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PAPER

The Influence of Mobile Technology on STEM Education Student Learning Outcomes

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ABSTRACT

In many educational institutions, the adoption of mobile learning continues to be a growing topic. As has been considered recently, wireless technologies are currently employed by mobile technology to spread and exchange data via thinking, communicating, exchanging, and understanding. As a consequence, merging mobile technologies into teaching and learning can enhance the ambiance in higher education. Thus, the purpose of this investigation is to implement mobile learning to examine students' applications in the framework of educational technology. The use of mobile technologies in STEM education is always efficient and engaging for the students. According to its potential to redefine traditional classroom learning paradigms, the inclusion of cellular phones into STEM (science, technology, engineering, and mathematics) education has drawn significant interest. Three artificial intelligence education (AIEd) paradigm structures are utilized to narrow our exploration of how AI is influencing the STEM sectors. An established cross-disciplinary topic of research dealing with leveraging artificial intelligence (AI) approaches to improve training is defined as AIEd. There seems to be an increasing desire to harness AIEd's promise to tackle academic barriers in STEM fields. The implications of mobile phones on the educational outcomes of students in STEM education settings are explored in this study. By performing a deep review of existing scholarship and empirical investigation, we look for the impact of mobile devices, functions, and platforms on pupil engagement, understanding, and performance in multifaceted STEM fields. A learning approach entitled STEM Project-Based Learning merges project-based curriculum design with the STEM approach to education. As a whole, pupils' science and technology literacy were improved by the STEM mobile learning package on the ecosystem. Certain learning packages deserve to be studied isolated, while others might be given outright during offline or personal conversations.

KEYWORDS

mobile learning, science, technology, engineering, and mathematics (STEM), mobile technologies, artificial intelligence (AI), new learning approach, literacy improvement

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1 INTRODUCTION

By employing better techniques (technology) and problem-solving in various settings, kids and adolescents accelerate the overall cognitive development process and build the cognitive mechanisms required to deal with other problems in other contexts (metascience). Students are between the ages of 14 and 17 in high school. In comparison with the initial stages of cognitive development, in which an infant only frequently handles problems through applying apparent logical modifications to stimuli, learners at this point in history begin to solidify their hypothetical-deductive capacities. When individuals solve problems in different settings and with more advanced tackles (technology), children's and young people's cognitive development speeds. This lets learners pick up the thinking instruments essential to address other difficulties in various circumstances (metascience). At this age, pupils can engage in cognitive, behavioral, and emotional engagements; therefore, they must stay engaged in new surroundings. These three proportions of student assignment are defined in the following order: (i) behavioral engagement, where students present compliance with social expectations, such as presence and engrossment, and the lack of troublesome or harmful habits; (ii) sensitive commitment, at which learners indicate affective reactions, consisting of enjoyment, interest, or a sense of belonging; and (iii) cognitive engagement, at which students are involved in their learning, keen to go far beyond the call of obligations, and enjoy problems. Figure 1 demonstrates when science, technology, engineering, and mathematics (STEM) and artificial intelligence (AI) may collaborate to enhance student engagement [1]. The phrase mobile learning, also defined as ubiquitous learning, principally concerns the implementation of academic services employing handheld digital devices. With the advent of the Internet and wireless technologies, learning can happen anywhere at any time with the adoption of handheld devices into the school. Mobile advancements not only enable flexibility, and ubiquity but ultimately need a moment on the strategies of normal educational institutions. Six crucial modifications regarding smart education with smart mobile devices will influence education: The Internet's quantity of information has made it attainable for consumers to collaborate, build numerous organizations, and acquire knowledge without ever relying upon educators. Mobile devices are more realistic for genuinely personalized learning and can be considered as a variant of human organs. Flexible thinking has taken over closed-mindedness in learning alongside. An online presence in a real-life classroom is not anymore mandatory. The classroom can be interconnected to the outside world using text, voice, video, rich media, holograms, and augmented reality. The conventional curriculum completely transformed in the digital age; learning has encountered a revolution instead of an evolution. The obligations of teaching in China's higher education institutions have been raised for scientists. Considering they can access knowledge from the Internet, youngsters are less inclined to care about the monotonous and complicated lecture-based instruction that gets in the classroom. Beyond ever before, the objectives of a multilayered portion of high-tech media have been fulfilled. In contrast, ready-made video lectures and audio learning tools are still an important component of online courses, which are essentially text-based. Consequently, for online course designers and providers, "engaging learners in substantive education is a devastating and ongoing challenge" [2].

