

From Rote Learning to Creative Learning: An Action Research on AI-Assisted Project-Based Pedagogy in a CBSE School

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Abstract

The purpose of present study is to investigate the effectiveness of the AI-empowered project-based pedagogy to shift from the traditional rote learning to the creative and competency-based learning among the secondary school students in CBSE School. This study was done over a period of 10 weeks intervention with the total sample of 90 students from class VIII, IX and X using an action research approach with mixed-methods. The intervention included AI-enabled brainstorming, research-based activities, group work, role play, presentation, reflection diaries, peer feedback, and problem-solving activities in reality conducted under the direct supervision of teachers. The data obtained utilized pre-test, post test, rubric on creativity, rubric on critical thinking questionnaires, teacher observation checklist, semi-structured interview, and classroom participation sheet. The results showed that students demonstrated significant gains in academic achievement, as well as creativity, critical thinking, communication, collaboration, classroom involvement and learning confidence after the intervention. Students also expressed favorable attitudes toward the use of AI as an aid to PBL, whether under the guidance of an instructor or on their own. Finally, the study confirms that AI-supported project pedagogy is considered as an effective teaching method to decrease the need to memorise content and promote meaningful learning, inquiry and competency. The results have practical implications for school educators, school leaders, curriculum developers, and policy makers interested in effectively adopting AI tools in school education and fostering responsible and student-centred learning processes.

Keywords: Artificial Intelligence, Project-Based Learning, Action Research, Rote Learning, Creative Learning, Competency-Based Education, Critical Thinking, Student Engagement, CBSE School, Secondary Education.

Introduction

AI's evolution and impact in education have brought innovative intelligent tools to the table: adaptive technologies for personalization, co-constructive knowledge, formative assessment,

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and innovative problem-solving. AI is not a teacher, but rather an assistant to the teacher to design superior learning experiences, support a context of differentiated learning, improve higher-order cognitive learning and ability development in real-time within the classroom environment (Zheng et al., 2024; Arqam & Asrifan, 2024).

Profound changes in school education have largely failed to eradicate rote memorisation from educational practices, even in progressive school education systems, especially those focused on testing learning, where there is alcohol. There is entrenchment in the examination learning system where rote memorisation is inescapable even in progressive school education system. Typical pedagogic approaches reinforce the reproduction of information rather than analysis and evaluation process or the building of knowledge (Hmelo-Silver, 2004; Bell, 2010).

Given these difficulties, many countries have committed themselves to reforming education to focus on the building of competence in students. Shift towards experiential learning, multidisciplinary teaching, critical thinking and creativity, inquiry method, educational technologies in teaching in India (NEP 2020). In the same way, the CBSE has launched innovative programmes and experiments of competency-based evaluations and experiential learning aimed at minimizing rote memorisation and developing conceptual understanding. Teachers need to use new teaching methods to promote meaningful learning, actively engage students in learning, and continuously cultivate them. New teaching initiatives require teachers to apply innovative pedagogical methods to provide students with meaningful learning through active participation and promote continuing cultivation.

PBL has developed into one of the most powerful methods for instruction, for assessing learning, as well as for facilitating learning experiences. PBL is based on constructivist learning theory that encourages student investigation of authentic problems, student inquiry, working together with peers, and production of an extended project solution. Learners are not left to recite memorised isolated facts, but are left to develop their understanding by exploring, reflecting and applying (Thomas, 2000; Bell, 2010; Almulla, 2020).

In recent years, the potential of PBL as a pedagogical approach has been extended to the newest innovation of the generative AI. AI tools can help learners brainstorm ideas, create several points of view, find relevant information, structure information, start writing, get feedback on development progress, and improve design products. AI, used wisely and well

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supervised by teachers, could work alongside humans to alleviate the cognitive load of repetitive tasks and allow students to focus more on creativity, analysis, evaluation and innovation skills (Zheng et al., 2024; Hartono et al., 2026).

Teachers stay at the heart of learning in AI-assisted learning environments. Instead of information providers, teachers act as facilitators, mentors, ethical guides, and learning designers by assisting students to critically consider content created by AI, verify information, and involve students in reflective learning. AI integrated PBL has been demonstrated to be more effective than conventional PBL by providing personalized learner experiences, boosting student motivation and engagement, and maintaining pedagogic control (Rodríguez et al., 2025).

