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Artificial Intelligence As a Tutor: Enhancing Self-Regulated Learning In Transportation Engineering Through AI-Driven Feedback

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Abstract

Background: The contemporary civil engineering landscape, particularly in transportation, necessitates updated knowledge, skills, and practical learning approaches. This study focuses on assessing self-regulated learning strategies through Active Learning in the context of the "Fundamentals of Logistics Services" course within the civil engineering postgraduate program at Unicamp. Methods: Thirty participants, comprising master's, doctorate, and undergraduate students with an average age of 26, engaged in the study. Sixty

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percent attended classes in person, while the remainder attended virtually. The study employed a three-hour lesson format, integrating four instructional methodologies: Kahoot, "Design Thinking," Opposition Group, and Verbalization and Observation Group. The self-regulated learning cyclical model framed the research approach. Students received homework assignments four days before each class, with presentations by students at the lesson's onset and practical implementation of one of the approaches by researchers at the conclusion. Each lesson concluded with a spoken assessment, except for the Kahoot strategy, which underwent its evaluation. Results: The implemented strategies demonstrated positive outcomes regarding student engagement and commitment to coursework. However, challenges related to internet connectivity, particularly affecting the proper execution of Kahoot activities, were noted and criticized. Conclusion: The study underscores the efficacy of integrating self-regulated learning methodologies into transportation civil engineering education. Despite issues like internet connectivity, the positive engagement and commitment outcomes warrant continued implementation. Future iterations of the study propose involving teachers from diverse disciplines to enhance the effectiveness of self-regulated learning approaches.

Keywords: Active Learning, Teaching Method, Self-Regulated Learning, Learning Strategy.

Introduction

Around the world, there is constant development and adaptation in higher education, especially in transportation and civil engineering.

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This is explained by the fact that people are immediately impacted by the political, economic, and cultural environments in all nations, personally and professionally. They discuss social media, technology, the Internet, and their difficulties with younger Generation Y pupils and others. Schools and teachers attempt to reinvent and update themselves to meet these ever-changing problems.

Table 1:

Reference
Ilbeigi, M., Bairaktarova, D., & Ehsani, M. (2024)
Padilha Alves, L., Fadel Miguel, R., Holdorf Lopez, M., & Beck, A. (2024)
Ibars, A., Peña, A., & Torre, J. (2024)
Lima, A. et al. (2024)

Table 2:

Reference
Lemos, C. et al. (2024)
H. Li et al. (2024)
Martins, F., Lordsleem Jr, S., & Pedrosa, R. (2024)
Winson, C., Narayana, S., Sailaja, T., & Kashyap, A. (2024)

Planning, fostering a climate that encourages student participation, providing opportunities for students to attempt new abilities, receiving feedback on successes and failures, and being motivated to study are all factors that are essential for learning (Ilbeigi, Bairaktarova, & Ehsani, 2024; Padilha Alves, Fadel Miguel, Holdorf Lopez, & Beck, 2024).

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According to the American Society of Civil Engineers (ASCE), a teacher's presence can inspire students as she serves as a role model in the classroom. In class, the instructor can convince his pupils of the material and, most importantly, of the value of Learning. According to him, persuasion is one of the foundations of the concept of self-efficacy: our assessment of our chances of succeeding in our endeavors. Objectives. Assuming feedback on the student's objectives shows them capable, and it should boost their motivation, self-efficacy, and achievement. When students believe they can attain their goals through constant work, self-efficacy keeps them motivated. Argues that developing a resilient sense of self-efficacy necessitates facing adversity head-on and overcoming increasingly challenging tasks with persistent effort (Ibars, Peña, & Torre, 2024; Lima et al., 2024). If new talents work well in practice, they will be employed for a while. Students who employ learning tactics effectively increase their knowledge acquisition and improve their academic achievement. Only when learning and performance align with students' values will they be valued by them.

Additionally, how well students succeed will affect their future value preferences. Teachers need to draw the attention of the younger pupils by utilizing social media, web-based tools, and feedback and opinion exchange. It is crucial to note that the application of learning strategies and persuasion are related. Students' motivation, focus, retention, and reproduction can all be improved by using the tactics in the classroom, practicing under the

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teacher's guidance, and providing more exercises and feedback. The instructor is the change agent (Lemos et al., 2024; H. Li et al., 2024).

