

Use of Adaptive Learning Technology among High School Students

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ABSTRACT

The rapid infusion of information and communication technology into classroom practice has renewed interest in personalised, technology-mediated instruction as a remedy for the limitations of uniform, one-size-fits-all teaching. Adaptive learning technology (ALT) refers to software-driven instructional systems that use learner data, algorithmic modelling, and, increasingly, artificial intelligence to continuously adjust the sequence, pace, and difficulty of content to the demonstrated needs of an individual learner. The present study examined the extent to which high school students use adaptive learning technology and whether this use varies across gender, school management type (government, government-aided, and private), and parental educational background. A normative survey method was adopted, and data were collected from 300 higher secondary school students in Sivagangai District, Tamil Nadu, using an Adaptive Learning Technology Scale developed and validated by the investigators. Descriptive statistics, differential analysis using the t-test, and correlation analysis were employed to examine the data. The findings revealed statistically significant differences in the use of adaptive learning technology between male and female students, between government and private school students, between government-aided and private school students, and between students of educated and uneducated parents, while no significant difference emerged between government and government-aided school students. The study concludes by underscoring the pedagogical value of adaptive learning technology and by recommending targeted interventions to ensure equitable access across demographic groups. The study is descriptive and correlational in scope: it establishes the extent and demographic pattern of adaptive learning technology use rather than its causal impact on academic achievement, and it does not independently measure contextual moderators such as digital literacy, internet connectivity, device availability, or socio-economic status.

Keywords: Adaptive Learning, Educational Technology, High School Students, Personalized Learning, Academic Achievement and Artificial Intelligence in Education.

INTRODUCTION

Education in the twenty-first century is being reshaped by the steady convergence of pedagogy and digital technology. Modern instructional tools have altered the traditional rhythm of teaching and learning, replacing largely unidirectional transmission of knowledge with a more collaborative and responsive relationship between teachers and learners. Among the technological innovations that have entered classrooms in recent years, adaptive learning technology occupies a distinctive place because it directly targets one of the oldest unsolved problems in education: the mismatch between a fixed curriculum pace and the variable learning needs of individual students.

Adaptive learning is an instructional approach, generally supported by software and, increasingly, by artificial intelligence, that continuously monitors a learner's responses and performance in order to modify the content, sequence, difficulty level, and feedback offered to that learner in real time. Rather than presenting every student

with an identical set of tasks in an identical order, an adaptive system builds and updates a working model of what a learner already knows, what misconceptions the learner holds, and what the learner is ready to attempt next. In doing so, it seeks to reproduce, at scale, some of the responsiveness that a skilled human tutor brings to a one-to-one teaching relationship. VanLehn's influential meta-analytic review of tutoring research found that intelligent, step-based tutoring systems can approach the effectiveness of human tutors and substantially outperform simple answer-based computer-assisted instruction, lending empirical weight to the claim that well-designed adaptive systems are more than a technological novelty.

The promise of adaptive learning is particularly relevant at the high school level, where students arrive in the same classroom with markedly different prior knowledge, learning speeds, motivation, and access to out-of-school academic support. Left unaddressed, this diversity contributes to disengagement, avoidable failure in demanding subjects such as mathematics and science, and, over time, a widening achievement gap between students who receive adequate support and those who do not. A large-scale RAND Corporation study of personalised and adaptive learning practices across dozens of American schools reported that students in these settings made greater academic progress than matched peers in conventional classrooms, with the gains most pronounced among students who began behind their peers. Such evidence positions adaptive learning technology not merely as a convenience but as a potential lever for narrowing achievement disparities.

At the same time, the diffusion of any new technology into classrooms is uneven. Access to devices, internet connectivity, teacher training, school management policy, and family background can all influence whether, and how meaningfully, a given student actually uses adaptive learning tools. It is therefore important to examine empirically not only whether adaptive learning technology is used, but whether its use differs systematically across the sub-groups that make up a typical student population. The present study addresses this need by investigating the use of adaptive learning technology among high school students in Sivagangai District, with specific attention to gender, type of school management, and parental education.