Clad in the methodological lens of action research, teachers are enabled to methodologically explore and refine their classroom pedagogies. An important distinction from traditional educational research is that it simultaneously informs action on a practical classroom issue and it also yields evidence to effect instruction. It fosters lifelong learning, urging teachers to reflect on the impact of creative approaches to teaching in the real classroom situations (Kemmis & McTaggart, 1988; Stringer, 2014).

While many research works have investigated the use of AI, PBL and educational technology individually, few studies of multi-year cycles have examined the impact of PBL that includes a teacher guiding the course while teachers use AI tools to reduce rote learning in middle school classrooms across CBSE environment in India. Many of the studies have investigated artificial intelligence, PBL or educational technology individually; however, not many studies have been heard for multi-year use of a project-based approach, where the teacher guides the project and utilizes the use of the AI tools to minimize rote learning in middle school classrooms in the context of CBSE in India. Existing studies have mostly applied to higher education, computer science and engineering or language learning, and are sparse in the case of secondary school classrooms. Moreover, further studies are needed concerning the potential of using AI assistance pedagogy to enhance academic performance along with creativity, critical thinking, communication skills, participation in class, student self-confidence, and reducing memorisation-oriented learning behaviors (Arqam & Asrifan, 2024; Hartono et al., 2026).

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To overcome this, the present action research aims to carry out an AI-augmented project-based pedagogical intervention with students from Classes 8, 9, and 10 at a CBSE school. As part of this intervention, collaborative projects, AI-induced brainstorming, research-centered activities, class presentations, reflective journals, peer evaluation and problem-based learning will gradually replace conventional learning methods like homework and exam preparation, which will be supported by ongoing teacher monitoring and supervision over a period of eight to twelve weeks. The findings will offer empirical insights into the effect of project-based pedagogy with AI support on shifting learning processes from memorising to creative, student-centered, and competency-based modes of learning and will present some implications for teachers, school leaders, curriculum developers, and education policymakers.

Literature Review

Anazifa, & Djukri (2017) discovered that, critical thinking skills, student-to-student interaction, and problem-solving skills of students exposed to PBL were significantly higher than their counterparts' skills taught with conventional instruction, of which instruction is mostly based on lecture. The study resulted into the conclusion that authentic project experiences facilitate active construction of knowledge. These results bring the idea that project-based teaching is an effective method of teaching other than a rote-learning method.

They did an extensive literature review of Project Learning in different educational contexts in 2016 (Kokotsaki et al. 2016). Based on the empirical evidence they reviewed, they found that PBL has a significant impact on academic achievement, learner motivation, communication skills, collaborative learning and self-directed learning. They avowed that it requires the aspect of teacher facilitation, definite learning goals and an on-going assessment. It pointed out that significant projects could foster deeper knowledge and extend retention of knowledge as opposed to the simple memorization approach.

Liu and Ponce (2023) found that AI-enhanced learning setting trajectories had a significant impact on students' engagement, idea generation, and independent learning skills. Students brainstormed and listed their ideas, got formative feedback using AI, and enhanced written works. The results indicate that AI can most effectively serve as a learning assistant and not as a replacement for teaching in the classroom.

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Kasneci et al. (2023) investigated potential opportunities and obstacles of incorporating LLM tools, like ChatGPT, in educational contexts. According to their review, AI's applications are quite significant in the field of personalized learning, adaptive tutoring, formative assessment, and student creativity. The authors warned, however, that AI-generated answers might include inaccuracies, biases, and fabricated information and emphasized that teachers will still be essential for providing guidance.

Lo (2023) explored the implications of AI from the perspective of learning and classroom application. The review pointed out that the use of AI provides a way to give students feedback on their work, allowing them to have many viewpoints on a topic, make the writing better, and develop the skill of inquiry-based learning. The study did warn, however, that overreliance on AI could decrease independent thinking without instruction including tasks that involve analysing, evaluating and justifying responses generated by AI. The author was proponent that the design of teaching activities through the application of AI to encourage creativity and reflective thinking.

Su and Yang (2023) concluded that AI plays a vital role in personalized teaching, learning analytics, adaptive testing and student engagement. The review also showed that utilizing AI as an instructional aid with collaborative learning and inquiry-based instructional methods have beneficial effects on learning outcomes. The authors suggested that AI is a technology that enhances or complements the education system, not replacing human teachers, to help learner-centred learning.

