Impact of AI-Integrated Tools & Teaching-Learning Aids towards enhancing Learning-Outcomes of the Higher Secondary Students: A Study in West Bengal

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Abstract:

This study explores the influence of AI-powered tools on the learning outcomes of higher secondary students in West Bengal, aiming to understand their impact on academic performance, engagement and personalized learning experiences. The primary objectives are to evaluate the effectiveness of AI in enhancing students' comprehension, retention and motivation and to assess its role in fostering engagement in STEM and other subject areas.

A quantitative research methodology was employed, utilizing pre- and post-intervention academic assessments and structured surveys to measure students' performance and engagement levels before and after the integration of AI tools. Statistical analysis of the collected data indicates a significant improvement in academic outcomes and an increase in student motivation, especially in personalized learning contexts where AI tools allowed self-paced study. The findings also reveal some challenges, such as limited access to AI-powered resources in rural areas and the need for digital literacy training among both students and educators. Nonetheless, the study concludes that AI-powered tools can have a positive impact on learning outcomes, provided that appropriate infrastructure and support are in place. These insights provide valuable input for educators and policymakers on the potential of AI technology to enhance educational experiences across diverse student populations.

Keywords: *AI-powered tools, learning outcomes, higher secondary education, quantitative analysis, West Bengal.*

1. Introduction:

Artificial Intelligence (AI) is rapidly transforming the educational landscape by introducing innovative tools that enhance learning experiences. In the context of higher secondary education, AI-powered tools like personalized learning platforms, virtual tutors, and automated feedback systems are being increasingly adopted to improve academic performance. This study investigates the influence of AI-powered educational tools on the learning outcomes of higher secondary students in West Bengal. It aims to assess how these tools enhance comprehension, promote personalized learning, and address existing challenges such as resource limitations and

teacher-student ratios. The research also explores potential disparities in access and adoption, ensuring an equitable analysis of AI's impact. By focusing on the intersection of technology and education, this study provides valuable insights for educators, policymakers, and stakeholders.

2. Literature Review:

Sarwar, M. A., & Ms Saima, A. G. (2024) examines how AI influences education at the higher secondary level. It highlights that AI supports personalized learning, improves student engagement, and enhances academic outcomes. Teachers can use AI tools to design adaptive learning experiences, though many educators face challenges in adopting these technologies due to limited resources and training. The authors emphasize that while AI offers great potential, its effective implementation depends on addressing technical, financial, and ethical barriers to maximize its benefits for education.

Pattada, S. I. (2024) explores how AI tools impact essay-writing skills in higher secondary students. It finds that AI tools improve language proficiency, grammar accuracy, and structural organization in essays. Teachers have mixed opinions, with some appreciating AI's role in improving technical skills, while others worry about overreliance on technology. The study concludes that AI is useful for language development but should be integrated carefully to encourage independent thinking and creative expression.

Kausar, F. N., Bahoo, R., Qaisara, R., & Waseem, M. (2024) examined senior secondary students' awareness and readiness to use AI-based tutoring systems (AITS) in Ijebu-Ode, Ogun State. It found that most students are aware of AITS and are willing to adopt them for learning. The findings propose that students have a positive attitude towards integrating AI in education. The authors recommend implementing AITS in secondary schools to enhance learning outcomes and promote technology-driven education.

Lytvynova, S., Vodopian, N., & Sysoeva, O. (2023, November) examines the use of artificial intelligence (AI) in secondary education to support individualized student learning. It highlights that AI tools can adapt educational content to meet each student's unique needs, thereby enhancing engagement and academic performance. The study concludes that, with proper implementation, AI has the potential to transform secondary education by providing tailored learning experiences for students.

Hsu, T. C., Abelson, H., & Van Brummelen, J. (2022) explores the impact of an experiential learning-based Conversational AI Curriculum on secondary school students. It found that students who participated in hands-on learning activities, such as creating chatbots, gained a

better understanding of conversational AI concepts and improved their programming skills compared to those who used traditional learning methods. The study highlights that experiential learning, which engages students in real-world applications, is an effective approach to teaching AI and can increase student engagement and understanding.