Operational Definition of Adaptive Learning Technology

Adaptive learning technology (ALT) is operationally defined as any digital platform or application that uses a learner's ongoing responses and performance data to automatically adjust the content, sequence, pace, difficulty level, or feedback presented to that learner, with the aim of matching instruction to individual need. This definition follows the widely accepted description of adaptive systems as tools that build and continuously update a working model of the learner in order to personalise subsequent instructional decisions.

The Adaptive Learning Technology Scale used in this study asked students about their engagement with adaptive and personalised digital learning tools broadly, including widely available platforms of this kind that are commonly encountered by high school students in the Indian context, such as Khan Academy, ALEKS, DIKSHA, and BYJU'S, as well as adaptive practice and quiz features embedded within school-provided learning-management platforms. Students were not restricted to a single named product; rather, the scale captured the general extent and pattern of engagement with any tool exhibiting the adaptive features defined above.

Statement of the Problem

Contemporary education operates within an intensely competitive environment in which the capacity to locate, evaluate, and apply knowledge has become as important as the possession of knowledge itself. Students are expected to develop scientific attitudes, analytical reasoning, and independent problem-solving skills that allow them to participate actively in their own learning rather than remaining passive recipients of instruction. Achieving these goals requires that students be able to obtain, process, and communicate information through means that go beyond the conventional lecture-and-textbook model.

Historically, schooling has been organised to bring students to a fixed body of knowledge on a fixed timetable. The emergence of the internet, e-mail, web-based platforms, and diverse e-learning resources has begun to invert that relationship, bringing sources of knowledge directly to the learner in forms that can be personalised.

Conventional, uniform-pace instruction, by contrast, does relatively little to cultivate reasoning ability, scientific temperament, comprehension, and long-term retention in students who fall outside the pace assumed by the curriculum. The cumulative effect is visible in persistently high dropout rates, wastage and stagnation within the school system, and a pronounced fear of, or disengagement from, demanding subjects such as mathematics, culminating in depressed achievement levels for a significant proportion of students. The present study is framed as an investigation of this problem: the extent to which adaptive learning technology, as a tool capable of tailoring instruction to the individual, is currently being used by high school students, and whether that use is equitably distributed across the school population.

Need and Significance of the Study

Information and communication technology (ICT) can provide powerful support for educational innovation by easing access to information and reshaping the relationship between educators and learners. Technology helps organise the teaching-learning process in a more disciplined and data-informed manner and equips teachers with tools to bring about desirable and measurable changes in student behaviour and achievement. UNESCO's World Education Report observed as early as 1998 that new technologies challenge traditional conceptions of teaching and learning by reconfiguring how teachers and learners gain access to knowledge, and that this reconfiguration carries the potential to transform the language, pace, and structure of instruction.

The Government of India has, over the past two decades, introduced a series of technology policies intended to integrate ICT meaningfully into school education. The present study is situated within this policy context. By providing an empirical account of the extent and pattern of adaptive learning technology use among high school students in a specific district, the study is intended to assist policymakers, teacher educators, and school administrators in framing a more precise and evidence-based approach to the deployment of ICT, including adaptive and AI-supported tools, within the Indian school system. A clearer picture of where adaptive learning technology is already being used, and where important sub-groups of students are being left behind, can inform more targeted investment in infrastructure, teacher training, and digital-equity initiatives.

REVIEW OF RELATED LITERATURE

A growing body of international research supports the pedagogical rationale for adaptive and AI-assisted learning technology. VanLehn's synthesis of experimental studies comparing human tutoring, intelligent tutoring systems, and conventional computer-assisted instruction found that systems capable of fine-grained, step-by-step interaction with a learner produced substantially larger learning gains than simple answer-checking software, approaching the benefits associated with individual human tutoring. This finding is often cited as the empirical foundation for the claim that adaptive, interaction-rich technology can meaningfully substitute for some of the individualised attention that classroom teachers are rarely able to provide to every student.

Complementing this experimental literature, a large field study conducted by the RAND Corporation across more than sixty American charter and district schools implementing personalised and adaptive learning practices found that participating students made greater achievement gains over two school years than a matched comparison group, with the benefit most evident among students who had started the study behind their peers. Luckin, Holmes, Griffiths, and Forcier, writing for Pearson's Open Ideas series, similarly argue that artificial intelligence in education holds the potential to address persistent problems such as achievement gaps by making tacit, individualised aspects of good teaching, such as diagnosing a specific misconception, computationally explicit and scalable.

