INTELLIGENT TUTORING SYSTEMS AS AN AI-DRIVEN TOOL FOR INCLUSIVE HUMAN CAPITAL DEVELOPMENT

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ABSTRACT

'No Child Should Be Left Behind (NCLB)' advocates the mandate of UNICEF, presidential administration by George Bush, to bridge the gap and promote equitable learning opportunities for all the children irrespective of their differences. This forms the vital part of Indian Legislation 'Right to Education Act'. Intelligent Tutoring System (ITS) in domain of AI, can be at the service of the learner 24X7, providing the ease of learning at own space, pace and place supporting education on-demand. The study focuses on the effectiveness of ITS on the academic performance of the learners with differences. It adopts True-Experimental method. The sample of 30 students of grade11 was randomly selected from the class of 35 and divided into two equivalent groups (Experimental and Control) by matching pre-test score. Mann-Whitney test confirmed the equivalence of the groups. Two sub topics 'Surface Tension' and 'Capillarity' were taught to both groups using the traditional teaching method; experimental group using ITS in complement. Data collected through post-test on completion of the topics was analyzed using t-test. Results show calculated t-6.5061>critical t-2.048 for df=28, with P<0.0001 at 95%confidence level highlighting extremely statistically significant difference in the mean post-test score of experimental and control group, strongly indicating the efficiency and effectiveness of using ITS in learning. The t-value also indicated no significant difference in the mean post-test score of girls-boys and general-OBC and SC students using ITS, proving the effectiveness of ITS irrespective of the gender and cast differences.

The study builds strong evidence for use of ITS for inclusivity, supportive learning and enhancing teacher's potential in achieving the learning outcomes irrespective of the individual differences, providing insights to the stakeholders to plan and design the curriculum so as to leverage the AI's potential in the form of ITS in the education positively.

Keywords: Artificial Intelligence, Intelligent Tutoring System (ITS), Individual Differences, Achievement

INTRODUCTION

The National Education Policy 2020 strongly suggests the equitable education throughout the nation. No child should be deprived of the opportunity of learning because of any differences. Therefore, the policy proposed the classes to be inclusive and teaching to be adapted to the learning style and pattern of the child. No individuals are similar and therefore teaching has to be offered in multiple ways using multimodal techniques. Present development in the science, research and technology can come to rescue if integrated ethically and meaningfully in traditional teaching. Perpetual refining of the artificial intelligence can largely supplement the traditional teaching by empowering the teachers to cater the teaching to individual need (UNESCO).

Each child being unique in its ability and intellect, the potential of traditional human teacher needs to wrestle to fulfill the individualized need. Artificial Intelligence therefore, shoulders the responsibility of supporting the learner on demand. The branch of artificial intelligence which specifically deals with the development in education (AIED) promotes the use of AI in various ways depending on its need. The features of AI such as Personalized learning, Automated Administration, Automated Assessment, Virtual Assistance and 24x7 guidance to the learner by Intelligent Tutoring System can largely contribute in letting the learner equitable opportunity to learn irrespective of difference in their gender, cast, class, economic status, demographic location, learning habits and abilities Morandín-Ahuerma (2024).

This experimental study is an attempt to investigate the effectiveness of Intelligent Tutoring System (ITS) in supporting the learner irrespective of the differences. The paper provides the concrete base and proof for supportive role of ITS in inclusivity.

OBJECTIVES OF THE STUDY

To find the effectiveness of Intelligent Tutoring System on the academic performance of the diverse learners.

REVIEW OF RELATED LITERATURE

Kestin et al. (2025), in the study conducted to investigate the role of AI tutoring in learning gain and learner's perceptions showed that AI tutoring can assist the learner with homework, offer guidance and provides remedial

for the slow learners. The learners perceived the learning engaging, motivating, enjoying leading to growth in mindset with the help of AI tutor. In addition, the learning with AI tutor is self-paced supporting inclusivity.