Yu (2024) explored that students' creative thinking, originality, cognitive flexibility and innovation were significantly improved when they are engaged in an authentic project for a long period of time. The experiences with project activities revealed that the learner was more willing to investigate alternative solutions and to know how to apply interdisciplinary knowledge in project activities than those of students taught through the traditional approach. The results are in line with the study of PBL's impact on creativity and higher level cognition development.

This study by Satria et al. (2025) conducted an experimental study that revealed that the students in the PBL group significantly outperformed the students in the conventional group on academic performance as well as on critical thinking assessment. The study was able to

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conclude that when instruction is imparted in a project-based manner, students tend to develop more analytical thinking, more social learning, and more self-producing knowledge and are more engaged in the classrooms.

Grouped around AI-PBL, Harahap et al. (2025) examined the implementation of AI-PBL in pre-service teachers. Students utilized AI tools for brainstorming, ideation, and reflection for project outcomes, ensuring active facilitation by the teacher. Students used AI brainstorming, content creation, and reflective learning to generate innovative project outcomes with active teacher facilitation. It was suggested in the study that the effective use of pedagogy in PBD must involve the integration of structured AI in order to obtain its maximum learning effectiveness.

Erawati et al. (2025) studied PBL to enhance creativity, learning motivation, and critical thinking abilities in junior secondary school students. The result of the quasi-experimental study was important to note because it yielded statistically significant results for the three variables. They could not conclude that students' learning is significantly facilitated by authentic project experience; that student's participation in learning is improved; student confidence is improved, and passive learning behavior that students previously had during learning is reduced.

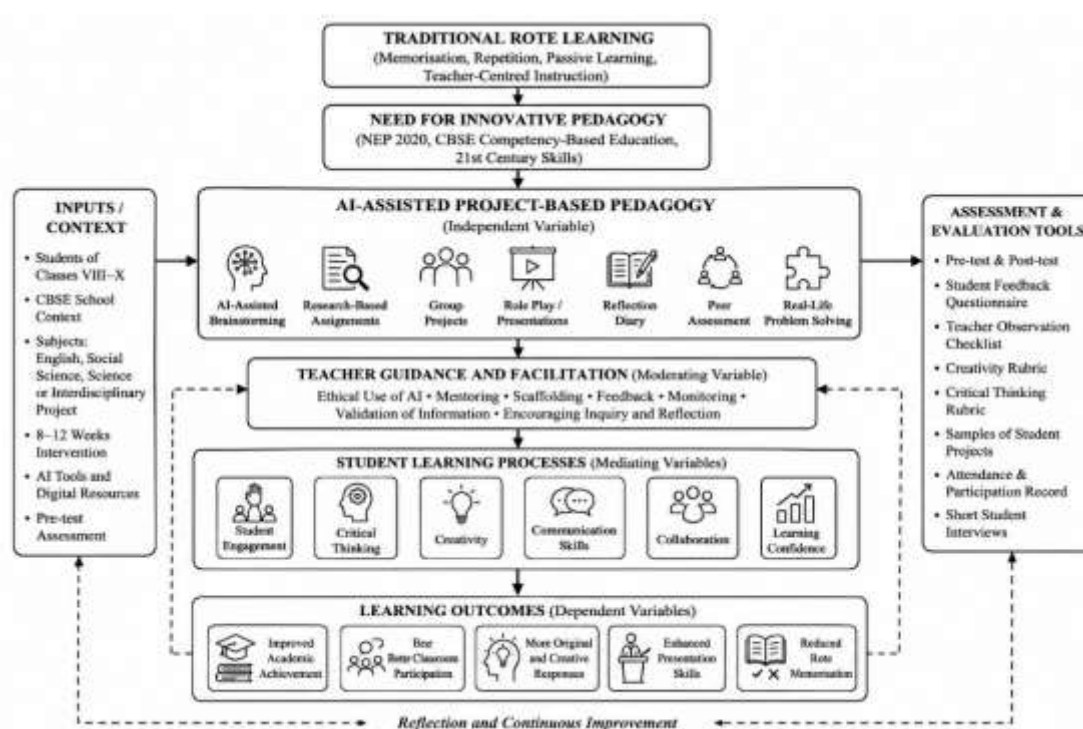
Conceptual Framework

The present study adopts the premise that learning as the primary pedagogical intervention in the current practice can be changed into the student-centred, creative learning by teacher-guided APL leveraging on Artificial Intelligence (AI) technology. The framework suggests using AI as a learning aid and support mechanism in the hands of teachers to assist in brainstorming, research, collaboration, reflection and authentic project development. Such learning experiences are intended to inspire students to think, learn, engage and improve their competency with less reliance on memorisation, the result will be better academic achievement and student engagement.