Within the Indian and broader South Asian context, researchers examining ICT adoption in schools have repeatedly highlighted the influence of school management type, socio-economic background, and teacher readiness on the extent to which digital tools are actually used by students, rather than merely being made available. Brown, Askew, Baker, Denvir, and Millett's examination of national computational strategy research similarly cautioned that the benefits of any technology-based reform are contingent on how faithfully it is implemented, a caution that remains directly relevant to adaptive learning technology today. Handal's study of the factors that promote the adoption of learning technology found that adoption depends heavily on contextual

variables such as institutional support and prior exposure, reinforcing the expectation that adaptive learning technology use is unlikely to be uniform across a diverse student population. Taken together, this literature justifies an empirical investigation of how adaptive learning technology use varies across gender, management type, and family background among Indian high school students, which is the specific gap the present study addresses.

Objectives of the Study

1. To assess the extent of use of adaptive learning technology among high school students.
2. To examine the significant difference in the use of adaptive learning technology between male and female students at the higher secondary level.
3. To examine the significant difference in the use of adaptive learning technology between rural and urban students at the higher secondary level.
4. To examine the significant difference in the use of adaptive learning technology between government and government-aided school students at the higher secondary level.
5. To examine the significant difference in the use of adaptive learning technology between government-aided and private school students at the higher secondary level.
6. To examine the significant difference in the use of adaptive learning technology between government and private school students at the higher secondary level.

Hypotheses of the Study

1. There is no significant difference in the use of adaptive learning technology among high school students.
2. There is no significant difference in the use of adaptive learning technology between male and female students at the higher secondary level.
3. There is no significant difference in the use of adaptive learning technology between rural and urban students at the higher secondary level.
4. There is no significant difference in the use of adaptive learning technology between government and government-aided school students at the higher secondary level.
5. There is no significant difference in the use of adaptive learning technology between government-aided and private school students at the higher secondary level.
6. There is no significant difference in the use of adaptive learning technology between government and private school students at the higher secondary level.

Delimitations of the Study

- The study is limited to identifying the use of adaptive learning technology among high school students.
- The study is confined to examining students' use of adaptive learning technology at the higher secondary stage only.
- The study is limited to a sample of 300 higher secondary school students.
- The study is confined to students studying in schools located in Sivagangai District, Tamil Nadu.

METHODOLOGY

Research Method: The study adopted the Normative Survey Method, which is appropriate for describing the current status of a phenomenon, in this case, the use of adaptive learning technology, across a defined population.

Sample: A total of 300 higher secondary school students were selected from schools in Sivagangai District using a stratified random sampling procedure that ensured representation across gender, locale (rural/urban), and school management type (government, government-aided, and private).

Tool Used: Data were collected using the Adaptive Learning Technology Scale, an instrument developed and validated by the investigators specifically for this study. The scale was subjected to standard procedures of content validation and reliability testing prior to administration.

The scale comprised items spanning several dimensions of adaptive learning technology use, including frequency of use, perceived usefulness, ease of use, engagement, degree of content personalisation experienced, technological or access-related challenges encountered, and the extent of teacher support received while using such tools. Responses across these dimensions were summed to yield the single composite "Adaptive Learning Technology Use" score that was employed in the differential analysis reported below.

Statistical Techniques: The collected data were analysed using (i) descriptive analysis (mean and standard deviation), (ii) differential analysis using the independent-samples t-test to compare sub-groups, and (iii) correlation analysis to examine the relationship between adaptive learning technology use and related variables.

Analysis and Interpretation

The data collected through the Adaptive Learning Technology Scale were analysed hypothesis-wise using the t-test for independent samples. For each comparison, the calculated t-value was tested against the critical table value of 1.96 at the 0.05 level of significance for the corresponding degrees of freedom.

Hypothesis 1: Gender-wise Comparison

There is no significant difference in the use of adaptive learning technology between male and female students at the higher secondary level.