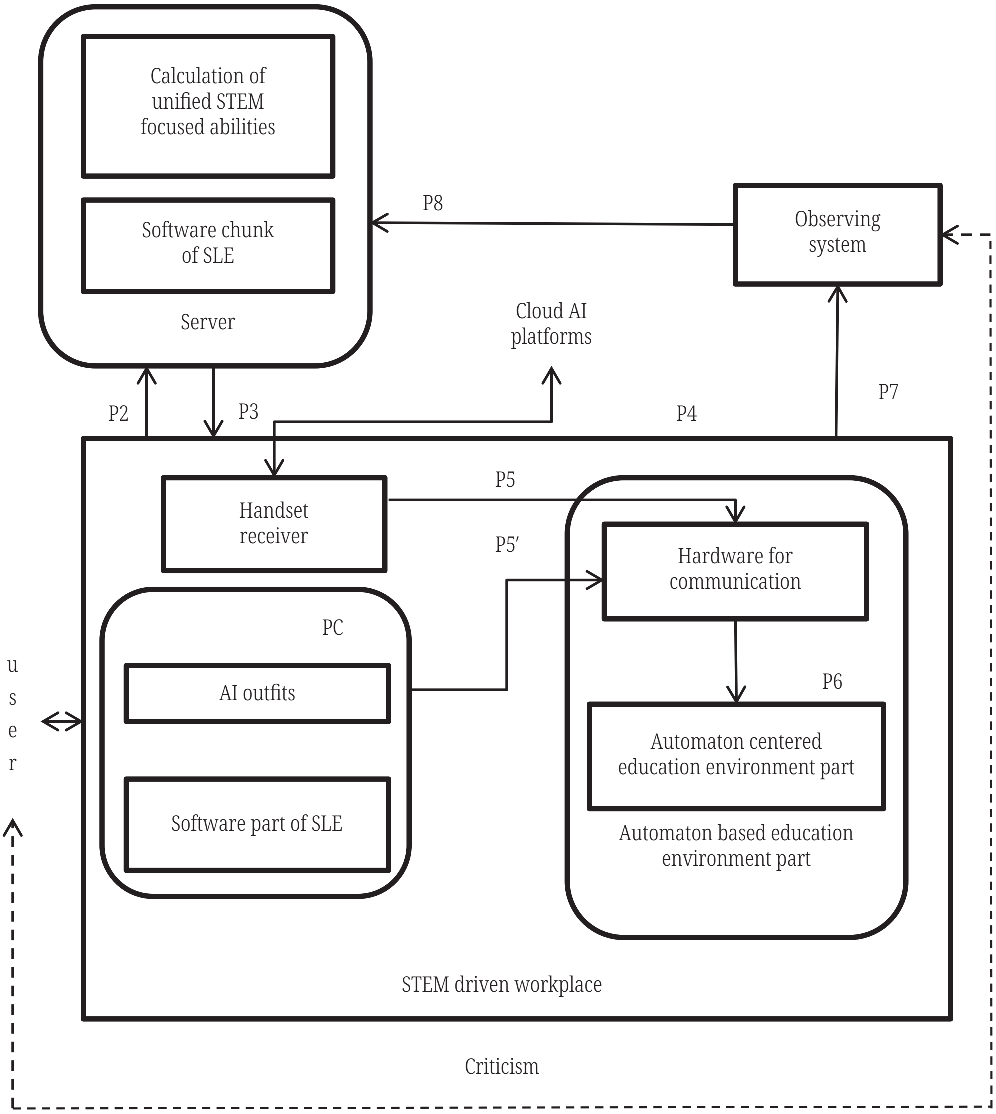

Fig. 1. AI and STEM tasks beneath a single architecture

The four dimensions may also be blended by the students. Establishing a teaching model that empowers students to establish relationships among their knowledge and skills is an opportunity for technical lecturers. Research reveals that students utilize integrated understanding and skills when engaging in a STEM environment. All of the STEM subjects are interconnected by students, which is a good sign that pupils can metacognitively integrate every area of learning taught. For instance, science is learned as knowledge about concepts, facts, rules, and laws that should be understood; technology is provided as a skill for managing groups, institutions, knowledge, and critical tools for implementing work simply; engineering is shown as knowledge about conceptualization or constructing tactics to resolve problems; and mathematics is explained as knowledge about integrating numbers and rooms with logical thinking without the requirement for empirical evidence. When all of this knowledge merges, it will begin to make sense. Leveraging STEM approaches to teaching science enables students practical experience integrating all facets of learning. Students can swiftly investigate them according to their integration. One of the researchers believed that incorporating real-world obstacles, this technique assisted children to absorb matters with greater ease. When mastering physical science, students do trials with modern equipment to test scientific ideas or laws. Next, data management guided by mathematical reasoning is used to verify all findings [3]. The initials of the phrases science, technology, engineering, and mathematics are changed to STEM. The development of 21st-century abilities including versatility, communication, social skills, problem-solving, imagination, self-control, and scientific thinking, is greatly supported by all of the STEM disciplines. STEM education aims to establish a technique that promotes integration by developing links through the disciplines rather than addressing these as distinct courses. The development of twenty-first-century skills including finishing issues, support, serious thinking, leadership, scientific thinking, flexibility, entrepreneurship, curiosity and imagination, communication, information access, and use are helped by all the STEM disciplines [4].

