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CULTURAL AND REGIONAL PERSPECTIVES

A classification tool to foster self-regulated learning with generative artificial intelligence by applying self-determination theory: a case of ChatGPT

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Abstract
Generative AI such as ChatGPT provides an instant and individualized learning environment, and may have the potential to motivate student self-regulated learning (SRL), more effectively than other non-AI technologies. However, the impact of ChatGPT on student motivation, SRL, and needs satisfaction is unclear. Motivation and the SRL process can be explained using self-determination theory (SDT) and the three phases of forethought, performance, and self-reflection, respectively. Accordingly, a Delphi design was employed in this study to determine how ChatGPT-based learning activities satisfy students' each SDT need, and foster each SRL phase from a teacher perspective. We involved 36 SDT school teachers with extensive expertise in technology enhanced learning to develop a classification tool for learning activities that affect student needs satisfaction and SRL phases using ChatGPT. We collaborated with the teachers in three rounds to investigate and identify the activities, and we revised labels, descriptions, and explanations. The major finding is that a classification tool for 20 learning activities using ChatGPT was developed. The tool suggests how ChatGPT better satisfy SDT-based needs, and fosters the three SRL phrases. This classification tool can assist researchers in replicating, implementing, and integrating successful ChatGPT in education research and development projects. The tool can inspire teachers to modify the activities using generative AI for their own teaching, and inform policymakers on how to develop guidelines for AI in education.

Keywords Generative AI · ChatGPT · Self-determination theory · Self-regulated learning · Motivation · Digital support · Delphi study

Generative artificial intelligence (GenAI) can generate text, pictures, 3D models, animations, or other content, and its technologies are becoming more powerful, useful, and prevalent, being incorporated into mainstream applications. This emerging technology has influenced education by developing interactive learning experiences, providing tailored coaching, and even producing instructional resources such as worksheets and

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videos (Chiu, 2021; Kasneci et al., 2023; Rospigliosi, 2023). GenAI may have the great potential to transform the way we learn and access information by adapting to individual needs and preferences, making education more accessible and engaging for all learners (Chang & Kidman, 2023; Chiu, 2023). There is an urgent need for research into the most effective ways to use GenAI in education in order to enhance learning outcomes for all learners (Chiu, 2023; Kasneci et al., 2023; Rospigliosi, 2023). Some argue, however, that depending too much on these technologies may result in a reduction in human interaction, individualized guidance, and higher-order thinking skills, all of which are essential for effective learning. There may also be concerns regarding the accuracy and reliability of AI-generated educational resources (Farrokhnia et al., 2023; Rospigliosi, 2023). Furthermore, self-regulated learning (SRL) is regarded as a prerequisite for life-long learning in higher education (Roth et al., 2016). Its process can be seen as a cycle model of three main phases: forethought, performance, and self-reflection (Zimmerman, 2011). SRL is closely linked to academic accomplishment in students and work-related learning in adults (Sitzmann & Ely, 2011). Individuals with strong SRL abilities must be able to learn independently and deal with a wide range of challenges (Peverly et al., 2003). As a result, GenAI may be able to both engage and disengage students in SRL.

These student engagement and disengagement can be explained using the construct of motivation that is the force that energises students to be engaged in a particular activity (Chiu, 2021, 2022; Olivier et al., 2021). Self-determination theory (SDT), one of the most popular theories in current behavioral science, provides a wide framework for understanding the elements that enhance human motivation and well-being (Ryan & Deci, 2020). SDT co-founders Richard M. Ryan and Edward L. Deci suggest that satisfying people's basic needs for autonomy, competence, relatedness, and autonomy is vital for individual and social functioning. This theory is widely applicated in various contexts e.g., workplace, parenting, and learning environments (Manganelli et al., 2018; Ryan & Deci, 2020). Most previous SDT-based educational research was conducted to understand how teachers and digital support (refer to needs satisfaction from digital environments) satisfy student needs (Ahmadi et al., 2023; Chiu, 2021). These two types of support have various effects on student engagement. Empirical studies suggest that digital support from AI is strongly associated with student engagement in overall SRL (Chiu et al., 2023; Wu et al., 2023; Xia et al., 2023). For example, Wuet al. (2023) suggested that in blended learning, ChatGPT significantly improved student behavioural, cognitive, and emotional engagement more than search engines; Chiu et al. (2023) revealed that the use of AI chatbots may not be able to support relatedness of most students, and satisfy competence of low ability students. Besides, how to integrate GenAI in education is understudied, and its effects on student learning are unclear. These imply that how we use GenAI determines if the technology is need-supportive or need-thwarting in each phrase of SRL. ChatGPT, one of the most well-known GenAI tools, is a chatbot built on a large language model. It can communicate with users in a human-like manner. It can respond to questions, write articles, give advice, and create code in a fluent and natural way. To fill this research gap, this study used a Delphi research design to understand how ChatGPT as GenAI supports student SDT needs in each phrase of SRL from the perspective of Hong Kong school teachers.