A survey evaluating the possible use of cognitive, metacognitive, and dysfunctional learning processes by the 247 students who participated was administered in three Unicamp courses: undergraduate, postgraduate, and specialist. Every student's toolkit of tactics was quite limited, and students in college were particularly susceptible to unhealthy tactics. Outlines the steps involved in implementing Active Learning in the MIT Engineering course, including creating early change incentives, methods for removing obstacles, and a particular set of Active Learning techniques. In the engineering and computer science courses at the Catholic University of Chile, MUÑOZ et al. detail the teaching and learning processes achieved through active Learning. This study relates to the School of Engineering's curricular change during its implementation phase (Martins, Lordsleem Jr, & Pedrosa; Winson, Narayana, Sailaja, & Kashyap, 2024).

Self-Regulated Learning

The topic of how children could become proficient in their educational methods gave rise to the development of self-regulated learning research and theory in the mid-1980s. Converting students' mental capacities into academic skills relevant to tasks and proactive learning behaviors is known as self-regulation. It is expected of students participating in self-regulated Learning that they possess initiative, tenacity, and adaptability (Azam, Farooq, & Riaz, 2024; Wang, Zhang, Yang, Liu, & Skibniewski, 2024).

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Cyclic Model Of Self-Regulated Learning

The self-regulation processes that comprise the cyclical self-regulated learning model include anticipatory thinking, realization, and self-reflection. Every stage serves as input for the one after it. A series of motivating principles in the predictive thought procedure, among which are self-efficacy, task interest and instrumentation, and goal orientation, determine the desire to start the self-regulatory process (Wang et al., 2024).

Anticipatory Thinking Phase

This stage sets up the framework for education and fosters behavior growth. Although they belong to separate categories, task analysis, and self-motivational beliefs are related in this stage. The strategic plan and the objectives are defined as part of the activity analysis. Students set goals to help them reach the intended outcomes before starting their assignments. Individuals participate in strategic planning to develop methods and techniques to help them maximize their activities throughout learning attempts (Chun, 2024; Vosniadou et al., 2024).

Realization Phase

This stage involves task engagement, which involves processes that happen while working and impact focus and behavior. Self-observation and self-control are the two main procedures. Self-instruction, creativity, focus, and activity strategies, all of which assist pupils in directing their Learning, are the different categories of self-control (Ploennigs, Berger, Mevissen, & Smarsly, 2024).

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Self-Reflection Phase

This stage completes the self-regulation cycle by influencing attempts to succeed while in the anticipatory thinking stage. If students feel they are not succeeding, they assess their development and adjust their behavior. They examine the accurate assessments of achievement or failure concerning objectives to self-react (Neto & Amaral, 2024).

Active Learning

Involving learners in the learning process through active Learning has recently gained popularity. However, some academics view it as a drastic departure from conventional education and as just another passing trend in education. Conversely, a lot of educators highly suggest Active Learning as a substitute. The critical components of this approach are the students' purposeful activities, which use tactics that make them reflect on what they are doing and include them in the learning process. This approach inspires Teachers to consider learning and instructing in unconventional ways. For a comparison of active and passive methods, see Figure 1. They conclude that students who engage in active Learning have better attitudes, ideas, and writing skills (Lu, Li, Mi, & Huang, 2024; Zhang, Liu, & Wilson, 2024).

One type of active learning, discussion, outperforms traditional lectures because it helps students retain the information, excites them about continuing their education, and fosters critical thinking. One of the seven excellent practice elements endorsed by Chickering and Gamson in the "American Association of Higher Education and Accreditation" includes Active Learning. They claim that educational

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resources facilitate student participation in the learning process. Active Learning is one of the seven good practice standards that the "American Association of Higher Education and Accreditation" supports. They claim that educational resources facilitate student participation in the learning process. It is not enough for students to sit in class as well as listen to their teachers; instead, they need to discuss as well as compose about what they have learned (Modak & Chakraborty, 2024; Pires, Moustapha, Marelli, & Sudret, 2024).

ACTIONS	ACTIVE STUDENT	PASSIVE STUDENT
To Read	Read with the aim of understanding and remembering	Read but may not understand or remember
Reflect And Think	Connect your knowledge and the new information acquired (books, classes, etc.)	He only thinks a little about the subject, limiting himself to processing the information received.
To Hear	Is involved during classes by taking notes in an organized way	Is not paying attention during class and takes disorganized or incomplete notes
Manage Time	Utilize time effectively	You can waste a lot of time studying, but this time is not helpful for Learning.