The overall topic matter sequence for paper is as follows: Section 3 discusses students' engagement in STEM environments using AI; Section 4 looks at the experimental results of AI in STEM; and section 5 concludes it.

2 RELATED WORKS

To learn how significant gamification through self-determination theory can be embedded in a research-based STEM PBL course, this study [5] acquired survey data from 43 students. To get insight into the feelings of our respondents concerning three main themes—relatedness, competence, and autonomy—we divided them into distinct diversifications. Furthermore, we revealed attitudes toward virtual and actual rewards changed between our classification of self-directed (SD) and not self-directed (NSD) learners. Earlier gamification investigations were predominantly focused on high school or undergraduate students. Research on PBL courses at college levels, which provides obstacles for academic staff owing to deeper demographics and many reasons student backgrounds, is further explored by this study. The shortage of knowledge in the survey's questions, such as the situations beneath which the students will get their badges, was one of its weaknesses. In this case, it might have been conceivable to offer them virtual incentives for mastering this course's library subject on information obtaining.

M-learning is an emerging trend in higher education, but it has been gaining an abundance of popularity among students [6]. It is gradually making itself integrated into the current education. Since employing mobile devices has been so widespread in recent years, there is a likelihood that learning will grow increasingly incorporated into everyday usage. The purpose of the present research was to pinpoint the variances in mobile device use in higher education. Students from three different disciplines who attended school in two academic years (2015–2016 and 2019–2020) were incorporated in the study. The outcome of the exam demonstrated an immediate increase in the use of mobile devices for instruction. It was determined that in the academic year 2015–2016, 1%, 34.3%, 10.4%, and 90.1% of students employed PDAs, tablets, smartphones, and laptops primarily for instruction. They therefore utilize specialized laptop programs with greater frequency. Considering this, it could be good to study how mobile devices are employed for instruction in relation to the specifications of the curriculum and the domains of concentration of the students.

Teachers and administrators overseeing educational institutions may find usefulness in the research findings. The higher education sector must remain up-to-date on m-learning trends for the reason of enabling the full capacity of mobile devices.

[7] The study's conclusions add to our awareness of the adoption and application of digital games in STEM education by demonstrating that they can substantially complement and improve students' learning achievements. Furthermore, we examined the numerous moderator variables that potentially have a consequence on the influence sizes of video games. Based on the observations in this study, three recommendations for further investigation on digital games in STEM education are given. In the beginning, future research should enhance the gameplay appearance and game mechanisms. The influence of various digital gaming categories on STEM education student learning should also be researched. The vast majority of STEM education's knowledge content encompasses abstract and multidimensional ideas. These are sometimes hard for students to understand and quickly sap their eagerness to learn. This hampers people's capacity to soak up and synthesize knowledge. It contributes to their bad academic performance, depressed attitudes, and occasionally course discontinuation. Numerous game categories and platforms have enabled the performance of pupils to improve, but additional research on the inner functioning of digital games will be required by educational professors to better understand their effects.

The outcomes [8] illustrate how, according to Padlet software, improving enrollment in activities both within and outside of the classroom can help students learn more successfully. Students may function on assignments for both groups and individuals in their environment according to the software's many capacities. Youngsters will be working cooperatively on allocated projects, making the events allocated to them faster to raise and less stressful. Students can perform better, and the learning process can be perceived as a greater achievement when they are not highly stressed with regards to concluding their occupation. In line with this study, using Padlet could improve students' understanding of the subjects they are studying. Thus, to accomplish a more successful learning and teaching process, the application of more knowledge software should be encouraged and further developed. Conditions such as inspiration, engaged education, partnership, learning chance to prosper, effectiveness, ease of utilization, and contentment were employed to gauge their participation. The conclusions demonstrate that active learning through Padlet has a noteworthy consequence in boosting students' commitment to classroom activities.

The present research [9] compares traditional learning environments—textbooks, lectures, and hands-on lab work—with MB and VR educational technologies in the area of recall and comprehension of chemistry topics. Although chemistry is a subject that supplies itself well with violently enhanced explanations to help in grasping difficult concepts, we focused on this particular field of education. Recognizing the breadth of these research inquiries is vital if one is to promote supplementary exposition of the problem subject in the classroom. In the end, the present research provides a foundation for assessing whether or not educational technology could ignite high school pupils to engage in STEM fields. With this extensive overview of technology in the classroom, we can assess whether it makes financial sense to conduct further study in this field. We were however able to see changes in the academic performance of youngsters in the classroom, notwithstanding the existence of confounding variables. Future educational investigations should devote effort to splitting aspects since investing in them will be paid off in the type of certified data, which is necessary for education research.