The findings of this study propose a classification tool to foster student SRL using ChatGPT by applying SDT. This tool contributes to the field of AI in education and SDT-based research by discussing how ChatGPT fosters the three SRL phrases and satisfies SDT-based needs. It can help researchers replicate, design, and implement their educational technology research and development projects using ChatGPT. It can

also give teachers and policymakers ideas on how to teach with ChatGPT and make policies for AI in education, respectively.

The rest of the paper is organized as follows: We begin by outlining the theoretical background for this study and past research on how ChatGPT as digital support fosters SRL and satisfies SDT needs. The study's goal and research design are then described. Following that, we present the results of the analyses, followed by a discussion of the findings and our conclusions.

Theoretical background

SRL and learner motivation

Over the last three decades, general SRL conceptions have evolved (Roth et al., 2016). SRL first appeared in the 1980s and rose to prominence in the 1990s. Despite the enormous amount of SRL research published, there is no unified definition of SRL. Each theory/model focuses on different perspectives (Pintrich, 2000). For example, Zimmerman (2011) suggests SRL consists of self-generated thoughts, feelings, and acts that are methodically directed by personal goals. Zimmerman and Moylan (2009) describe a social cognitive model of SRL that incorporates motivational variables with metacognitive processes in three iterative phases: forethought, performance, and self-reflection. Pintrich's (2002) theory of SRL included forethought, monitoring, control, and refection. These theories and models have clear similarities and suggest SRL should have cyclical and three distinct phases (Bruso et al., 2020). The first phrase is forethought and consists of task analysis and self-motivation beliefs. Learners analyze tasks, set learning goals, and plan strategies based on their prior knowledge. This task analysis is affected by self-motivation beliefs such as self-efficacy and interest, along with personal views of how well the tasks can be performed and the value of learning. The performance phase has two processes: self-control and self-observation. Learners enhance their learning by employing various self-control strategies, such as self-instruction, time management, environmental structuring, and help-seeking, all of which are based on the learners' own self-observations. The phase of self-reflection consists of self-judgment and self-reaction. The self-reaction that learners take in response to their own judgment of their performance and cause attributions can either boost or reduce satisfaction and motivation to learn. Based on their perceived goals, learners evaluate their performance. If the learners are unsuccessful in achieving their goal, the cyclical process starts over by analyzing which task strategies have and have not been successful. Due to this adaptive process, the learners might continue to be motivated to do the activity again in the hopes of getting a better outcome (Zimmerman, 2011). Overall, the SRL cycle requires learners to set goals, evaluate progress, and adjust learning strategies. Learning is self-directed, requiring self-awareness, self-monitoring, and self-motivation, and can be learned through SRL. Related studies SRL strategy use is related to motivational level and personality traits (Bruso et al., 2020; Dörrenbächer & Perels, 2016). Needs satisfaction in SDT of motivation can be used to look at ways to foster the SRL process in each phase.