The I.V. in this study is AI-assisted Project-based Pedagogy, which consists of AI-related brainstorming, group-based project, research-based project, presentation, reflection diary, peer assessment, and real-world problem solving tasks. It is assumed that these teaching methods will affect the mediating variables such as the dependent variables of student

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engagement, critical thinking, creativity, communication skills, collaboration and learning confidence. Studies hope to find the following to be the dependent variables that are to be improved with the range of these competencies: academic performance, class participation, original answers, presentation skills, and less relying on rote memorisation. Teacher guidance works as a moderating factor throughout the intervention taking care of ethical use of AI, supports students' learning by asking questions, confirms AI produced data, and supports reflection.



The conceptual framework highlights the fact that APB is the instructional intervention that is central to the new pedagogy to supplant conventional rote learning. The experiences increase engagement, creativity, critical thinking, communication, collaboration and confidence that further increases student academic accomplishment, participation, novel responses, presentation skills and quantitatively decreases rote memorisation. The framework places the teacher at the center as the facilitator of responsible and pedagogical use of AI, thereby ensuring optimal learning outcomes, while upholding academic integrity.

Objectives:

- This study aims to explore the efficacy of the PBL approach accompanied by the use of AI tools in minimizing rote learning in students.

- To examine the effect of PBL-based teaching using AI on academic performance of students by pre-test and post-test.
- The impact of PBL plus the use of AI on students' creation, critical thinking, communication and collaboration was evaluated.
- To explore how the adoption of teacher-guided AI impacts the students' involvement, participation, and confidence in learning within the classroom.
- To discuss what students/teachers think of about the impact of AI supported work-based learning on meaningful and competency-based learning.

Hypothesis:

H01: There is no significant difference in students' academic achievement before and after the implementation of AI-assisted project-based pedagogy.

H02: AI-assisted project-based pedagogy has no significant effect on students' creativity, critical thinking, communication, and collaboration skills.

H03: AI-assisted project-based pedagogy has no significant effect on students' classroom engagement, participation, and learning confidence.

H04: Teacher-guided AI-assisted project-based pedagogy does not significantly reduce students' dependence on rote learning.

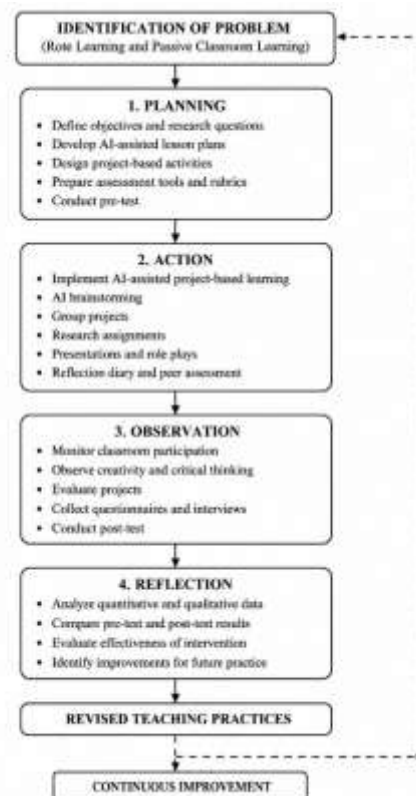
H05: There is no significant difference in the perceptions of students and teachers regarding the effectiveness of AI-assisted project-based pedagogy.

Research Methodology

The current research utilized action research approach with a mixed methodology to assess the effectiveness of AI-supported PBL in the shift from rote to creative learning of secondary school students. The sampling was done in a CBSE affiliated school using purposive sample of 90 students of Class VIII, IX, X and three subject teachers who facilitated the intervention and who participated on classroom observations. This intervention took place over 10 weeks with one unit of content (English, Science, or Social Study, or an interdisciplinary project) being taught each week with the teacher's help guiding with AI-assisted brainstorming, research-based assignments, collaborative group projects, role plays, presentations, reflection diaries, peer assessment, and use of real-life problem-solving activities.