[10] Based on the literature we assessed, challenges outlined, and potential solutions, we support studying engagement analytics as an opportunity to obtain factors of learning overlooked by metrics so far proposed and as tools for reaching out to children about how engagement might change for the better. By combining trace information—which integrates comprehensive descriptions of the behaviors that individuals take in an interface with the kinds of information they process—engagement analytics improve on the types of data that are previously regularly obtained. This stereoscopic different light of engagement presents a creation for participation about how students may participate significantly and with what they could engage differently. As a way to gauge the utility of solutions to engagement-based analytics challenges, we recommend rating themselves based on how effectively they address the cognitive, emotional, and motivational dimensions of engagement in addition to how effectively they facilitate the way teachers and students express about students' engagements in setting targets, progress tracking, and learning modification. To more accurately portray the intricate complexity of inflammation, we recommend carrying out extra studies on the design and interpretation of trace data.

[11] Although the simple fact that STEM professions have been the primary focus of most AI studies, the increasing proportion of artificial intelligence education (AIEd) users has rendered cross-disciplinary approaches imperative. Using AI technologies in hybrid educational institutions will enhance student engagement and the overall level of their education. As technology changes, AI in the classroom will eventually change. Studies on the implementation of AI in the classroom, especially at the university level, have found an insufficient relationship between the application of AI and theoretical frameworks or instructional methods. The essay's primary assertions are the rising acceptance of online learning as well as an urgent need to study the best ways to make students prepared for it. The development of hybrid education, which mixes instruction via the internet and in person, and the potential advantages offered by AI for education are addressed. Furthermore, this article presents an in-depth examination of AI for instruction currently, spanning chatbot and augmented reality applications.

3 METHODS AND MATERIALS

3.1 AI paradigm adjustments for STEM education

In its brief lifespan, AIEd has encountered many different paradigmatic alterations in research, practice, and equipment. The first major advancement is behaviorism-based AI-directed education. According to this paradigm shift, students are mainly assisted by AI systems' perceptions of knowledge and learning pathways when they become acquainted with STEM facts and/or course content. Complex adaptive system theory serves as the basis of theory for the third paradigm in education, nicknamed learner-as-leader or AI-empowered learning. In this paradigm, AI algorithms work as a dynamic agent to promote students' active learning. Under this paradigm, students might develop into effective managers who actively work with AI systems and dynamically customize their private learning. This paradigm is able to group in harmony novel thoughts such human-centered AI systems, human-AI collaboration, and human-centered AIEd. The overall number of AIEd publications from 2010 to 2020 can be seen in Figure 2. As can be noticed, studies concerning all three of these paradigmatic alterations have acquired momentum. It's interesting to consider that a variety of those investigations deal with paradigms that are supported and augmented by AI. These paradigm shifts can be applied to STEM education as a whole, even if they are applicable educational frameworks. This process includes progressively moving STEM education from a teacher-centered learning approach to one that is student-centered (see Figure 2). The three AIEd paradigms in STEM education are discussed in more detail in the section that continues. We also go through the present AI applications for STEM education under these three paradigms, their implications in STEM education, and related design and research.