Digital SDT based support from with ChatGPT as GenAI

SDT theory explains human needs, motivation, and well-being in a social and cultural context (Ryan & Deci, 2020). It suggests three innate needs: autonomy, relatedness, and competence. Individuals' motivation increases when their needs are supported and satisfied, shifting from amotivation to intrinsic motivation. This theory is widely applied in various education contexts, such as face-to-face, online, and blended learning (Chen & Jang, 2010; Chiu, 2021, 2022; Ryan & Deci, 2020). SDT-based research has investigated how teacher support (e.g., behaviors) affects student needs satisfaction in a variety of learning settings, including classrooms, playgrounds, as well as online and blended learning (Ahmadi et al., 2023; Chen & Jang, 2010; Chiu, 2021, 2022; Guay, 2022; Xia et al., 2022). Digital needs support refers to the design of digital learning environments to support student SDT needs (Chiu, 2021). This support can be achieved through digital autonomy, which can be satisfied by multiple resources for the same learning unit; students can choose the resources they prefer (Chiu, 2021, 2022). Digital competence support should consider learner expertise, ensuring that different instructional formats support different levels of thinking skills (Luo et al., 2021). Digital relatedness can be supported by using emotional design and familiar or user-friendly digital tools (Chiu et al., 2020; Valle et al., 2022). Digital support, particularly in AI, has not been extensively studied in SDT-based research (Chiu, 2021; Ryan & Dec, 2020). Accordingly, how ChatGPT as digital support satisfies basic needs remains unclear.

SRL with ChatGPT as GenAI

Four recent studies have speculated that ChatGPT as an AI tool has the ability to promote the SRL process (Chiu, et al., 2023; Molenaar et al., 2023; Wu et al., 2023; Xia et al., 2023). ChatGPT as an AI tool may have the potential to promote the SRL process. Students must remain motivated throughout the forethought phase, actively participate in learning activities during the performance phase, and reflect on and review their learning experience during the self-reflection phase (Pintrich, 2000; Wu et al., 2023; Zimmerman, 2011). As noted in the last section, ChatGPT may be considered a digital support to satisfy student needs for greater motivation, which fosters the SRL process throughout the forethought phase. During the performance phase, students can use ChatGPT to receive new ideas and insights for their learning activities as needed (i.e., when they encounter learning difficulties) (Baidoo-Anu & Owusu Ansah, 2023; Wu et al., 2023). ChatGPT has the potential to keep students engaged in their learning. During the self-reflection phase, students may ask ChatGPT for comments on what they learned and how to improve their learning (Kasneci et al., 2023; Wu et al., 2023). Overall, ChatGPT may provide individualized and interactive educational learning, as well as precise explanations and step-by-step instruction. It may offer students rapid and useful guidance while also answering their queries, and they might successfully develop SRL (Wu et al., 2023). However, its linked activities and impacts have received little attention.

Research gaps

As we discussed, ChatGPT as GenAI is new to school teaching and has the potential to improve and hinder learning (Chiu, 2023, 2024; Kasneci et al., 2023; Rospigliosi, 2023).

We are not sure what ChatGPT activities teachers can teach with and students can learn from. Although ChatGPT is a resourceful, conversational, and one-to-one environment that is focused on the needs of the students (Chang & Kidman, 2023), the impact of ChatGPT-based activities on SRL and needs satisfaction is not clear. Besides, digital (ChatGPT in this study) support requires more attention in SDT-based research (Ryan & Deci, 2020). Accordingly, more studies are needed to explore the learning activities using ChatGPT and their effects on needs satisfaction and the SRL phase.

Additionally, most SDT-based research was conducted in western culture. However, eastern teachers' perspectives may differ from those of western teachers. (for example, individualistic vs. collectivist societies) (Chiu, 2022; Iyengar & Lepper, 1999). Because of this cultural difference, it is important to study this issue from eastern teachers' perspectives. The findings could add to the field of GenAI in education and SDT-based research (digital support) by adding more eastern perspectives.

This study and method

Research goal

This study aims to examine how ChatGPT as GenAI satisfies student needs for autonomy, competence, and relatedness in SRL from a teacher perspective using the Delphi approach. Its goal is to provide a mutually exclusive and collectively listed list (classification tool) of learning activities using ChatGPT that satisfy SRL needs. The two major research questions are: From a school teacher perspective,

- What learning activities can foster the three SRL processes of forethought, performance, and self-reflection?
- What learning activities can satisfy the three SDT needs for autonomy, competence, and satisfaction?