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Request Assistance	Understands when you need help and asks carefully	If you seek help, it will be too late.
Accept Accountability	Understand that you are responsible for your Learning, understand what is not working well, and change your study habits to correct it.	Blames others for poor performance; Has the same attitude toward all subjects and doesn't learn from mistakes.
Question The Information	Question new information whenever it doesn't agree with what you already know.	Accepts, without question, everything you read and hear in classes

Figure 1 – Differences between active and passive-adapted learners

Suitable activities foster a profound comprehension of the key concepts that need to be learned, according to Mctighe. Activities should be planned with significant learning objectives in mind and encourage active participation from students. The cornerstone of Active Learning is the implementation of instructional strategies that include students in the learning process. According to SCHUNK, students' social environments are crucial because they allow them to watch how they behave and pick up knowledge, values, norms, and instructional techniques in the classroom. All that students can do is

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see their teachers in action. If they are successful in reproducing, they can remember the information; if not, they are going to attempt again (França, Lyra, Carvalho, & Opolski, 2024; Huesca, Rodríguez-Rosales, Lara-Prieto, Ruiz-Cantisani, & Acevedo, 2024).

In 1915, Dewey asserted that Learning occurred best in the classroom and that teachers and books were no longer the exclusive sources of knowledge. The information came from the hands, eyes, hearing, and entire body, while the teacher and textbook served as the initiator and assessor, respectively. While there are many descriptions of active Learning in the research, most of them relate to the following traits: students participate in the suggested tasks, going beyond simple listening; students participate in high-level cognitive tasks (analysis, synthesis, evaluation); demonstrating emphasizes skill development over information transmission; teaching takes students' values and attitudes into consideration. Strategies must be implemented in an active learning environment to enable students to participate in their assignments and, most importantly, to reflect on their work. It asserts pupils can manage their learning challenges more effectively when using learning strategies. Cognition, metacognition, motivation, feelings, and student involvement are all necessary for learning strategies (Tian, Zhi, Guan, & He, 2024; Tsai, 2024). I concur that more people use the term "self-regulated learning strategy" these days and that it aids students in developing self-regulated learning skills. Ineffective metacognitive techniques, such as "procrastinating," "not paying focus to the lesson," "watching TV while studying," and "being diverted by something while

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studying," are known as dysfunctional or simply dysfunctional metacognitive methods. They hinder pupils' ability to perform well on assignments. The teaching technique will assist in resolving conflicts by applying learning methods. Still, even with perfect mastery of the approach, another factor is that some impact factors are regularly possible. The following is a list of the tactics employed in this case study for both in-person as well as remote learning students (Guo, Liu, Xiao, Deng, & Wang, 2024; Liu, Yang, Huang, & Wang, 2024).

Observation Group And Reporting Group (Gogv)

It's a tactic built around the types of goals meant to be accomplished in fictitious scenarios. The GO group, or observation group, comments on the GV group's discussion of a particular topic while the GV group verbalizes. The groups switch roles after the conversations (Krisna, 2024b).

Kahoot

It is a Personal Response System (PRS) tool that allows students to communicate with each other through questions and answers, much like a clicker. Some refer to it as a quiz game. The teacher sets up the questions and their accurate responses. After gathering every student's response, the Kahoot tool assigns points. Developers John Brand, Jamie Brooker, and Morten Versvik of the Norwegian University of Sciences and Technology (NTNU) created Kahoot in 2012, making it freely available online (Xiang, He, Zou, & Jing, 2024).

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Opposition Group (Go)

Two groups are formed out of the students: one supports a particular subject, while the other opposes it. The roles are switched after the conversations.

"Design Thinking (DT)":

This approach determines people's requirements, behaviors, and preferences through instruments. This approach involves three stages to guarantee the innovation's viability and practicality: listening to decide who should be contacted, cultivating empathy, and identifying requirements and limitations; Create: to comprehend the data gathered in the preceding phase and pinpoint potential solutions; and Implement: to determine the skills required, build prototypes, watch for possible environmental effects, and develop an implementation strategy (Kapoor, Kumar, Kumar, Kumar, & Arora, 2024).

Method

This study used a case study with thirty Unicamp students enrolled in the postgraduate "The Fundamentals of Logistics Services" course in civil engineering, namely in the transport field. The students were master's, doctoral, and occasionally undergraduate students, with an average age of 26. Sixty percent of pupils showed up in person for class. In-person students utilized Google Hangout via YouTube Live. Every lesson lasted for three hours. Active Learning was the instructional strategy employed in this study. The subject matter expert addressed the class on the initial day of instruction regarding lesson planning. You gave an introduction to both of the investigators

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who will be in every session and who are working on creating the methods and interventions that are required for Active Learning. You mentioned that assignments for the class (doc, pdf, and video files) would be sent to the students by email along with additional media four days ahead of time (Yuhanafia, Widodo, Budi, & Julianto, 2024; Zhu, Zhao, Song, & Wang, 2024).