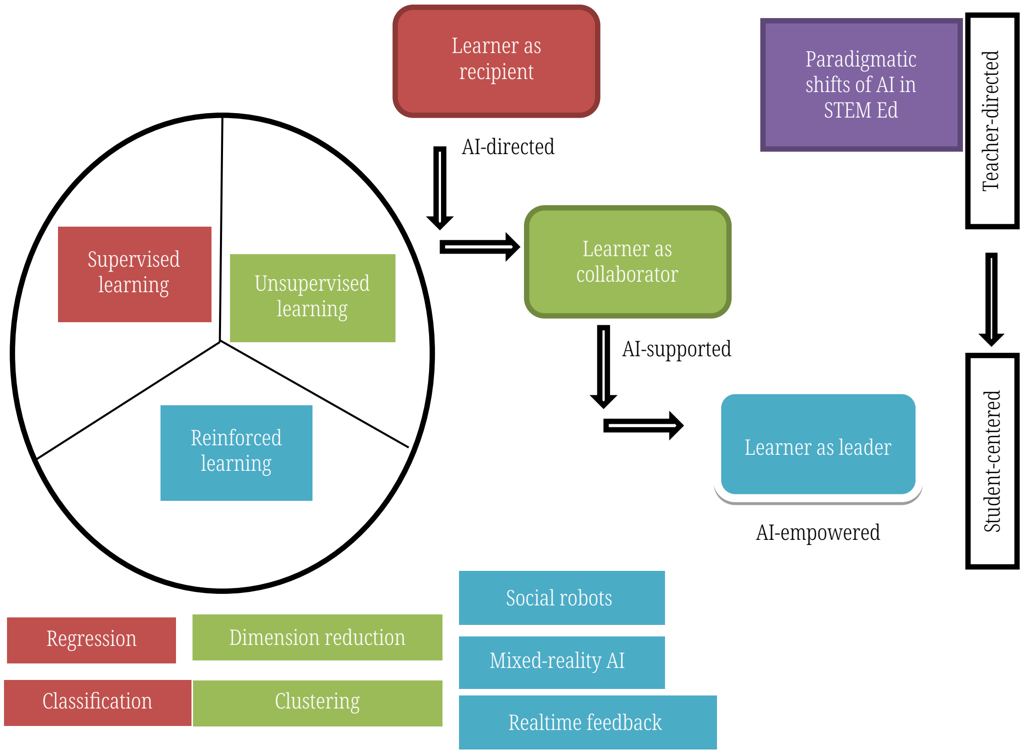

Fig. 2. Three AIEd principles in STEM education are changing

3.2 Paradigm one: AI-directed STEM education

Inside the AI-directed paradigm, the learner performs the posture of a recipient, adopting the AI-enabled learning path, although AI is equipped with specialist knowledge and controls the whole process of learning. Behaviorism focuses an enormous value on promoting children to achieve criteria by offering these students a particular sequence in which they must digest the material. Under the AI-directed paradigm, learning is about presenting individuals with a prearranged learning path or instruction to help students reinforce their existing skills. When students are learning new concepts, for example, the pattern demands the inclusion of rapid corrections for wrong answers and the staging of stimuli to assist students in obtaining mastery. For the algorithm to cater to pre-prepared knowledge, students must comply with fixed learning ways and procedures and maintain the scheduled learning sessions that the AI has set forth until the intended outcome arrives. In regards to the AI-directed paradigm, AI systems are reminiscent of Skinner's "teaching device," which allows participants logical subject matter and different learning pathways and demands this group to respond directly, illustrate their knowledge quickly, and then move forward to personalized learning paths. Incorporating AI technology in STEM education is an avenue of AI-reinforced learning and instruction, according to the AI-directed paradigm. In STEM education, on the one hand, AI techniques release or replace the instructor's teaching. In particular, AI is usually utilized as a tutoring platform six or a pedagogical agent that supports professors in fulfilling interactive materials and resources, conveying information to students, and completing lesson plans. In the case of the ACT programming tutor system, it estimates the possibility that a student will acquire a given set of rules and use that information to develop a manufacturing rules database for programming ability. On the flip side, behavior-oriented AI applications enhance what students learn in STEM education. As an example, experienced educators navigate and evaluate students as they absorb unfamiliar concepts, wrap up tasks, and score on assessments.

3.3 Paradigm two: AI-supported STEM education

The AI-supported paradigm indicates that the AI system loosens its control and executes duties as a learning support system, while the role of the learner switches to those of a contributor interacting with the system, focusing on individual self-directed learning. This paradigm assumes that learning occurs when learners spend time with individuals equipment, and information in the social domain in light of social constructivism learning. As stated alternatively, the learner encounters better or more effective learning as a result of connecting with the AI system, which continuously collects data from the learner through the course of study as incremental input to optimize the student model. In general, learner-centered learning is assisted by AI-assisted frameworks given that they promote successful interaction and ongoing engagement between learners and AI systems. While the student communicates with the technology and focuses more on their educational journey, the AI system functions as an aid to support that lacks control over the learning process. In the present scenario, during STEM education, a collaborative connection arises between AI techniques and learners. This agent analyzes the method the learner operates in a commitment to guide them along the way to more advantageous behaviors. As a result, the AI-supported paradigm promotes the use of AI tools to support individuals' collaborative and indulged roles to foster individualized STEM learning.

3.4 Paradigm three: AI-empowered STEM education

The AI-empowered paradigm connects plenty of learners and instructors by leveraging AI as a support engine to promote high-quality instruction and learning. It is influenced by student responsibility and instructor agency. The AI-empowered paradigm's theoretical underpinning, complexity theory, regards education as a complex intelligent system that develops learner intelligence through multi-agent teamwork. Additionally, from a standpoint of system conception and execution, stakeholders in this architecture must recognize that AI technology is an integral part of a complicated framework that comprises teachers, students, and other humans. Many creative concepts have been set out to establish synergistic partnerships in the intricate structure after taking into consideration the situation, expectations, and surroundings of humans. These predominant concepts include AIEd that is concentrated on meeting the demands of mankind, human-machine interaction, and human-centered AI systems, including human-AI collaboration.

Under the AI-empowered paradigm, AI enables augmented intelligence by offering educators and learners improved feedback, deeper insight into the learning process, and more helpful instruction. Teacher perception of the learning and instruction process, interpretation, and tailor-made learning-oriented support are all enhanced via AI systems, which further assist in boosting student-centered learning activities. The AI-empowered paradigm that relies on the learner-centered principle utilizes AI technologies to permanently place academics at the center of STEM education, converting them from passive spectators to active participants [12, 13].

The psychological principles for all three phases of engagement are provided in Table 1, which could potentially be employed to develop a computational counterpart for autonomous engagement monitoring.