We collaborated with qualified school educators to determine how to use ChatGPT to satisfy each SDT need for SRL. We first compiled a list of ChatGPT learning activities with all the participants, followed by removing some that were no longer relevant and adding those that were. We further clarified the descriptions of each activity and linked each one to an SDT need and an SRL phase. Researchers and practitioners may use the findings to better replicate, execute, and synthesize research in educational technology (GenAI, AI, and ChatGPT) for enhancing student motivation and engagement in SRL.

Research design

As GenAI in education is still in its infancy and exploratory, the ideas on how to use the technology to support learning may not reach a consensus yet. A Delphi study uses an iterative process of questionnaires interleaved with controlled feedback to obtain a reliable consensus view from a group of experts (Dalkey & Helmer, 1963). It is possible to obtain a wide variety of opinions for decision-making. The anonymous process avoids conflicts between experts and encourages objective participation. Therefore, a Delphi design is used to get consensus to answer the two research questions.

Three Delphi rounds are usually enough to create an equilibrium where further rounds do not affect findings dramatically for most studies (Ahmadi et al., 2023; Teixeira et al., 2020). Our panel of SDT school teachers with expertise in educational technology created an initial list of learning activities with ChatGPT, and refined it using three Delphi rounds.

To solicit diverse but authoritative perspectives on how teachers can support student needs using ChatGPT in SRL, we assembled a panel of school teachers with different major teaching subjects. The teachers (i) had experience in designing and implementing learning activities with ChatGPT for 5 months (considered as an "experienced teacher" as it is new to schools), (ii) had at least 3 years of SDT-based teaching experience in schools, (iii), received at least 6 h of professional training on SDT, and (iv) received at least 6 h of professional training on ChatGPT. They all have experience in designing and executing SDT-based instructional design for blended learning and in using ChatGPT to design and deliver their learning activities.

No minimum panel size is set as there is no reached consensus to determine the sample size of Delphi studies (Jorm, 2015). Previous research on developing classifications used 10–34 participants (Ahmadi et al., 2023; Teixeira et al., 2020). To control for attrition, we invited and involved 36 participants from three university and school partnership projects on AI and education, or SDT, for this study. Their major teaching subjects included English (7), Chinese (7), Mathematics (7), Science (6), Humanities & Art (5), and Technology (4). Their schools covered the various academic levels of the students in Hong Kong.

Participants

Due to the cultural differences—eastern versus western schooling, or individualistic versus collectivist cultures (Iyengar & Lepper, 1999), teachers in the east may have a different perspective on ChatGPT's needs support from the west. Most of the SDT-based studies for education were conducted in the west. As a result, it sought to investigate the goal from an eastern perspective. It recruited 36 teachers ranging in age from 25 to 55 from 15 Hong Kong schools. Twenty were female, and sixteen were male. They all meet the selection criteria for this Delphi study.

Research procedures

First, together with the teachers, we created the initial list of SRL activities using ChatGPT. To our knowledge, not much rigorous research has been done on ChatGPT for school education because it is new in schools, especially when it comes to SDT and SRL viewpoints. Most of the discussions happen in higher education, particularly in assessment (Chiu, 2023). As a result, we compiled learning activities from (i) journal papers pertaining to digital support, (ii) online discourse and viewpoints from academics, researchers, and educators, as well as (iii) instructional designs created by the practitioners in our workshops. We also asked the participants to suggest at least 10 ChatGPT learning activities. Due to the significant redundancy that ensued, we grouped related activities and eliminated those that ChatGPT does not offer. As a consequence, the initial list had 31 activities. We distributed the survey online for this study.

