Zusho (2002) wrote, "*self-regulated learning …[is] an active and constructive [learning] process that involves the students' active, goal-directed, self-control of behaviors, motivation, and cognition for academic tasks*" (p. 303). We infer and postulate a link between these two components based on our assumptions that learners who participate in active learning processes also exhibit levels of self-regulation, as described by Pintrich and Zusho (2002). Using self-regulated and active learning strategies by the learner can inform the chatbot's recommendations and adapt its responses to better suit the learner's needs. An example is using generative AI or machine learning to render meaningful data-driven inferences of learner models to help learners to find, access, and retrieve adaptive learning content, which improves SRL and active learning (Kuleto et al., 2021; Lameras & Arnab, 2021). Similarly, the Active Learning mode of learning can allow the learner to apply their knowledge and skills in real-world contexts, which can inform the chatbot's recommendations and adapt its responses accordingly. The bidirectional relationships between the modes of learning and the learners highlight the learner's central role in this framework, emphasizing that effective learning requires active engagement and participation in the learning process.

This comprehensive and integrated approach to utilizing personalized chatbots in SRL and active learning can significantly impact individual learners' learning outcomes. By acknowledging the importance of learner characteristics, feedback, support, assessment, goal setting, study tactics, adaptations, motivation, engagement, strategies, activities, social interactions, contents, and resources, this framework can provide a holistic and personalized learning experience for learners. Educators and instructional designers can use this framework as a valuable tool to develop personalized chatbots that support and enhance learners' SRL and active learning skills. The framework's flexibility allows it to be adapted to various learning contexts and learner needs, making it a valuable resource for designing and implementing effective personalized learning technologies.

4. Possible impacts of the proposed framework

The proposed framework for integrating personalized chatbots into SRL and active learning has the potential to have positive impacts on learners. Here are some of the possible impacts of the framework:

- Enhanced engagement and motivation: Personalized chatbots can provide learners with instant feedback, which can boost their motivation and engagement levels (Baskara, 2023; Yin et al., 2021). By receiving personalized feedback and guidance from a chatbot, learners may be more likely to stay on track with their learning goals and persist through challenging tasks (Chang et al., 2022; Fidan & Gencel, 2022; Pérez et al., 2020).
- Improved learning outcomes: Using personalized chatbots can also help learners achieve better learning outcomes (Lin & Chang, 2020; Vanichvasin, 2021). By tailoring their feedback and guidance to each learner's needs and preferences, chatbots can help learners identify their strengths and weaknesses, set realistic goals, and track their progress, leading to more effective learning strategies and better retention of information (Wang et al., 2021).
- Scaffold and build self-regulation: Personalized chatbots can also support learners in developing self-regulation skills (Chang et al., 2023; Du et al., 2021). Through the provision of prompts intended for reflection and self-assessment, chatbots possess the potential to facilitate learners' comprehension of their learning processes and strategies (Yin et al., 2021). This process, in turn, can help them become more self-directed learners, who can better set goals, monitor their progress, and adjust their strategies accordingly (Winne & Hadwin, 1998).
- Accessibility and flexibility: Personalized chatbots can make active learning and SRL more accessible and flexible to learners (Pérez et al., 2020; Wu et al., 2020). Chatbots can help learners with limited access to traditional learning environments or who want to learn at their pace overcome time and space constraints by providing personalized feedback and guidance anytime.

The proposed framework is intended to enhance learners' engagement, motivation, learning outcomes, self-regulation, and accessibility, paving the way for a more effective and personalized learning experience. By leveraging the potential of chatbot technology, educators and learners can reap the benefits of this integrated approach.

5. Effective strategies for integrating personalized chatbots into active learning and SRL

Integrating personalized chatbots into active learning and SRL requires careful consideration of several factors. Based on the proposed framework, this section discusses effective strategies for integrating personalized chatbots into active learning and SRL environments.

First, it is critical to consider the pedagogical goals of a lesson and how chatbots can support these goals. After the pedagogical goals are defined, instructors can design the tasks for students when they interact with the chatbot. For example, chatbots can be designed to provide personalized feedback and guidance, tailor instructional tasks, set achievable learning goals, and support learners during the learning process. In a peer review writing activity, the students can first work with the chatbot for the first round of revision, and then the chatbot can assign a student author with a reviewer to promote collaborative learning (Fidan & Gencel, 2022; Pérez et al., 2020; Wu et al., 2020).