Table 1. Psychological concepts for the three categories of engagement

Types of Engagement	Cognitive (C)	Behavioral (B)	Emotional (E)
Psychological construct	Levels of processing	Targets of attention	Affective context
Engaged state	Deep processing	On-task attention	Positive affect
Disengaged state	Shallow processing	Off-task attention	Negative affect
External Operationalization	Not directly observable	Eye gaze, head pose, etc.	Facial action coding system

3.5 Real-time automated STEM engagement detection system

We constructed an innovation, named the real-time automated STEM engagement detection system (RASEDS), that measures learners' stages of contribution automatically and quickly to accommodate the exceptionally dynamic and intricate nature of learning in STEM activities. Figure 3 exhibits the system's architectural diagram. In the beginning, RASEDS leverages object detection technology, notably YOLOR, to detect all of the items for learning utilized in the activities and also those in the hands of learners. The technique that students' hands interact with the educational resources is recognized and employed to measure how strongly they are responding straight away. In the final stage, these initiatives are associated with the ICAP framework to gauge students' level of engagement with STEM-related activities. IoU, an algorithm to figure out overlap regions, is utilized frequently to find out what percentage of overlap can be found between them. In tasks comprising object detection, there are two bounding boxes. The IoU threshold in this study was fixed at 0.7. An interaction between the learner's hand and the provided learning material has been detected if the IoU is larger than 0.7. In the final stages, this relationship with the learning content can be leveraged to describe the learner's behaviors. For instance, it can be believed that the learner is using the computer if there is interaction between the learner's hand and the laptop.

$$IOU = \frac{Learner's\,hand \cap Learning\,materials}{Learner's\,hand \cup Learning\,materials} \tag{1}$$

We initially established a STEM performance projection model to provide adaptive learning materials based on learners' involvement in STEM activities. This model estimates final learning outcomes based on the engagement levels calculated by RASEDS. The STEM performance prediction model has been built employing data from 86 students who took part in the STEM Workshop: Python and Raspberry Pi Experimental Activity. During the workshop, RASEDS was utilized to examine the subject's degree of inflammation, obtaining estimates for each participation indicator for each learner. A Practical Activity utilizing Python and Raspberry Pi. During the workshop, RASEDS was applied to evaluate everyone's degree of inflammation, yielding % for each engagement indicator for each learner. In a multivariate regression study, the project reviews of each participant constituted the dependent variable, whereas the percentages of each of those engagement indicators served as the independent variables.

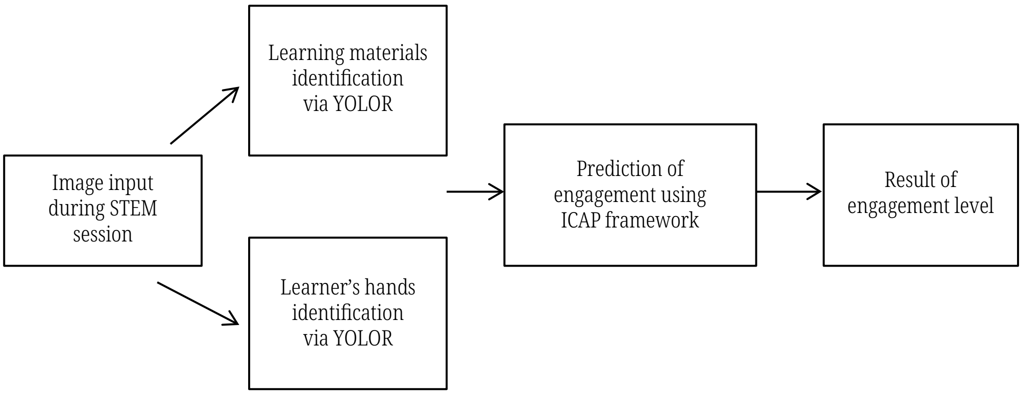

Fig. 3. RASEDS's architecture

The initial regression formula is shown as Formula 2, where *J*, *D*, *B*, *Q*, and *P* symbolize the proportion of collaboration, construction, active, passive, and other indicators, respectively. Here, we are able to analyze the information from the 86 attendees to the workshop to pinpoint a_1, b_2, b_3, b_4, b_5, and c.

$$achievement = a_1 J + b_2 D + b_3 B + b_4 Q + b_5 P + c \quad (2)$$

The five independent variables—*J*, *D*, *B*, *Q*, and *P*—had a linear relationship because they had been converted into percentages during data collection to denote the percentage of each engagement type (i.e., $J + D + B + Q + P = 100$). This means bringing consideration to the independent variables' multicollinearity, paving the way for the application of professional regression methods [14].