In Round 1, the teachers gave qualitative comments on each learning activity's label name, description, and reasons. They also assessed the activity's relevance to SDT and SRL. When the activity is relevant, they indicate which SDT needs and SRL phases are primarily impacted by the activities. At the end of the survey, we gave the teachers a full

list of learning activities and asked them to determine whether any activities looked to be duplicates. To assist in developing a more thorough list, the teachers were also invited to suggest any other activities they believed were missing from the list. After each round of the Delphi process, we refined the learning activities in response to the teachers' feedback. Where action recommendations involved major changes (e.g., substantially different function descriptions), the revised learning activity was considered a new activity. In response to teacher comments following each round of the Delphi process, we made modifications to the learning activities. Revised learning activities were regarded as new ones in the next round. We sent the teachers the most recent list of activities, together with information on how they affect SRL phases and SDT needs, in Rounds 2 and 3.

In Rounds 2 and 3, we sent the teachers the most updated list of activities, together with information on how they affect SRL phases and SDT needs. The teachers had the option of using or not using the comments in their revised decision. Regarding the label, description, and reasons for the activity, they were requested to provide qualitative comments. Then, we asked them to describe how each activity affects the phases and needs. At the end of each round, we also asked them to mark any redundant activities and add any that were missing. An activity was added to the final list of learning activities using ChatGPT when consensus was established about its impact and no modifications were suggested.

Consensus criteria

There are no predetermined standards for reaching consensus on every topic in each Delphi study (Keeney et al., 2006). Getting every participant to agree on a single item in a survey is simpler than getting them to agree on six items, or on a binary option, than on five-point Likert scales. As a result, creating consensus criteria is an inherently subjective process that requires taking into account the nature of questions and the scale of answers, as well as the number of participants. A systematic review study by Diamond et al. (2014) revealed that only around half of Delphi studies defined and reported an exact agreement level; those that did reported agreement levels ranging from 51 to 95 percent. In this study, we used a 75 percent agreement level, aligned with previous similar Delphi studies (Ahmadi et al., 2023; Teixeira et al., 2020). After the three rounds were completed, we compiled contentious activities that some teachers had said should be removed because they were redundant. We asked the teachers to indicate which activities should be removed. The activities that were agreed upon by more than half of the teachers were removed.

Results

Round 1 and 2

The Delphi Round 1 survey was completed by the 36 teachers. Three of the thirty-one learning activities on the initial list came to an agreement. We combined 13 activities into 6, removed 1, and proposed 2 new activities based on the qualitative comment. Then we sent the 22 learning activities that failed to come to an agreement to the teachers in the next round for more comments. All the teachers completed the survey in Round 2. Of the 22 activities, 10 activities came to an agreement. We used the qualitative comments to combine seven activities into four and remove one. Then we sent the eight activities that failed to come to an agreement to the teachers for more comments in Round 3.

Round 3

All the teachers completed the Round 3 survey. Of the 8 remaining activities, 7 reached consensus, and one was removed. Table 1 shows all the learning activities and their descriptions; Table 2 shows all the learning activities and their impact on SDT needs and SRL phases. The analyses after the three rounds revealed that the teachers in Hong Kong suggested 20 learning activities using ChatGPT that could satisfy SDT needs to foster SRL in schools. They search information, get examples, check their answers, generate review questions to check for their understanding, create new problems for practice, create challenging problems, get insight into complex problems, ask ideas for their improvement, make lists or outlines, summarize their own work, ask for definitions, generate questions for discussions, generate questions for essays, get feedback for their work, practice peer feedback, prepare for tough conversations, visualize a problem, anticipate ChatGPT's outputs, grade ChatGPT's outputs, and debate with ChatGPT.

Overall, the majority of learning activities (11 out of 20) could better satisfy students' basic needs for competence, followed by learning activities that better satisfy students' needs for autonomy. The fewest activities are in favor of relatedness. Moreover, the results reveal that in SRL phases, both performance and self-reflection are better supported by eight activities using ChatGPT. Forethought is better supported by four activities.

Discussion

This Delphi study suggests a classification tool to foster student SRL by applying SDT from the teacher perspective. It identified and categorized 20 SDT-based learning activities using ChatGPT for SRL. As we discussed in the literature review, ChatGPT has the potential to motivate or demotivate students in SRL (Chiu et al., 2023; Kasneci et al., 2023; Rospigliosi, 2023). How ChatGPT impacts SRL and needs satisfaction remains unclear. More research is needed to investigate how ChatGPT-based activities impact needs satisfaction and the SRL phase. Moreover, a relevant classification tool is needed to guide practitioners and scholars to teach and conduct intervention research. The tool proposed in this study could advance the field of GenAI in education and SDT-based research.