Second, the design of chatbots should be intuitive, easy to use, and responsive to the learner's inputs, as these factors directly influence user satisfaction (Clarizia et al., 2018; Kerly et al., 2007). Research further suggested incorporating user-centred design principles when designing chatbots for maximizing active learning and SRL, which involves understanding the learners' needs, preferences, and limitations (Ciechanowski et al., 2019; Lin, 2020; Tsivitanidou & Ioannou, 2021). Incorporating adaptive features such as personalized content, feedback, and recommendations based on learners' performance and preferences can facilitate active learning and scaffold SRL. Moreover, chatbots that promote metacognitive skills by encouraging learners to reflect on their learning process and providing opportunities for goal-setting and planning can further enhance the effectiveness of chatbots in supporting SRL. Consequently, we recommend applying Universal Design for Learning (UDL) principles, so chatbots can provide a more inclusive learning

experience that accommodates a diverse range of learners' needs and preferences, ultimately leading to better learning outcomes (Kerly et al., 2007; Lin, 2020; Rose & Meyer, 2002).

Third, regular evaluation and refinement of chatbots ensure their effectiveness in helping learners to achieve the desired learning outcomes and user satisfaction (Lin, 2020; Wang & Petrina, 2013). To facilitate this process, it is essential to collect and analyze data on learner interactions with the chatbot, including the frequency of usage, types of queries asked, and overall engagement levels. Additionally, seeking feedback from learners about their experiences with the chatbot provides valuable insights into its usability, perceived usefulness, and overall impact on the learning process (Kuhail et al., 2023; Sáiz-Manzanares et al., 2023). By incorporating these evaluation strategies, educators and developers can continuously improve the chatbot's performance and tailor its features to better meet the learners' needs and enhance their learning experience.

Taking together, integrating personalized chatbots into active learning and SRL requires a thoughtful approach that considers pedagogical goals, user-centred design principles, and regular evaluation. By leveraging chatbots to provide personalized feedback, guidance, and support, educators can enhance the learning experience and promote active engagement (Hodges, 2020; Vanichvasin, 2021). The intuitive design and adaptive features of chatbots, combined with their ability to promote metacognitive skills and foster collaboration, contribute to the effectiveness of these tools in supporting SRL. Incorporating UDL principles ensures inclusivity and accommodates diverse learner needs (Rose & Meyer, 2002). By following these strategies with our proposed framework, educators and developers can harness the potential of personalized chatbots to empower learners and optimize their learning experiences in active learning and SRL.

6. Conclusion

In this paper, we introduce a pedagogical framework that centers around the individual learner and encompasses three distinct modes of learning: personalized chatbot interaction, active learning, and SRL. The framework emphasizes the dynamic interplay among personalized chatbots, SRL, and active learning, converging around the learner as the focal point. Within the personalized chatbot mode of learning, we encompass evaluation, feedback, and planning processes, enabling chatbots to fine-tune their responses and support each learner's unique needs. In the SRL mode of learning, we incorporate goal setting and study tactics as pivotal components, while the active learning mode encompasses activity-based learning and teaching strategies.

These integrated components form the foundational pillars that underpin and enhance active learning and SRL within the context of personalized chatbot-assisted education. By elucidating these fundamental principles, we aim to provide valuable guidance to educators and developers in designing and implementing personalized chatbots, thus fostering more effective and engaging learning experiences for students.

The proposed framework has several implications for using chatbots in educational contexts. First, it can enhance learner's learning experience, such as engagement and motivation, by providing personalized feedback and guidance, ultimately improving learning outcomes. Second, it can scaffold and develop learners' self-regulation skills by cultivating reflection, goal setting, and monitoring learning progress. Third, it can make active learning and SRL more accessible and flexible by providing learners with support and guidance anytime and anywhere.

The framework also highlights the need for effective strategies when integrating personalized chatbots into active learning and SRL. These strategies include considering pedagogical goals, designing user-friendly chatbots by applying user-centred design and UDL principles, and regularly evaluating and progressively refining the chatbot's effectiveness.

As for future research directions, empirical studies are needed to test the effectiveness of the proposed framework in different educational contexts and with diverse learner populations. For example, future research could apply the proposed framework and investigate the impact of personalized chatbots on learner engagement, motivation, self-regulation, and learning outcomes.

In conclusion, integrating personalized chatbots into active learning and SRL holds great promise for enhancing learner experiences and outcomes. The proposed framework provides a comprehensive and integrated approach to guide the design and implementation of personalized chatbots in educational settings. By leveraging the potential of chatbot technology and its ability to provide personalized support, feedback, and guidance, educators can create more engaging and effective learning environments that promote active learning and SRL.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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