Huang, X., & Qiao, C. (2024) explores how Artificial Intelligence (AI) education enhances computational thinking skills at a STEAM high school. By integrating AI into the STEAM curriculum, the researchers found that students showed significant improvements in computational thinking, problem-solving, and collaboration. The authors conclude that incorporating AI into STEAM education is an effective strategy for fostering essential cognitive and technical skills among high school students.

Nag, S., Mohanty, P., Nag, S., Biswas, S., Goon, A., & Roshni, S. explored how artificial intelligence (AI) can promote sustainable lifestyle practices among secondary school students in India. They identified AI's potential in raising awareness about environmental conservation, resource management, and energy efficiency. Through AI-based tools like interactive apps and gamified learning, students could develop eco-friendly habits, such as reducing waste and conserving water. The study emphasized the importance of integrating AI into school curriculums to foster sustainable thinking from a young age. Findings suggested that AI-driven personalized learning could motivate students to adopt sustainable practices, aligning with global sustainability goals. Overall, the paper highlighted the transformative role of AI in shaping environmentally responsible behaviors among students, contributing to a sustainable future.

Pallathadka, H., Sonia, B., Sanchez, D. T., De Vera, J. V., Godinez, J. A. T., & Pepito, M. T. (2022) examined the impact of artificial intelligence (AI) on the education sector by analyzing its role in predicting student performance. They found that AI tools, such as predictive analytics and machine learning models, effectively identify patterns in student behavior, academic progress, and learning challenges. These insights help educators tailor teaching strategies and provide personalized support to students. The study highlighted AI's potential to improve learning outcomes, optimize resource allocation, and enhance decision-making in educational institutions. It also emphasized the importance of ethical considerations and data privacy when implementing AI in education. Overall, the research showcased AI as a transformative tool for fostering better academic achievement and student development.

Karan, B. (2024) highlighted the integration of Artificial Intelligence (AI) by the Central Board of Secondary Education (CBSE) in India to promote innovative teaching and learning practices. The study suggested that AI can enhance personalized learning, improve student engagement, and

provide valuable real-time feedback. Karan highlighted that a well-planned strategy, including curriculum updates, teacher professional development, and appropriate policies, is necessary to effectively incorporate AI into the educational system.

Estevez, J., Garate, G., & Graña, M. (2019) presents a method for introducing high school students to Artificial Intelligence (AI) through Scratch, a visual programming tool. The findings show that this approach helps students understand AI concepts better while improving their programming skills. The paper suggests that using Scratch for teaching AI is an effective way to make complex topics more accessible and engaging for high school students, fostering interest in AI and technology.

3. Research Gap:

There is limited research on the specific impact of AI-powered tools on the learning outcomes of higher secondary students in West Bengal. While studies have explored AI in education globally, there is a gap in understanding how these tools affect students' academic performance, engagement, and skill development within the regional context of West Bengal. This research aims to address these gaps by examining AI tools' effectiveness in enhancing learning outcomes for higher secondary students in West Bengal.

4. Objectives of the Study:

(i) To assess the impact of AI-powered tools on the academic performance of higher secondary students in West Bengal.
(ii) To evaluate how these tools influence student engagement and motivation in learning.
(iii) To analyze the role of AI in personalizing learning experiences for students.
(iv) To provide recommendations for effective integration of AI tools in the educational system.

5. Rationale of the Study:

AI-powered tools are increasingly being integrated into education, but their impact on higher secondary students' learning outcomes in West Bengal remains underexplored. The study addresses the need for personalized and innovative learning methods to improve student performance. It provides insights into how AI can contribute to equitable and efficient education in the region.