RIZVI (2023)In the review investigated the potential of AI-Powered Tutoring Systems for the adaption to the individualized need and personalized guidance. The comprehensive review upholds the widespread impact of AI enabled tools, but also recommended rigorous testing and assessing the use of AI integration in education as the framework and systems are still in its experimental stage.

Baillifard et al. (2025), AI tutor has the potential to provide the personalized learning experience personalized to individual need and abilities in learning sciences and addressing the challenges in implementing effective strategies thereby supporting the inclusivity.

Sedlmeier (2001) mentioned that ITS can be used to provide individualized sophisticated instructional advice far better than CAI in par with good human teacher. ITS can provide customized instructional interventions tailored to the strength, weaknesses and the level of knowledge of the learner.

Shute & Zapata-Rivera (2010) in the chapter mentioned that ITS has the intelligence to track the learners work, adjust feedback and provides the hints while learning. The software has the potential to collect the cognitive as well as non-cognitive data of the learner in student model and infer about the strength, weaknesses and abilities of the learner and can suggest the additional work to achieve the desired learning outcomes.

Gomes (2024) ITS integration in education enable to analyze data and tailor the learning experiences in diverse educational settings empowering learner in personalized learning journey.

RESEARCH QUESTIONS
Q1. Is there any difference in the academic achievement of the learners learning by using ITS and learners learning by traditional way of remedial learning.

Q2. Is there any difference in the academic achievement of the girls learning by using ITS and boys learning by using ITS.

Q3. Is there any difference in the academic achievement of the General category students learning by using ITS and Other Backward Class students learning by using ITS.

HYPOTHESIS
Null Hypothesis
1. There is no significant difference in the mean post-test score of the experimental group using ITS and the control group not using ITS for learning.

2. There is no significant difference in the mean post-test score of the girls and boys using ITS for learning.

3. There is no significant difference in the mean post-test score of the general and other backward class students using ITS for learning.

Research Hypothesis
1. There is significant difference in the mean post-test score of the experimental group using ITS than the control group not using ITS for learning.

2. There is significant difference in the mean post-test score of the girls and boys using ITS for learning.

3. There is significant difference in the mean post-test score of the general and other backward class students using ITS for learning.

METHODOLOGY USED
The pre-test post-test control group experimental method was used for the purpose of the study. Pre-test score was used as the reference to get an idea of the previous knowledge of the learner on the topic. Based on the pre-test score the learners were divided into two equivalent groups viz. the experimental group and the control group. The care was taken to assure that both the groups contain equivalized diverse population in terms of gender, cast and economic class.

Two sub topics 1) Surface Tension 2) Capillarity from 'Mechanical Properties of Fluids' was taught to both the groups in the class using traditional teaching method. Along with the teachers teaching, the Experimental group used ITS features of Khan Academy for learning the topic at their own space and time. Whereas, the control group was provided with the regular remedial teaching. The post test was conducted after completion of both the topics.

SAMPLING

The intact class of grade 11 consisting of 35 student from Govt. Higher Secondary School, Pernem Goa was selected as the population for the study. Out of which 30 students were randomly selected as the sample for the study. The students were assigned to the experimental and control group by matching the pre test score. Care was also taken to make the group equivalent in terms of gender, cast and economic class.

The experimental and control group consists of 15 students (9 girls and 6 boys) each. Both the groups had 7 general, 7 OBC and 1 SC student. The group equivalency was tested using Mann-Whitney test for pre-test score.

STATISTICAL TOOLS AND METHODS OF DATA ANALYSIS

Tools for data collection

The achievement test designed by the researcher was used as the tool to collect the data in pre-test and post-test form.

Learners were interviewed in groups to obtain the feedback.

Tools for data analysis

The Mann-Whitney test was used on pre-test to test the equivalence of two groups since the groups were small in size.

The data collected through the achievement tests was analyzed using t-test.