4 IMPLEMENTATION AND RESULTS

Test-based evaluation methods, such as TTCT, were utilized in prior research to measure divergent and convergent thinking. Nonetheless, executing invasive inspections in test-based examinations is not natural in the genuine schooling industry. Being in a position to come up with a lot of ideas in a short amount of time is essential to divergent thinking. The total amount of topics that pupils arrive up with ideas for in class is how we put into practice divergent thinking in this study; subject number can be observed in Table 2. As an outcome, we analyzed the number of vulnerable changes undertaken by students as a quantitative measure of various levels of thinking. Convergent contemplation, on the other hand, combines knowledge, insight, and wisdom to realize the best possible solution to a problem. Convergent thinking in this study revolves around the amount of prompting that has been determined surrounding a single issue.

Table 2. The analysis of one-tailed t-tests revealed substantial variation in the S7 score, S14 outcome, and the n_unique_dirary between male and female students

	Mean		Df	t-statistic	p-value
	Female	Male			
S7	–0.5234	0.4888	41.386	3.9686**	0.0044
S14	–0.5811	0.5796	42.816	4.7628***	0.0005
n-unique-diary	0.3776	–0.3554	35.323	1.847*	0.0569

Notes: $*q < 0.16$, $**q < 0.12$, $***q < 0.112$.

Significant distinctions among male and female students were identified in the S7 score, S14 result, and n_unique_dirary, as determined by the analysis of one-tailed t-tests. With the goal to explore specifics, we constructed a line graph illustrating the pupil's prompt period and a cosine correlation of request length. Cosine similarity is a methodology used in natural language processing (NLP) to determine commonalities between terms or paragraphs. Leveraging text data via sentence-BERT, we constructed text integrated values, or dense vectors. The cosine similarity between this particular sentence (st) and the previous phrase (T_{u-1}) was estimated for the full data set of students, which constituted a sequence of sentences (*Similarity* = $\cos(T_u, T_{u-1})$, where $u \in (1,O)$, $\cos(B,C) = \frac{BC}{\|B\|\|C\|}$).

Three-line graph patterns—convergent group, balanced team, and divergent set—can be recognized using the line graph. Using the generative AI, convergent groups first presented an increasing prompt length pattern. First, the line graph of student "S101" suggests dimension and cosine similarity can be noticed in Figure 4 (up). The prompt length is marked on axis y; in addition, the sequence number is on axis x. Watch the way the value of the s101 line graph continuously advances from left to right. The length of the prompt, expressed as the value on the y-axis, periodically minimizes in the graph, but it never descends below 20 characters—that is, until the start of the prompt. This graph's interpretation indicates an ensemble of prompts that are all based on the same theme. The real prompt data's semantic analysis uncovers that 'T101' engaged with convergent activities, frequently developing and enhancing their prompts by paying attention to an individual theme. The cosine similarity of the 'T101' sequence is displayed as a line graph in Figure 4 (down). The similarity increases at first and never decreases to less than 0.9. This indicates that every sentence is semantically related to the one before it, meaning that the subjects of the sequence that don't differ from the original subjects can be understood. Second, the equilibrium bundle regularly displays the pattern of expansion and fall. The line graph of Student's205's prompt length and cosine similarity could have been observed in Figure 5 (up). The "S205" line graph patterns consist of rising and minimizing that nearly zero. When analyzing the actual prompt data, we see that a convergence pattern develops around a single topic as the number of characters in the prompts increases. However, not clear to the infection threshold, where the prompt's length approaches zero, we detect a shift in topics. The cosine similarity between the previously stated and the current prompt sentences is seen in Figure 5 (down). The cosine similarity climbs to zero in the immediate area and then declines to one. The pattern in Figure 5 (up) suggests a period of rising and decreasing patterns. While the number of sequences between 120 and 175 in Figure 5 (up) demonstrates which means building a pattern, for example, the cosine analogy between the sequences 120 to 175 reveals an increasing pattern at first glance and gets calculated over 0.9 after 150 [15].

