

Impact of Artificial Intelligence on Abstract Reasoning and Learning pattern in higher Mathematics

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Abstract: *The Artificial Intelligence (AI) has emerged as a transformative tool in education by enabling personalized feedback, adaptive learning, and data-driven instructional strategies. Although several studies have examined its role in mathematics education, the findings remain fragmented and inconclusive. This study employs a meta-analytical approach to systematically evaluate the overall impact of AI applications on students' performance in mathematics. Examines how AI tools such as intelligent tutoring systems, automated problem solvers, adaptive learning platforms affect student's conceptual understanding, cognitive skills, problem-solving ability, and learning behaviour. Quantitative and qualitative data from surveys, performance assessments, and interviews provide insights into AI's role in enhancing mathematical reasoning and learning strategies.*

Keywords: Artificial intelligence, Mathematics, mathematical reasoning, Learning Pattern

I. INTRODUCTION

The Artificial Intelligence (AI) plays an increasingly important role in the education sector by enhancing student's learning experiences and academic performance. Artificial Intelligence (AI) has become a powerful transformative element in modern education, substantially impacting students' learning processes and academic achievement. AI technology facilitates the innovation and creativity that could be used to achieve the sustainable development goals (SDG), where education is the third SDG [1]. Higher mathematics is fundamentally abstract, demanding strong reasoning skills, clear conceptual understanding, and analytical thinking. However, traditional teaching approaches often struggle to effectively cultivate these abstract reasoning abilities among students. It has a fundamental role to play in enriching education, engaging all the learner's senses, leading to increased positive participation and experience (Al-Buwaihi et al., 2018) [2]. In contrast, AI-based technologies provide personalized learning experiences by adapting to individual learning styles, offering immediate feedback, and enabling interactive problem-solving environments. As a result, these innovations support students in understanding complex mathematical concepts more effectively. AI-powered tools are developed to be intelligent tutoring systems, adaptive learning platforms, and chatbots, chatgpt, Wolfram Alpha, Photomath/Symbolab, Lean/coq AI Gemini, and Meta AI which support personalized help for students.

II. EXPERIMENTAL DETAILS

In this study, the survey method was used for data collection, and this was done with the help of well-structured questionnaires as the research instrument. The population is of M.Sc, B.Sc Mathematics Students of Willingdon College, Sangli. We collected data from 68 Students. The study is based on primary data only. The primary data was collected by using the questionnaire method. The questionnaire was designed so that the data could be collected from a number of respondents from Google Forms. The questionnaire designed was closed-ended. Several questions were asked in logical order so as to gather the maximum and accurate information. The main research objective is to evaluate the



awareness and frequency of Artificial intelligence application usage, and the second objective is to check which AI tool and purpose of AI used most in education To identify which area of mathematics is perceived as the most abstract.. The association between AI usage and Learning pattern improvement in Mathematics improved for this study, we use Chi square test.

i. To check the awareness of AI in Education.

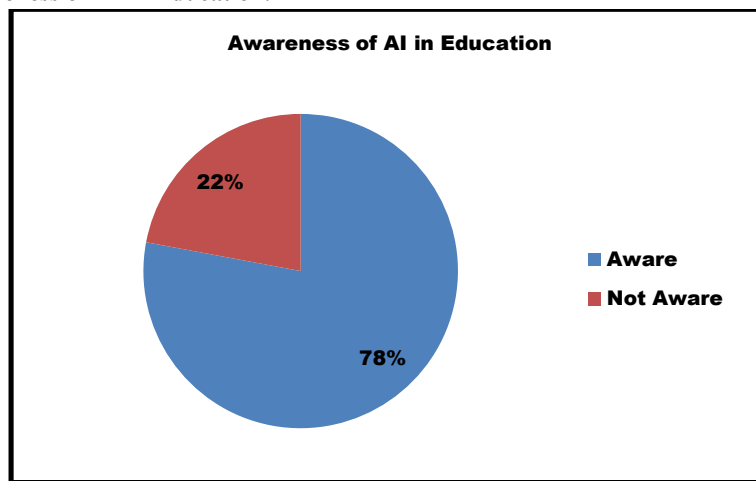


Fig 1. To check the awareness of AI in Education.

Conclusion-Majority of Students (78%) are aware of AI in education. This indicates that AI is well-recognized in the education sector. Students are familiar with AI tools and their applications in learning. Only 22% of Students are not aware of AI in education. A small portion of the population still lacks knowledge about AI in learning.

i. To check usage of AI and Mathematical Tool :

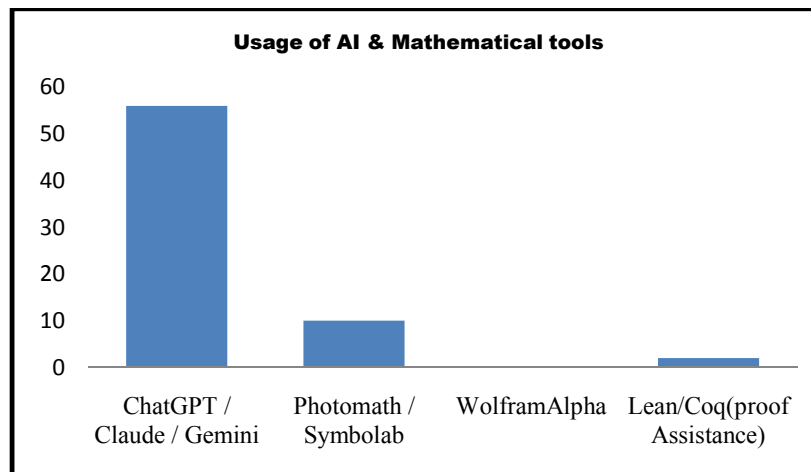


Fig 2 To check Usage of AI and Mathematical tools

Conclusion-The figure clearly indicate that AI base tool Chatgpt/Claude/Gemini are mostly widely used with a significant higher usage count (56) .Photo math/Symbolab shows a moderate usage indicating that they are used for problem skill and The negligible use of Wolfram Alpha(0).Lean/Coq(proof Assistance) tools have very limited usage (2).



ii. To check which area of mathematics find most abstract.