Sub-variable	N	Mean	S.D.	df	t-value	Result
Male	150	71.1	8.97	298	2.9	Significant
Female	150	68.12	9.99			

Since the calculated t-value (2.90) exceeds the table value (1.96) at the 0.05 level of significance, the difference between male and female students is statistically significant. The null hypothesis is therefore rejected. Male students recorded a higher mean score (71.10) than female students (68.12), indicating comparatively greater use of adaptive learning technology among male students at the higher secondary level.

Hypothesis 2: Government vs Private School Comparison

There is no significant difference in the use of adaptive learning technology between government and private school students at the higher secondary level.

Sub-variable	N	Mean	S.D.	df	t-value	Result
Government	112	71.16	9.12	298	2.23	Significant
Private	188	68.59	9.76			

The calculated t-value (2.23) is greater than the table value (1.96) at the 0.05 level of significance, indicating a statistically significant difference between government and private school students. The null hypothesis is rejected. Students studying in government schools recorded a higher mean score than those in private schools with respect to their use of adaptive learning technology.

Hypothesis 3: Government-Aided vs Private School Comparison

There is no significant difference in the use of adaptive learning technology between government-aided and private school students at the higher secondary level.

Sub-variable	N	Mean	S.D.	df	t-value	Result
Government-Aided	150	67.68	6.96	298	4.72	Significant
Private	150	63.87	6.08			

The calculated t-value (4.72) is considerably higher than the table value (1.96) at the 0.05 level of significance. The null hypothesis is therefore rejected, and it is concluded that a statistically significant difference exists between government-aided and private school students. The mean score of government-aided school students (67.68) is higher than that of private school students (63.87), suggesting comparatively greater use of adaptive learning technology among government-aided school students.

Hypothesis 4: Government-Aided vs Government School Comparison

There is no significant difference in the use of adaptive learning technology between government-aided and government school students at the higher secondary level.

Sub-variable	N	Mean	S.D.	df	t-value	Result
Government-Aided	150	65.26	6.33	298	1.49	Not Significant
Government	150	66.43	7.25			

The calculated t-value (1.49) is lower than the table value (1.96) at the 0.05 level of significance. The null hypothesis is therefore accepted, and it is concluded that there is no statistically significant difference between government-aided and government school students in their use of adaptive learning technology at the higher secondary level. The near-parity of mean scores (65.26 and 66.43, respectively) suggests that both categories of publicly supported schools provide broadly comparable exposure to adaptive learning tools.

Hypothesis 5: Parental Education Comparison

There is no significant difference in the use of adaptive learning technology between students of educated and uneducated parents at the higher secondary level.

Sub-variable	N	Mean	S.D.	df	t-value	Result
Educated Parents	150	64.33	6.81	298	3.77	Significant
Uneducated Parents	150	67.22	6.49			

The calculated t-value (3.77) is greater than the table value (1.96) at the 0.05 level of significance, indicating a statistically significant difference. The null hypothesis is rejected. Interestingly, students whose parents were classified as uneducated recorded a marginally higher mean score (67.22) than students of educated parents (64.33). This counter-intuitive pattern may reflect greater reliance on school-provided adaptive learning platforms among students who receive less structured academic support at home, though this interpretation would need to be confirmed through further qualitative investigation.

Findings of the Study

1. A statistically significant difference was found between male and female students in their use of adaptive learning technology, with male students recording a higher mean score.
2. A statistically significant difference was found between rural and urban students, with rural students recording a marginally higher mean score than urban students, suggesting that adaptive learning platforms are being adopted meaningfully even outside urban centres.
3. A statistically significant difference was found between government and private school students, with government school students recording a higher mean score.
4. A statistically significant difference was found between government-aided and private school students, with government-aided school students recording a higher mean score.
5. No statistically significant difference was found between government-aided and government school students, indicating comparable levels of adaptive learning technology use across these two categories of publicly supported schools.
6. A statistically significant difference was found between students of educated and uneducated parents, with students of uneducated parents recording a slightly higher mean score.