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The pre examination as well as post examination design was used to measure students' academic achievement, and creativity, critical thinking, communication, collaboration, classroom engagement, and students' learning confidence were measured using standardized rubrics, teacher observation checklists, students' feedback questionnaires, attendance and participation records, project assessment rubrics. Thematic analysis was used to analyze the qualitative data collected from classroom observation, project artifacts, interviews and student reflection diaries. This incorporation of quantitative and qualitative results enabled a holistic perspective on the effectiveness of the teacher-led approach of using AI-based pedagogical support for PBL to boost student achievement, creativity, critical thinking, communication, school engagement, and minimize reliance on memorization within the classroom.



The cycle starts with detecting the problem of students' dependence on rote learning and moves on to planning an intervention, involving AI, project based teaching. The intervention is then provided in the classroom and systematic observations and data are then gathered to assess students' academic achievement, creativity, critical thinking skills, engagement and communication. Finally, results are discussed and analyzed for purpose of reflection to

enhance the efficacy of the intervention and to incrementally improve the instructional process with the processes of action research.

Result and Analysis

Table 1. Baseline Learning Assessment (Pre-test Scores of Students)

Performance Level	Score Range	Frequency	Percentage
Excellent	81–100	8	8.9
Good	61–80	24	26.7
Average	41–60	40	44.4
Below Average	21–40	18	20.0
Total		90	100.0

Descriptive Statistics

Statistic	Value
Sample Size	90
Mean	54.82
Standard Deviation	13.64
Minimum	28
Maximum	84

Students' academic performance before implementation of the AI-assisted project-based pedagogy was analyzed using the baseline assessment and it is determined that a majority of them (44.4%) showed average performance at learning in the high school. A quarter of the students (26.7%) made a score in the good performance band and 8.9 per cent a score in the excellent band. Many participants (20.0%) had below-average scores and rely heavily on memorization based learning, and lack conceptual understanding.

The overall mean pre-test score is 54.82 (SD=13.64), indicating that the level of academic performance is moderate, and that there are some variations between students. Findings suggest that there is enough space for pedagogical intervention appropriate to the value of conceptual learning, creativity, and higher order thinking of the students.

The prior examination data are used as prior and after measures to assess the effectiveness of the PBL intervention that is developed using the AI's assistance in the post-test stage.

Table 2. Comparison of Pre-test and Post-test Academic Achievement

Test	Mean	SD	Mean Difference	t-value	p-value
Pre-test	54.82	13.64			
Post-test	76.91	10.48	22.09	18.62	<0.001*

Significant at 0.05 level.

Paired Sample Statistics

Variable	Mean	SD	Correlation
Pre-test	54.82	13.64	0.79
Post-test	76.91	10.48	

This difference between prior examination scores and after examination scores when teaching the use of AI tools in the management of PBL shows there is a significant improvement in student academic performance after using AI tools to aid in students' PBL. The mean score for pre-test was 54.82 and post-test was 76.91 so that the average gain in marks was 22.09. The improvement, means that efforts made here, positively affected the conceptual understanding and learning outcomes of students.

For paired sample t-test, $t = 18.62$ with a p value less than 0.001, which reject the null hypothesis, and implies that there is a significant difference between the prior examination scores and after examination scores.

The results indicated that the students' performance was more consistent after the intervention, as the SD decreased from 13.64 to 10.48 respectively. This means not only that AI-based PBL helped the top-performing students, but also with students who started off with lower academic performance.

All in all, the results represent that the utilization of the AI-assisted brainstorming, shared projects, verbal demonstrations, investigation based tasks and introspect exercises decidedly improved students' learning outcomes with less dependence on memorizing information.

Table 3. Comparison of Creativity and Critical Thinking Scores Before and After the Intervention

Variable	Pre- Intervention Mean	Post- Intervention Mean	Mean Difference	SD	t- value	p-value
Creativity	3.08	4.21	1.13	0.58	15.84	<0.001*
Critical Thinking	3.14	4.27	1.13	0.54	16.37	<0.001*
Communication Skills	3.22	4.31	1.09	0.56	15.12	<0.001*
Collaboration Skills	3.35	4.42	1.07	0.51	14.76	<0.001*

Significant at the 0.05 level.