SCOPE LIMITATIONS AND DELIMITATIONS

Scope

The present study is applicable to the students of grade 11 of Govt. Higher Secondary School Pernem Goa who have opted for physics. This study focuses only on the sub-topics 'Surface Tension and capillarity' from the main topic 'Mechanical Properties of fluids' from volume 2 from the Physics textbook prescribed by 'Goa Board of Secondary and Higher Secondary Education'.

Limitations

The previous knowledge of the learner, age, attitude, interest and aptitude are not taken into consideration for the purpose of the study.

t-test could not be administered to the student belonging to the Scheduled Cast category as there was only one student belonging to Scheduled Caste category in each group.

Delimitations

The study is delimited to the students of grade 11 from Govt. Higher Secondary School located at Pernem Taluka in the North Goa district in the state of Goa.

The study is delimited to only two sub topics 1) Surface Tension and 2) Capillarity from the chapter 'Mechanical Properties of Fluids' from grade 11 Physics.

The study is delimited to the use of free Intelligent Tutoring System offered by Khan Academy.

RESULTS AND DISCUSSIONS

The post test score of the students was analyzed statistically using t-test at 95% confidence level as follows

Post test score of Experimental and Control Group

Experimental	19	18	19	19	15	17	18	16	13	15	15	19	12	13	14
Gender	F	F	F	F	F	F	F	M	M	F	M	M	F	M	M
Caste	OBC	OBC	GEN	OBC	SC	OBC	GEN	GEN	GEN	OBC	GEN	GEN	OBC	GEN	OBC
Control	9	13	7	11	12	13	10	12	10	10	13	9	10	8	14
Gender	F	F	F	M	F	F	M	F	F	M	F	M	F	M	M
Caste	GEN	GEN	GEN	OBC	OBC	GEN	GEN	SC	OBC	GEN	OBC	OBC	OBC	OBC	GEN

Sr. No	Groups analyzed/ Values Obtained	Experimental Group using ITS and Control Group not using ITS	Girls using ITS and Boys using ITS	Students with General Class and OBC using
1	df	28	13	12
2	Difference in the means of the two groups	5.40	1.89	0.14
3	Standard error of the difference	0.830	1.248	1.417
4	Calculated t-value	6.5061	1.5136	0.1008
5	Critical t-value	2.048	2.160	2.179
6	Comparison of t-values	Calculated t > Critical t	Critical t > Calculated t	Critical t > Calculated t
7	P value	<0.00001 Result is significant at p<0.05	= 0.77033 Result is not significant at p<0.05	= 0.46067 Result is not significant at p<0.05
8	Acceptance/Rejection of Null Hypothesis	Reject Null Hypothesis	Accept Null Hypothesis	Accept Null Hypothesis
9	Result	There is significant improvement in the mean post test score of the learners using ITS.	There is no significant difference in the mean post test score of the girls and boys using ITS.	There is no significant difference in the mean post test score of the General Category and OBC category learners
10	Conclusion	ITS used in addition to traditional teaching effectively improves the academic achievement of the learner	ITS used in addition to traditional teaching effectively improves the academic achievement of the learner irrespective of the gender differences.	ITS used in addition to traditional teaching effectively improves the academic achievement of the learner irrespective of the cast differences.

The analysis of post test data on the t-test scale and the p-value shows that the use of Intelligent Tutoring System can be effectively used to enhance the academic achievement of the learners irrespective of the gender and cast of the learners. This clearly indicates the supportive potential of AI – Intelligent Tutoring System in making the education inclusive.

CONCLUSION

The experimental study provides strong proof for integrating ITS in complement with the traditional teaching for improved academic achievement of the learners. The study also highlighted that adaptive potentials of ITS such as 24x7 availability, personalized adaptation, individualized instructions and feedback enhances the learning by motivating the learners. Therefore, use of ITS proves to be effective irrespective of the learner differences such as gender and cast. The insights will definitely help the stakeholders to plan, design and implement the curriculum to effectively integrate ITS in education to obtain the maximum learning outcomes.

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