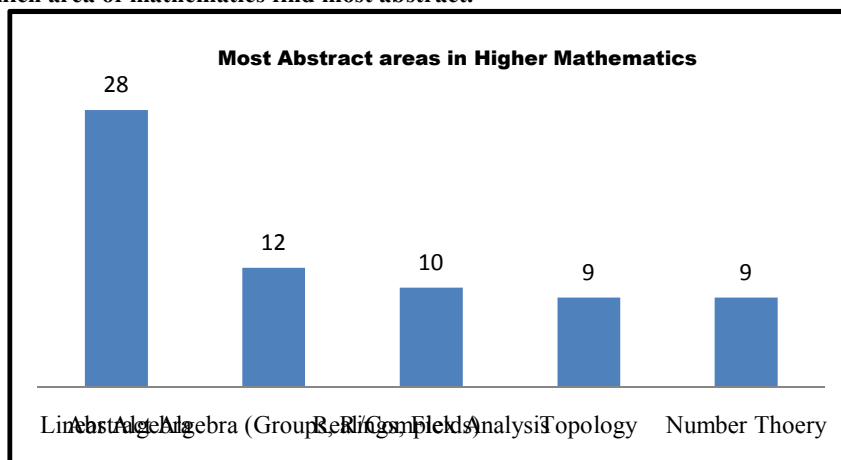


Fig 3. To check which area of Mathematics Find most abstract.

Conclusion-The figure clearly indicate that in Linear Algebra find most abstract area of higher Mathematics among students.

iii. To check AI tool help to think critically about Mathematics concept

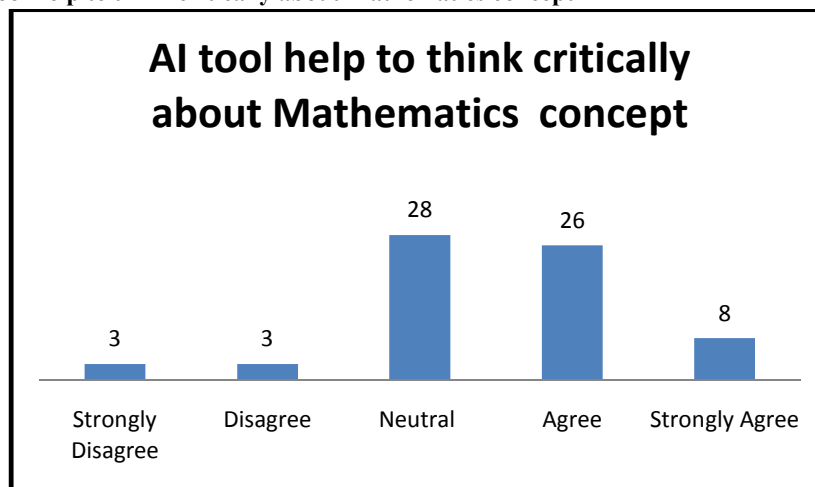


Fig 4. To check AI tool help to think critically about Mathematics concept.

Conclusion-The majority of students have a positive perception of AI tools in developing critical thinking in Mathematics From the above graph it indicate that students feel AI tool support to analytical and critical understanding of concept.

Table1. Observed frequency

AI usage	Academic performance		
	YES	NO	Total
YES	50	13	63
NO	3	2	5



Total	53	15	68
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Table2. Expected Frequency

Academic performance		
AI usage	YES	NO
YES	49.1	13.9
NO	3.9	1.1

III. RESULTS AND DISCUSSION

As part of our research into the to check the association between AI usage and Learning pattern in Mathematics has improved , we have used chi-square method to check the association in chi square test firstly we set up null and alternative hypothesis and calculate the expected frequency by using formula compute the chi square statistic by using the formula and then determine the degrees of freedom for test of independence the degrees of freedom is (r-1) (c- 1) i.e. 1 To find the critical value from the chi square distribution table value at significance level. At the last step, we make a decision. We have collected the total number of AI usage counts we derive observed frequency and calculated frequency table We observe that the p- value is greater than 0.05 and Tabulated value of chi square is 3.84 and calculated value is 1.02 hence we Accept the null hypothesis at 5 % level of significance. There is a no significant association between AI usage and the Learning pattern improvement in Mathematics.

Table3. Test Statistic Table

O_i	E_i	$\frac{(O_i - E_i)^2}{E_i}$
50	49.1	0.016497
13	13.9	0.058273
3	3.9	0.207692
2	1.1	0.736364

Chi square test statistic value is 1.02, and d.f. is 1.

IV. CONCLUSION

- Majority of students are aware about Artificial intelligence in education.
- In Linear Algebra find most abstract area of higher Mathematics among students.
- The majority of students have a positive perception of AI tools in developing critical thinking in Mathematics.
- AI base tool Chatgpt/Claude/Gemini are mostly widely used with a significant higher usage count .Photo math/Symbolab shows a moderate usage indicating that they are used for problem skill.
- We have obtained very simple and efficient results for AI app usage and Learning pattern improvement in Mathematics. We get the results as there is an no association between AI app usage and learning pattern improvement in Mathematics.

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