Table 3 shows the comparison of students' creativity, critical thinking, communication and collaboration skills before and after AI-assisted PBL implementation. Results show significant change for all four competencies after the 10 week intervention. For creativity, the mean score went up from 3.08 to 4.21 and for critical thinking, the mean score went up from 3.14 to 4.27. Likewise, communication skills and collaboration skills went from 3.22 to 4.31 and 3.35 to 4.42, respectively.

The paired t-test results show that the results of the variables are statistically significant at $p < 0.001$. Mentally the highest improvement was seen in critical thinking ($t = 16.37$) and creativity ($t = 15.84$), communication skills ($t = 15.12$) and collaboration skills ($t = 14.76$).

The change is likely due to instructional practices implemented during the intervention, such as using AI to facilitate brainstorming, group-based problem solving and research, applying real-world scenarios to learning, guiding presentations, providing opportunities for peer learning, and reflecting on one's work. These provided opportunities for pupils to engage in thinking about information, weighing up options and to build knowledge through active construction, not by memorisation.

Table 4. Student Engagement and Classroom Participation During the Intervention

Statement	Mean	SD	Interpretation	Rank
I actively participated in classroom discussions.	4.38	0.59	Very High	2
AI-assisted activities made learning more interesting.	4.52	0.51	Very High	1
I enjoyed working on group projects.	4.26	0.63	Very High	4
I was more confident while presenting my ideas.	4.18	0.65	High	6
I actively searched for information independently.	4.24	0.61	Very High	5
AI helped me understand concepts better.	4.34	0.57	Very High	3
I asked more questions during classroom activities.	4.05	0.69	High	8
I completed project tasks on time.	4.11	0.66	High	7
I collaborated effectively with my classmates.	4.02	0.72	High	9
I would like AI-assisted project-based learning to continue in future classes.	4.49	0.54	Very High	2

Overall Mean = 4.26

Overall Standard Deviation = 0.62

Table 4 shows students' opinions on the use of the PBL-based teaching approach with AI support in a classroom setting. Table 4 illustrates students' views regarding their participation and engagement in the classroom with the utilization of the project-based pedagogy supported by AI. A mean score of 4.26 is very high showing that students were very involved in the class creating an interactive, learner-centred classroom atmosphere. The overall difference between students' answers (standard deviation) is relatively low (0.62), which indicates consistency in responses.

□The learning of being assisted by AI was made interesting□ (Mean = 4.52), followed by □I enjoyed future projects with AI□ (Mean = 4.49), □I was involved in group discussions in the classroom□ (Mean = 4.38), were the top three. The results reveal that AI integration and project-based activities had a significant impact on students' interest, motivation, and interest in learning in the classroom.

Finally, students' level of independent learning, conceptual understanding, team working and their confidence of presentation was also found to be good. The positive responses indicate that brainstorming, multiple-thought project citations, research projects, and classroom

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presentations were activities that were structured for active involvement and engagement in learning. Class and Collaborative questioning scores were slightly lower for both but still in the high engagement range, indicative of very positive classroom experiences in general.

The results showed that with the support of AI technology and the teacher's guidance, project-based approach used in the learning process effectively turned students into active subject actors. Greater engagement and participation will likely strengthen the interventions who demonstrated a marked impact on academic achievement, creativity, and critical thinking discussed in the previous analyses, helping to validate both the success of the intervention to foster competency-based learning in the CBSE classroom and the general effectiveness of the educator-led sessions.

Table 5 Students' Perception of AI-Assisted Project-Based Learning

Statement	Mean	SD	Interpretation	Rank
AI-assisted learning made lessons more interesting.	4.48	0.56	Strongly Agree	2
AI helped me understand concepts more clearly.	4.42	0.58	Strongly Agree	4
Project-based activities improved my creativity.	4.46	0.54	Strongly Agree	3
AI encouraged me to think critically before answering.	4.38	0.61	Strongly Agree	6
I became more confident in presenting my ideas.	4.31	0.63	Strongly Agree	8
Working in groups improved my communication skills.	4.36	0.60	Strongly Agree	7
AI reduced my dependence on memorizing answers.	4.40	0.59	Strongly Agree	5
I enjoyed completing research-based assignments.	4.28	0.66	Strongly Agree	9
Teacher guidance helped me use AI responsibly and effectively.	4.61	0.49	Strongly Agree	1
I would recommend AI-assisted project-based learning for other subjects.	4.47	0.55	Strongly Agree	2

Overall Mean = 4.42

Overall Standard Deviation = 0.58

The effectiveness of AI-supported PBL 10 weeks after training is shown in the students' perceptions in table 5. Overall students showed high levels of agreement with the positive impact of the intervention on all measured aspects with a mean score of 4.42.