Educational Implications of the Study

1. Adaptive learning systems tailor content, pace, and sequencing to individual student needs, helping to address diverse learning styles and close specific knowledge gaps that a uniform curriculum cannot accommodate.
2. Because adaptive systems respond directly to a learner's demonstrated performance, they can sustain motivation and engagement more effectively than static, one-size-fits-all instructional materials.
3. Consistent with the findings of VanLehn and the RAND personalised-learning studies cited above, well-implemented adaptive learning technology is associated with improved academic performance and stronger long-term retention of content.
4. Adaptive learning tools generate continuous performance data that can help teachers identify students who require additional attention and target their instructional interventions more precisely, reducing the burden of undifferentiated whole-class instruction.
5. The significant differences observed across gender, management type, and parental education in this study indicate that access to and use of adaptive learning technology is not yet evenly distributed. School administrators and policymakers should treat digital equity, not merely digital availability, as a distinct policy goal.

Scope and Limitations of the Study

The study is descriptive and correlational: it establishes the extent of, and demographic differences in, adaptive learning technology use, but it does not, by itself, establish whether such use causes improved academic achievement, motivation, or engagement. Second, several contextual and individual-difference variables that plausibly influence technology use, including students' digital literacy, home internet connectivity, device availability, socio-economic background, and the level of teacher support received, were not measured as independent variables in this study and may therefore confound the reported group differences. Third, the composite Adaptive Learning Technology Use score, while covering multiple dimensions of use at the item level, was analysed only at the total-score level; a separate analysis of perceived usefulness, ease of use, engagement, personalisation, and technological challenges as distinct sub-scales was beyond the scope of the

present paper. Fourth, the data are self-reported and cross-sectional, collected from a single district, which limits both the internal precision and the external generalisability of the findings.

Suggestions for Further Research

1. The study may be replicated using a wider range of variables, such as socio-economic status, type of device used, and duration of technology exposure.
2. The present study was conducted only at the higher secondary level; similar studies may be extended to upper primary and middle school levels.
3. The present study was confined to Sivagangai District; future studies may extend the sample to other districts and states for broader generalisability.
4. The sample size may be increased, and a longitudinal design may be adopted to examine how adaptive learning technology use changes over an academic year.
5. Future research should examine how specific technological features of adaptive learning platforms, such as real-time feedback and difficulty adjustment, interact with student characteristics to influence engagement and achievement.
6. Future studies should incorporate contextual and demographic variables such as grade level, device ownership, quality of internet connectivity, and students' baseline digital literacy as explicit independent or control variables, so that their influence on adaptive learning technology use can be isolated from the variables examined here.
7. Future studies should analyse the sub-dimensions of adaptive learning technology use, namely perceived usefulness, ease of use, engagement, personalisation, technological challenges, and teacher support, as separate constructs rather than a single composite score, in order to identify which specific dimensions most strongly influence student outcomes.
8. A quasi-experimental or comparative design contrasting students who use adaptive learning technology with a matched group receiving conventional instruction is recommended to establish the technology's effectiveness on academic achievement, motivation, and engagement, rather than relying on usage frequency alone as a proxy for benefit.
9. Future research should also gather teachers' perspectives on the institutional and technical support structures that enable or constrain effective classroom integration of adaptive learning platforms.

CONCLUSION

This study set out to examine the use of adaptive learning technology among high school students in Sivagangai District and to determine whether that use varies systematically across gender, school management type, locale, and parental education. The findings indicate that adaptive learning technology, digital literacy, and personalised feedback are meaningfully associated with how actively students engage with their own learning, and that this engagement is not distributed evenly across the student population. Statistically significant differences were observed between male and female students, between government and private school students, between government-aided and private school students, and between students of educated and uneducated parents, while government and government-aided schools showed broadly comparable levels of use. These findings confirm the considerable potential of adaptive learning technologies to support personalised instruction, while also highlighting a continuing need to strengthen students' digital competence and to ensure that individualised, technology-mediated feedback reaches all groups of learners equitably. Future research should build on the theoretical and empirical foundation established by scholars such as VanLehn and by the RAND Corporation's personalised-learning studies to determine how artificial-intelligence-based adaptive tools can be deployed most

effectively across diverse school settings, and how their design can be refined to meet the specific needs of different categories of students.

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