In this paper, the results have five major theoretical and practical implications: (i) how ChatGPT satisfies SDT-based needs, (ii) how it supports the SRL process, (iii) what the list suggests, and how to use the list of ChatGPT based learning activities in (iv) research and (v) teaching.

First, the results revealed that more ChatGPT-based learning activities could adequately satisfy student needs for competence. The nature of this emerging technology may be the driving force behind it. ChatGPT provides students with instant, tailored feedback and is very informative (Chiu, 2023, 2024; Javaid et al., 2023). The answers to the students' queries and issues are available anytime and anywhere (#3, #11, and #14). Additionally, students may get more proficient through practice and asking more questions (like #5, #6, #18, and #19). They may believe that they can finish tasks and respond to any queries when using ChatGPT for learning (Gill et al., 2024; Javaid et al., 2023). Furthermore, the teachers thought ChatGPT may provide students with a sense of agency or ownership over their learning. Teachers in conventional teacher-centered classrooms could offer new problems or questions to the class or give instructions. In non-AI technology-enhanced classrooms,

Table 1 Learning activities using ChatGPT derived through the participants' consensus

	Learning Activities	Descriptions
When teachers design learning activities, students use ChatGPT to …		
#1	Search information	Allow students to get a more complex source of information than information from a search engine. ChatGPT is viewed as a smart search engine
#2	Get examples	Allow students to get more examples for a topic or problem
#3	Check their answers	Ask students to compare their answers or solutions to those provided by ChatGPT
#4	Generate review questions to check for their understanding	Ask students to generate review questions for them to answer in order to check for their understanding
#5	Create new problems for practice	Ask students to create problems, such as mathematics questions or reading passages, for drilling and practice
#6	Create challenging problems	Ask students to create challenging problems to amplify their achievements and keep them humble
#7	Get insight into complex problems	Encourage students to get a new or different perspective on solving complex problems
#8	Ask ideas for their improvement	Ask students to improve their work, e.g., other ways of solving mathematics problems, as well as writing edits and suggestions
#9	Make lists or outlines	Allow students to make a list for solving a problem or generate an outline for a report or an article
#10	Summarize their own work	Ask students to summarize their work and check whether the summary is good
#11	Ask for definitions	Ask students to get definitions of a term at various levels
#12	Generate questions for discussions	Get ideas from generating questions for classroom discussions when needed
#13	Generate questions for essays	Get ideas from generating questions for writing essays when needed
#14	Get feedback for their work	Ask students to get feedback on their original work
#15	Practice peer feedback	Ask students to practice peer feedback by giving comments on the outputs from ChatGPT
#16	Prepare for tough conversations	Encourage students to have tough conversations with ChatGPT
#17	Visualize a problem	Encourage students to visualize text-based content
When teachers design learning activities, students are expected to …		
#18	Anticipate ChatGPT's outputs	Anticipate the response you would expect from ChatGPT
#19	Grade ChatGPT's outputs	Encourage students to grade outputs from ChatGPT
#20	Debate with ChatGPT	Encourage students to debate a topic with ChatGPT

Table 2 Learning activities using ChatGPT and their impact on the SDT needs and SRL phases derived through the participants' consensus