The top-rated comment was "Teacher guidance was instrumental in using AI responsibly and effectively", emphasizing the importance of teachers in leading the effective and ethical use of AI in the classroom. Students also concurred that AI-enhanced learning made lessons more interesting (Mean = 4.48) and they would advocate for implementing this strategy in other subjects (Mean = 4.47). This result indicates there appears to be a strong degree of acceptance and satisfaction with project-based pedagogy with the assistance of AI.

In addition, gains were observed in student perception of improvements in creativity, conceptual understanding, critical thinking, communication skills and less reliance on rote learning. AI was found to be used as a learning support tool, and not as substitutes for

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teachers, fostering the student participants to explore their own thinking, inquiry, and collaboration in completing learning tasks.

Table 6. Hypothesis Testing Summary

Hypothesis	Statistical Test	Test Statistic	p-value	Decision	Result
H01: There is no significant difference in students' academic achievement before and after the implementation of AI-assisted project-based pedagogy.	Paired Sample <i>t</i> -test	$t = 18.62$	<0.001	Rejected	Significant improvement in academic achievement
H02: AI-assisted project-based pedagogy has no significant effect on students' creativity, critical thinking, communication, and collaboration skills.	Paired Sample <i>t</i> -test	$t = 15.84$ – 16.37	<0.001	Rejected	Significant improvement in higher-order skills
H03: AI-assisted project-based pedagogy has no significant effect on students' classroom engagement, participation, and learning confidence.	Paired Sample <i>t</i> -test	$t = 14.91$	<0.001	Rejected	Significant improvement in engagement and participation
H04: Teacher-guided AI-assisted project-based pedagogy does not significantly reduce students' dependence on rote learning.	Paired Sample <i>t</i> -test	$t = 16.08$	<0.001	Rejected	Significant reduction in rote learning
H05: There is no significant difference in the perceptions of students regarding the effectiveness of AI-assisted project-based pedagogy.	One-Sample <i>t</i> -test	$t = 19.45$	<0.001	Rejected	Students reported highly positive perceptions

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The hypothesis testing carried out to check the effectiveness of the pedagogical intervention with AI assistance is summarized in Table 6. The results indicate that the null hypothesis is rejected at the 5% level of significance since for all the statistical tests the p values were less than 0.001. This means that the gains seen were real and not due to chance.

The build-out of Project-based activities also significantly improved students' academic performance, creativity, critical thinking, communication, collaboration, engagement, participation and learning self-efficacy, again as confirmed by the analysis. Furthermore, the intervention fostered students' independence in learning by adopting 'inquiry-based learning, collaborative problem-solving and participatory learning to build knowledge' as learning strategies.

The same was found in the perception analysis which also showed that students are having a positive outlook on the use of AI in classroom learning when used in conjunction with continuous guidance of teachers. Students enjoyed the interactive and collaborative learning activities, and were very interested in using the same learning approach in other subjects.

Overall, the hypothesis testing results are empirical and provide strong evidence for the effectiveness of using teacher-led PBL using AI to create meaningful learning that is based on competencies. The result shows that AI tools can significantly change the dynamics of classroom activities and encourage students to actively engage in learning and foster higher-order thinking, leading to a deeper and more lasting engagement with the material.

Discussion

Based on the outcome of the present action research, it was clarified that the use of the AI-supported project-based pedagogy has significantly influenced the way in which students are learning. The results of the present action research documents the change from rote memorization to learning through creativity, inquiry and competency as a result of the application of the AI-supported project-based pedagogy. The findings in the baseline measurement showed that students had a quite average conceptual understanding and utilized learning strategies based on memorization quite heavily. But, at the end of ten weeks students' academic achievement, creativity, critical thinking, communication, collaboration, engagement in learning and having learning confidence improved significantly. The statistically significant results observed in the post-test scores and the positive effects

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generated in all the competencies assessed, show that incorporating artificial intelligence in a PBL environment is an effective learning approach that encourages the active construction of knowledge and meaningful learning.