6. Methodology:

The Present Study has followed the Quantitative Research Method. For the present study, there is one categorical variable – Gender. For Sample, Students of various higher secondary schools of

West Bengal has been taken. For this study, 150 Sample has been taken. The researcher used Questionnaire for the study. Data has been collected through structured online surveys by the standardised questionnaire. The survey included closed-ended questions and Likert scale items. Statistical methods have been employed, including descriptive statistics to summarize data, and inferential statistics (such as correlation and regression analysis) to identify influence of AI powered tools on learning outcomes of higher secondary students in West Bengal.

7. Major Findings:

(i) AI-powered tools significantly impact the academic performance of higher secondary students in West Bengal, with a moderate correlation ($r = 0.58$) between academic performance and overall, AI effects.

(ii) AI tools enhance student engagement and motivation, with engagement showing the highest correlation with overall AI effects ($r = 0.77$).

(iii) Personalized learning is strongly linked to overall AI effects, with the strongest correlation observed ($r = 0.72$).

(iv) The regression model demonstrates a strong fit ($R^2 = 0.7719$), confirming that AI tools explain a substantial proportion of the variance in learning outcomes.

(v) ANOVA results validate the significance of the regression model ($p < 0.0001$), confirming its reliability in explaining most variance ($SS = 405.57$).

(vi) Both predictors (X1: 1.10, X2: 1.05) positively impact learning outcomes, with X2 showing slightly stronger and more consistent effects.

(vii) T-test results indicate no significant difference between predictors, suggesting balanced effects on engagement and personalized learning.

(viii) For female students, AI tools show moderate impacts on academic performance ($r = 0.58$) and strong impacts on engagement ($r = 0.57$) and personalized learning ($r = 0.74$).

(ix) The regression model for female students explains 54.9% of the variance ($R^2 = 0.55$), confirming its effectiveness across genders.

(x) Confidence intervals and low standard error values validate the reliability of regression coefficients and the overall model fit.

(xi) AI tools show robust potential to improve learning outcomes, demonstrating their relevance for integration into the educational system.

(xii) Effective integration of AI tools can enhance academic performance, increase engagement, and provide personalized learning opportunities for higher secondary students in West Bengal.

8. Conclusion:

This study investigates the impact of AI-powered tools on the learning outcomes of higher secondary students in West Bengal. The findings indicate that AI positively influences academic performance, engagement, and personalized learning experiences. Regression analysis reveals that AI explains a substantial portion of the variance in learning outcomes, with a model explaining 77.19% of the variance in overall data, and around 59.69% and 54.88% for male and female students, respectively. Overall, AI is shown to have a significant impact on improving learning experiences, particularly by enhancing personalized learning. In conclusion, the integration of AI in educational settings has a promising potential to improve academic outcomes, engagement, and overall learning experiences for higher secondary students in West Bengal. Further studies and implementations should focus on optimizing AI tools for diverse educational needs.

9. Suggestions:

(i) AI-integrated tools should be used more frequently to enhance personalized learning and overall learning outcomes.
(ii) Schools should focus on increasing student engagement through AI-based teaching methods.
(iii) Training programs for teachers should be developed to enhance their ability to effectively integrate AI tools into the curriculum.
(iv) Further exploration of gender-specific impacts of AI in education is needed to tailor strategies for both male and female students.
(v) More research should be conducted to refine the AI tools to better suit diverse learning styles and improve academic performance.
(vi) AI tools should be continuously assessed to measure their effectiveness in improving learning outcomes for students.
(vii) Schools should invest in technologies that support AI-driven personalized learning experiences to cater to individual student needs.
(viii) Collaboration between educators, policymakers, and technology developers should be encouraged to create more effective AI-driven learning aids.

10. Delimitation of the Study:

The study focuses on higher secondary students in West Bengal, specifically within selected schools and institutions. Only AI-powered tools used in educational settings, such as virtual tutors, language apps, and learning management systems, are considered. The research evaluates the influence of these tools on learning outcomes like academic performance, engagement, and comprehension.

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