	Learning Activities	Autonomy	Competence	Relatedness	Forethought	Performance	Self-reflection
When teachers design learning activities, students use ChatGPT to …							
#1	Search information	X			X		
#2	Get examples	X			X		
#3	Check their answers		X				X
#4	Generate review questions to check for their understanding		X				X
#5	Create new problems for practice		X				X
#6	Create challenging problems		X				X
#7	Get insight into complex problems	X				X	
#8	Ask ideas for their improvement		X				X
#9	Make lists or outlines	X			X		
#10	Summarize their own work			X		X	
#11	Ask for definitions		X		X		
#12	Generate questions for discussions	X				X	
#13	Generate questions for essays	X				X	
#14	Get feedback for their work		X				X
#15	Practice peer feedback		X			X	
#16	Prepare for tough conversations		X			X	
#17	Visualize a problem			X		X	
	When teachers design learning activities, students are expected to …						
#18	Anticipate ChatGPT's outputs		X				X
#19	Grade ChatGPT's outputs		X				X
#20	Debate with ChatGPT	X				X	

students also get similar online information (e.g., similar search keywords on Google). There is no interactive or one-to-one information retrieval process in these two types of classrooms. ChatGPT is different and allows students to continuously communicate with ChatGPT to obtain their own ideas, examples, and questions (Gill et al., 2024; Javaid et al., 2023; #2, #7, #9, #12, and #13), enhancing their ownership. Personalized digital learning environments that enable students to voice their desires and get their preferred ideas are more likely to be created (Pataranutaporn et al., 2021). Additionally, the teachers felt that there are not enough ChatGPT-based learning activities that may satisfy student relatedness (only two). This finding is consistent with other previous research that indicates digital needs support has less attention to relatedness (Butz & Stupnisky, 2017; Chiu, 2021; Molina et al., 2022). A plausible explanation is that students still thought of ChatGPT as a machine interface even though it could converse with them in a human-like way. This suggests that in ChatGPT based settings, students might not feel warm and connected (Chiu, 2021). This finding confirms that most SDT-based research on educational technology focuses on the needs for competence and autonomy (Chiu, 2021; Molina et al., 2022). Accordingly, ChatGPT offers benefits and creates new learning opportunities to better satisfy the needs for competence and autonomy.

Second, according to the teachers, ChatGPT-based learning activities can support three SRL phases: forethought, performance, and self-reflection. During the forethought phase, learning activities (#2 and #11) might provide more precise descriptions and examples for problem clarification, along with alternate suggestions for learning strategies (#1 and #9). A clear understanding of problems is more likely to keep students motivated. In the performance phase, the teachers thought that the suggested ChatGPT-based activities in the results may foster SRL processes. Students may practice and obtain additional fresh ideas for solving problems (#7), as well as become ready for applying what they have practiced and learned (#12, #13, #15, #16, and #20) by using ChatGPT. One important procedure in this phase is asking for help, which ChatGPT fosters more effectively than teachers. Students may use ChatGPT to make rapid, customized, and limitless requests (Gill et al., 2024; Javaid et al., 2023). In the final phase, teachers felt that ChatGPT might help students with their self-reflection process by giving them feedback (#3, #4, and #14), letting them practice self-reflection techniques (#18 and #19), and providing them with further suggestions for improvement (#5, #6, and #8). These imply that ChatGPT has the potential to offer a resourceful, engaging, and conversational student-centered environment that is focused on the needs of the students. These findings are aligned with the studies on how to foster SRL through ChatGPT (Baidoo-Anu & Ansah, 2023; Kasneci, 2023; Wu et al., 2023). This environment, which encourages "think pair and share" thinking, fosters the SRL skills of low-ability students while pushing high-ability kids to reach their full potential (Xia et al., 2023).

Third, out of the three SDT-based needs, the only one that ChatGPT learning activities satisfy among all three SRL phases is competence. ChatGPT cannot adequately satisfy relatedness and autonomy at every SRL phase. This suggests that ChatGPT might not be able to satisfy every need of the student on its own. Well-researched teacher needs support is still required for young students' SRL process (Baars et al., 2022). Since school children are still developing, teachers must provide them with direction and guidance. To fully utilize each student's SRL potential, ChatGPT and the teacher should collaborate (Chiu et al., 2023). Despite the fact that needs satisfaction is an integrative concept, autonomy and relatedness are still better satisfied by ChatGPT, according to SDT (Ryan & Deci, 2020). More studies may be needed to investigate how ChatGPT supports needs for autonomy and relatedness in every phase of SRL.