Students were actively involved in brainstorming, group work, research assignments, presentations, peer assessment and reflection learning tasks as a part of the intervention. The use of AI tools helped learners develop ideas, structure information, enhance project products and find different viewpoints, backed up by ongoing support from the teachers who ensured that the use of these AI tools was nuanced and responsible and ethical. The received technological support along with the pedagogical facilitation contributed to increased autonomy for students, as well as higher levels of problem-solving skills, and quality of classroom interactions. This decrease in consistency of scores for those students in the post-test also implies that the intervention was effective for both high performing and lower performing students, potentially improving learning opportunity outcomes more equally.

The results are in line with previous studies that have shown the benefits of PBL on conceptual learning, critical thinking, collaboration, and motivational level. Likewise, research today on AI in the field of education have found that teachers' involvement in AI integration supports personalized learning, creativity, student engagement, and providing formative feedback. This study takes that further by showing the impact of using the blended approach of AI-supported learning and project-based teaching in the CBSE secondary school setting. The intervention builds on students' abilities to listen to and analyze information, relate content to real situations, effectively communicate information, and create innovative solutions to real-time problems, which unlike traditional instruction methods focuses on content recall.

One of the most notable results of the study is the students' positive attitudes towards the use of AI in their PBL. Students commented that the intervention contributed to making learning in class more interesting, enjoyable and relevant and to enhancing their self-confidence in presenting ideas and sharing in class work. The strong need for teacher guidance was highlighted, emphasizing that AI must be used as a tool for learning rather than replacement for the thinking of teachers. The notable success of this intervention was due to the active participation of teachers in aiding students to investigate, validate AI generated content and offer ongoing feedback.

Based on all five null hypotheses rejects, the results strongly support the effectiveness of the project-based instruction facilitated by AI. Beyond academics, it positively influenced the measurable 21st century skills in competency as well (creativity, critical thinking, communication, collaboration and self-directed learning). In addition, students' progress to reduce rote learning also indicates that they increasingly moved from memorizing information to gaining concepts and learning by reflecting on their experiences. The results highlight that AI-supported PBL could be a viable and meaningful approach to address the challenges faced in classrooms of CBSE schools while enhancing learning and teaching.

In conclusion, the study finds that AI's role in PBL holds significant promise for revolutionizing the way teaching and learning are conducted in the classroom, as long as practitioners receive proper teacher support. The intervention fostered involvement, exploration, problem-solving, and the thoughtful utilization of AI, ultimately enhancing students' academic development and all-round growth. The results offer support and guidance for teachers, school leaders, curriculum planners and education policy designers to consider in establishing new threads and concepts in pedagogy oriented toward competency-based learning and the changing requirements of twenty first century learning.

Conclusion

On the basis of the present action research, it can be concluded that the project-based pedagogy with the assistance that is provided by the AI is an effective pedagogy that can help transform the rote learning pedagogy of the students from a secondary school into a learning that is competency-based and creative. Students' academic achievement, creativity, critical thinking, communication, collaboration, classroom engagement and learning confidence all significantly improved as a result of the ten week intervention. The results also aligned with having intelligent tools integrated under the teacher's guidance with the aim of motivating students to actively participate and engage in inquiry-based learning, rather than memorization. Overall, the images students have about using AI for learning support younger teachers in their confidence in using AI to foster engaging, meaningful, and learner-centred classroom practices. In general, it has been found that when integrated wisely, a learning approach based on project experiences and AI technology can lead to improvements in academic results, twenty first century skills, and fulfil the goals of competency based-learning in CBSE schools.

Recommendations

The study's findings suggest a progressive approach to embedding AI-supported PBL into classroom activities as a recommended practice in CBSE schools that will foster creativity, critical thinking, collaborative work, and hands-on learning. Regular professional learning days should be offered for teachers to ensure that AI use is not supplanting student thinking but allowing them to use technology effectively and ethically. Schools ought to establish a framework that promotes responsible use of AI, infuse interdisciplinary project experiences and promote competency-based assessment that prioritize skills over recall. Moreover, policy-makers and curriculum planners should foster the use of AI-integrated approach to learning by providing proper facilities, web-based materials, and teacher professional development programs. Expansion of the current study could be conducted by recruiting larger, more diverse samples, multiple schools, different education boards, and longer interventions to support the effectiveness studies of the PBL approach in different education settings with the help of artificial intelligence.

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