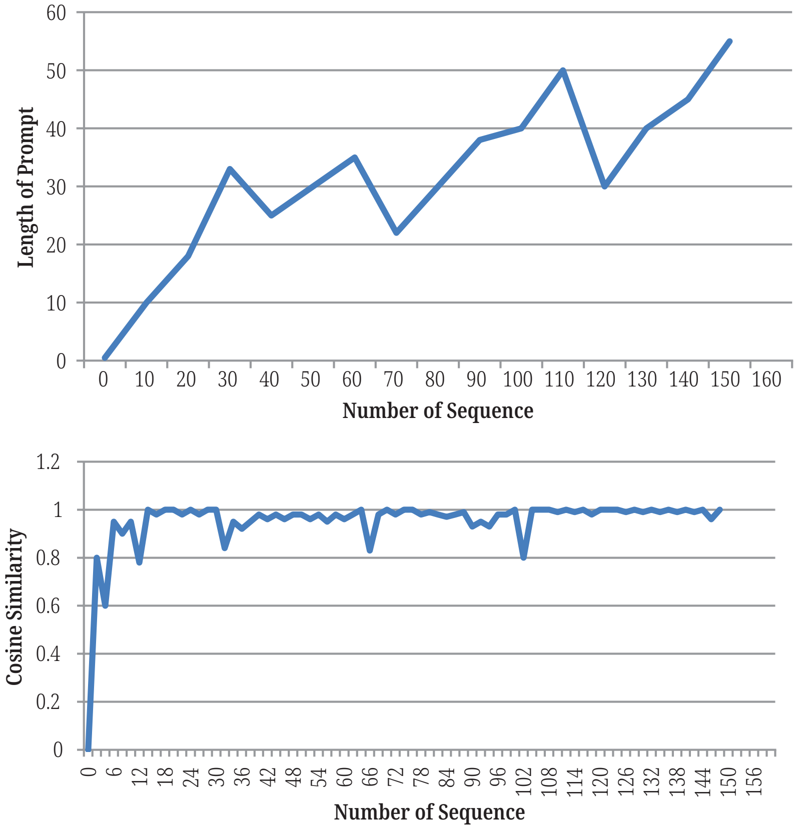

Fig. 4. The convergent thinking pattern as a graph of prompt length (up) and cosine similarity (down) from the "S101" dataset

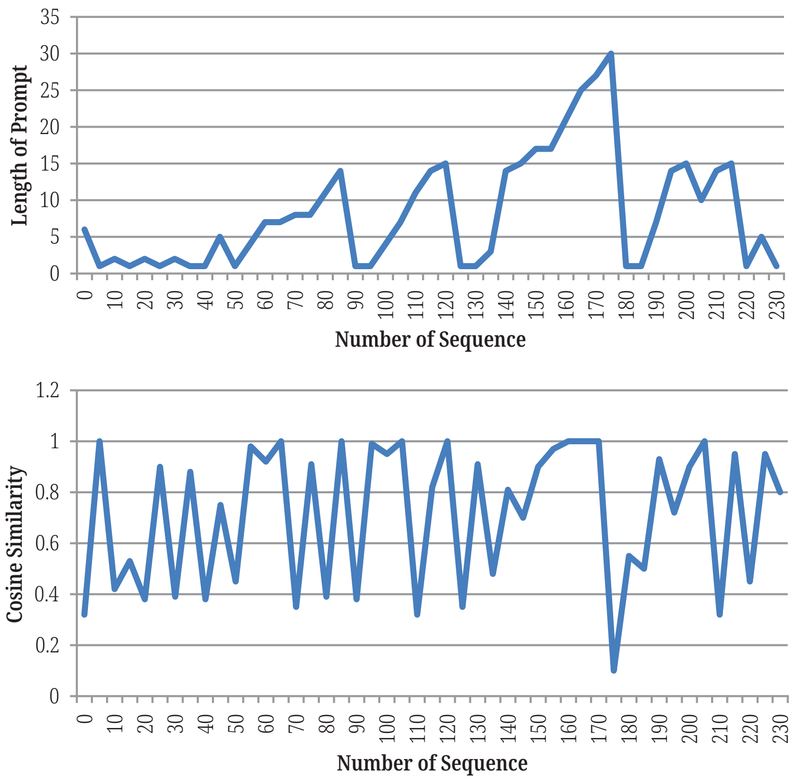

Fig. 5. Graph of prompt length (up) and cosine similarity (down) from the "S205" dataset depicts the iterative pattern of divergent and convergent thinking

5 CONCLUSION

This study recommends an assortment of STEM-based course modules for students who aren't mechanical and passionate about engineering. The modules will be composed of lectures, case discussions, and practical assignments. These training resources were produced employing a reinforcing AI literacy framework mentioned previously. Multiple outcomes of the analysis highlighted how the course successfully improved non-engineering students' AI literacy, or their beliefs toward integrating AI and operating in collaborations in an AI-rich environment. The appreciation of AI ethics among the students was associated with their AI literacy, and among those who had lower AI literacy, there were substantial increases in the awareness of AI ethics. On the flip side, we observed that learners who speak extensively may be either unaware or not at all aware of ethical problems. What might have happened to the highly literate learners multiple times during the course was not determined in the current study. Further studies can concentrate on establishing more challenging concrete tasks that challenge pupils who are more experienced in AI to see if they may improve their consciousness of ethical questions while engaging with partnerships. It is completely reasonable to adjust teachings to individuals' varying levels of perception of the primary educational objectives. The likelihood of applying image-generative AI models in STEAM instruction is demonstrated by this study. It presents an initial foundation for additional research into the effective implementation of these cutting-edge technologies in instructional settings. Overall, the findings of this study point to the potential advantages of utilizing image-generative AI models in art education-based STEAM classrooms to encourage motivation and creativity. However, when implementing these technologies into learning settings, it becomes essential to offer ethical considerations substantial consideration.

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