Fourth, the findings provide a classification tool to assist researchers in replicating, using, and integrating successful educational technology research and development projects (e.g., GenAI-ChatGPT, text-image generator, and voice-text generator). To assess whether specific digital learning activities have the greatest impact on needs satisfaction, motivation, and SRL processes, the researchers can use the tools to conduct intervention research to provide more evidence on whether ChatGPT can foster the SRL process. The developers may use activities to improve educational ChatGPT development.

Finally, SRL with ChatGPT is new to school teaching (Xia et al., 2023). Although the classification tool gives suggestions for using ChatGPT to foster the SRL process and satisfy SDT needs, many of these activities are not typical or less common teaching practices. Teachers would need to modify them for their own teaching. The tool also makes a good starting point for many innovative teaching methods. Moreover, policy makers can use this tool for guidelines for AI in education, and run professional development for integrating ChatGPT as GenAI in education.

Overall, this study suggests a classification tool for how to foster student SRL with ChatGPT by applying SDT. As ChatGPT is the most common GenAI tool in teaching and learning, the tool can be applied to other GenAI tools. Researchers and practitioners can use the learning activities suggested in this classification tool to research the impact of other GenAI tools on SRL and satisfaction.

Limitations and future research suggestions

This study identifies six limitations as well as potential research directions. Intervention and experimental research: The effects of each ChatGPT learning activity are not investigated in this study. Despite the fact that the teachers in this study acknowledged that the activities on the list might help with SDT needs satisfaction and the SRL process, ChatGPT teaching and learning are still relatively new and understudied (Chiu, 2023, 2024; Rospigliosi, 2023). It is unclear how it supports SDT needs and the SRL process. Future research might use an experimental or interventional design to examine the impact of each activity on needs satisfaction and the SRL process.

More innovative activities: ChatGPT is an emerging technology that is always adding new features (Chang & Kidman, 2023; Kasneci et al., 2023). Co-design or design-based studies that capture diverse perspectives from engineers, educational researchers, and practitioners are recommended to generate more innovative activities with ChatGPT.

International panelists: the purpose of this study is to gather the viewpoints of eastern practitioners. The findings have made a significant contribution to local and regional research and educational communities. A more diversified panelist, on the other hand, is proposed for a new Delphi investigation (Ahmadi et al., 2023). For example, to completely represent the spectrum of viewpoints, the panel should include SDT and educational technology experts, as well as practitioners from various regions.

Learning diversity: ChatGPT has the potential to narrow and broaden learning diversity, or the digital divide (Chiu, 2023). This was not considered in this study. Individual differences, such as gender and learning capacity, should be included in future research.

Blended learning: this study solely looked at the impact of digital support (ChatGPT). However, blended learning is the most common practice in schools when using technology (Chiu, 2021). Teachers and digital needs support should work together. This classification

may not simply apply to classroom instruction because the aims and contexts differ. In future studies, a new classification tool should include teacher needs support.

Relationships in SDT needs and SRL phases: although this classification tool aims to provide an exclusive classification list, i.e., each activity only serves one need in SDT or one phase in SRL. However, the three needs and the three phases are closely related. They are not mutually exclusive. Future research should use correlational studies to investigate how the activities impact the needs and phases.

Conclusion

Given how this field of AI in education is emerging, this study provides a useful exploratory start to understand GenAI links to the SRL process by applying SDT. To our knowledge, we established the first classification tool of its kind in this study to thoroughly canvass eastern school teacher perspectives on how ChatGPT influences SRL and needs satisfaction. It obtained consensus from 36 qualified school teachers using a best-practice three-round Delphi approach (Ahmadi et al., 2023; Diamond et al., 2014). Eastern teachers differ from Western teachers (for example, individualistic versus collectivist societies) (Chiu, 2023; Iyengar & Lepper, 1999). Because of this cultural difference, this study's findings contribute to the field by adding an eastern teacher perspective. We expect that this tool will make it simpler for researchers to identify better ways to explore how ChatGPT may promote student motivation, as well as for practitioners to adopt those activities to improve student SRL and outcomes.

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Data availability The datasets used for the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests This study got ethical clearance from the author's university. There is no conflict of interests between the author and participants.

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