Before class, students should review this content. Presentations made by pre-formed student groups at the start of the classes defined the curriculum. Following the lectures, the researchers used a particular technique related to the lesson's subject. The pupils received a thorough explanation of the method. An oral assessment of the present lesson marked the end of the lessons. "What do you think regarding the dynamics?" "What is the beneficial aspect of the dynamics?" and "How did you feel?" were the questions posed. All tactics were evaluated except for the Kahoot approach, created by the application automatically and answered by students using a notebook or a mobile device. The class's colossal screen showed the students' combined responses (Budi et al., 2024; Lestari, Suwarma, & Suhendi, 2024; Tuloli, 2024).

In the classroom, the following tactics were developed: Group Opposition (GO), Kahoot, Group Observation and Group Verbalization (GOGV), and "Design Thinking. All the strategies ."

Aside from "Design Thinking," which required three lessons, all the strategies were covered in a single class. The interventions adhered to the self-regulated learning cycle model. The topic teacher and the researchers spoke over and meticulously organized the first

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class together. They discussed the tasks and chose the GOGV technique, keeping in mind that there would be students present in person and those participating virtually (anticipatory thinking phase). As determined in the preceding stage, the researchers employed the GOGV approach during the lesson. The observing group and the one that verbalized group were the two groups into which the students were split. The GV group talked about the ideas covered in the class (Deng et al., 2024; N. Li et al., 2024). After watching GV's remarks for twenty minutes, the GO group offered their observations and pointed out any mistakes or overlooked details pertinent to the field. Following this stage, the groups switched roles, and the Implementation Phase was repeated. Following each lesson, there was a verbal assessment of the current class in which the students were allowed to share their thoughts and critiques (self-reflection phase). This stage was crucial because, in collaboration with the instructor, the researchers supported lesson planning for the upcoming class (Anticipatory Thinking Phase), which enhanced the research and started a fresh cycle of the self-regulated learning model (Kadam, Mishra, Iyer, & Deep, 2024; Lane, 2024).

Result

The Kahoot tactic was the next one. The teacher and researchers prepare ten questions on the subject in a questionnaire. The researchers used this questionnaire in the Kahoot (Anticipatory Thinking Phase). Students received the approach and completed the questionnaire on the day of the lecture. The accurate student percentage was immediately shown on the presentation screen via

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Kahoot. Everybody commented on every question (Implementation Phase). After the class, Kahoot created an automated survey with four typical inquiries to assess the use of the platform as a strategy: 1. "How fun was the experience? "; 2. "Did you learn anything? "; 3. "Would you suggest this strategy? "; and 4. "How did you feel?" with a 100% positive response. The following were the verbal assessments of the various strategies (Bader, Abotaleb, & Hosny; Yang).

What are your thoughts on the dynamic? Response: It was unique and creative, and most students thought it was great.What is Dynamics' strong point, please? For most students, the opportunity to engage in novel dynamics is the answer. What emotions did you experience? The internet connection speed needed to be faster to use Kahoot effectively. More participants and more time to apply the dynamics would be ideal. Additional remarks that are more focused on the tactics employed: students expressed their appreciation for the GO method's ability to allow them to put themselves in the shoes of others and their opinion of the "Design Thinking" strategy as being beneficial, enjoyable, and effective at promoting Learning (Leathem, Wetzel, & Farrow, 2024; Sanzana, Abdulrazic, Wong, & Yip, 2024).

Discussion

The teacher and researchers were inspired to conduct more research because of the pupils' enthusiastic comments about the tactics employed. When utilizing Kahoot's Personal Response System (PRS), interest was piqued. Because of the teacher's quick corrections and explanations of the eliciting question, which the students respond to through Kahoot, this tool enables students to exercise self-regulation.

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Increased student participation allows them to reflect and consider the topic at hand. This study's application of the cyclical model of self-regulated Learning allowed for a satisfactory exploration of the Self-Reflection Phase, which allowed for the questioning of essential processes and the distinction between concepts taught in class. The inability to get a reliable Internet connection has prevented advancement. The student may get demotivated as a result, losing interest in the assignment and the instrumentality associated with the chosen strategy in this example, Kahoot (Chan, Ismail, Sani, Yahya, & Yusop; Krisna, 2024a).

Conclusion

Valid results were obtained for the case study by applying the Active Learning instructional approach through self-regulated learning strategies that adhered to the cyclical model of self-regulated Learning. It also highlights the possibility of new applications incorporating different instructors and disciplines, which would improve the efficiency of the teaching-learning process. Because Kahoot is interactive and engages students, it is a more successful strategy for self-regulated Learning than other approaches. Future research can use a broad spectrum of instructional methods and learning tactics.

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