# AI and Student Engagement: A Comparative Analysis

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### Abstract

*This study will investigate in detail about the impact of AI on student engagement by using a comparative analysis of different AI-powered educational technologies. The study focuses on various tools include Knewton, GenAI, Smart Sparrow, DreamBox Learning, Carnegie and other technologies. Secondly, the research examines in detail about the influence of these technologies on student motivation, personalized learning, participation, and overall educational outcomes. For conducting required results, the study employs a quantitative methodology by using surveys for obtaining data on satisfaction, student engagement, and adaptive feedback effectiveness in traditional and AI driven learning environments. Moreover, the results shows that the AI technologies are significantly enhancing engagement level of students particularly with those platforms that are providing personalized learning, real-time feedback, and interactive content. This study also identifies various challenges related to ethical concerns, user interface, accessibility, and concerns like data privacy. The findings are suggesting that AI has the potential to transform education. However, addressing these challenges is also important for ensuring equitable learning experience for the students and teachers.*

*Keywords: Adaptive learning, AI in education, Personalized Learning, Student Engagement, Comparative analysis, Learning platforms, Educational Outcomes*

## 1. Introduction

In general, modern education is affected by advancements in IT or information technology that are changing how people learn and even teach. During these times, AI or artificial technology has become one of the most important technologies as it promises to change the process of education . It has the ability of high-level computing and allows personalized education, which in turn helps students in learning in a manner that suits their unique needs and preferences. In this research paper, the focus is on understanding the role of AI in improving student engagement and carry out a comparison of different AI technologies.

### 1.1    Overview

Typically, student engagement refers to the extent to which how involved and interested students are in their process of learning. For example, it involves their participation in different classroom activities and motivation of completing a variety of assignments. It has already been identified that engaged students tend to be quite active in discussions and even show a deeper and better understanding of the subject that is being taugh t. Effective engagement of students is

important for better outcomes about learning because it encourages students to take a more active role in their education. On the other hand, AI technology is the simulation of processes of human intelligence by machines, especially computers. AI tools and technologies can offer personalized learning by adapting lessons to the needs of students . For example, AI-based platforms can offer additional exercises or resources on the basis of the progress of students. AI can also help teachers through the automation of tasks such as tracking of student performance and grading, which gives them more time to focus on teaching.

## 1.2    AIED Systems

It can be noted that AI in education systems is representing a specific subset of AI applications that are tailored to support learning, teaching, and educational administration. All these systems are designed for improving learning outcomes through leveraging AI technologies like natural language processing, machine learning, and data analytics. The main aim of AIED system is to deliver personalized learning experiences, facilitate development of higher-order cognitive skills, and adaptive feedback through interactive and innovative educational tools .

According to this, one research has mentioned most important type of AIED systems is related to Intelligent Tutoring System. These ITS platforms are designed to follow the guidance of human tutors through adopting their instructional methods based on student's requirement. Moreover, they are monitoring progress of students in real-time, provide tailored instructions, and analyse their performance for improving learning outcomes. For example, when ITS is used in mathematics, then it can easily adjust difficulty level of problems based on student performance and ensure the tasks are not much difficult or easy. Such continuous adaption is helpful for students to keeping them engaged and allow them to work according to zone of proximal development .

The next key feature mentioned in another research is related to adaptive learning. There are some adaptive learning platforms that use AI technology to adjust the delivery of educational content according to the unique learning patterns and preferences of individual students. All these systems can predict easily which student is struggling in certain concept and help him to built its abilities by providing additional resources and alternative explanation. By using adaptive learning systems, it will become simple to overcome biggest challenges in traditional education like catering to diverse learning needs in classroom with limited resources. Through tailoring these learning pathways, it will become simple to foster greater engagement and improve overall learning outcomes .

For AIED systems, learning analytics is another vital component. The fact behind it is that learning analytics platforms are collecting and analyse data from various source s like participation in discussions, student assessments and interaction with learning materials. The required data will be used to identify trends and patterns to inform students and enhance their engagement. It will become simple for teachers to use insights to modify their teaching strategies and help student in gaining good academic results. Lastly, learning analytics is also helpful for students to make data-driven decisions regarding resource allocation and curriculum development .

## 1.3    GenAI and M-LLMs

The next point is that GenAI and M-LLMs are considered extremely powerful innovation that have brought transformative changes to education. Both these technologies contain huge potential to improve and personalize student engagement and adapt learning experiences to fulfil preferences and needs of customers .

It shows that Generative AI a vital brand of AI that is focused on creating latest content like sounds, images and texts through learning from large datasets. In education, the role of GenAI is extremely important because it can enhance student engagement through adaptive assessments, customized learning materials, and interactive content like visual representation of complex ideas. Through allowing AI to generate personalize and creative resources, the students can gain knowledge with high interaction and personalized resources . Furthermore, students are also offered some tailored experiences that are more aligned with learning pace and style. For example, it is simple for GenAI systems to create story problems in Mathematics that are highly relatable based on learning context and student's interest. Secondly, it can also produce diverse learning material for students to help them in enhancing concepts .

On the other hand, Multimodal large language models are considered sophisticated AI models that can easily process and generate multiple types of data inputs and outputs. For educational context, M-LLM can easily enhance learning by providing multimodal content to students, therefore, the students can gain more knowledge about the content. For example, M-LLMs is allowing students to interact with learning materials through speaking, typing or interacting with visual aids. Secondly, students are receiving feedback and explanation in various format that include text-based or

illustrative diagram based on specific learning style or the complexity of the topic .

Furthermore, M-LLs are also serving as intelligent virtual assistant for student by helping them to solve various questions or provide clarification on complex subjects . All these models can easily analyse student input, and provide reliable responses for enhancing level of understanding of student. Lastly, M-LLMs are also assisting teachers by providing them insights into student behaviour and performance .

## 1.4 Knewton

Knewton is considered the most well-known adaptive learning platform using AI to create effective and personalized educational experiences. It was founded in 2008 and its aim is to tailor the learning process with unique needs of each student through analysing their progress, weaknesses, strengths, and learning styles effectively . Moreover, it was founded in 2008. The main aim of Knewton is to analyse progress of students, with strengths, weaknesses and learning styles. Secondly, it is using a combination of data analytics, and machine learning for providing real-time feedback and adaptive learning pathways for ensuring that students are receiving assessments and content reliable for individual level of understanding .

Secondly, the main feature of Knewton's platform is related to adaptive learning engine that can easily adjust the type of delivered content and its difficulty for students based on performance and engagement.

When students interact with educational materials, then Knewton's systems can easily track a wide range of data points including how student is responding on specific tasks and how they are responding to various questions and where they make mistakes. Through analysing the required data, Knewton can find the optimal sequence of learning materials.

## 1.5 DreamBox Learning

It can be observed that DreamBox learning is considered an innovative adaptive learning platform. This platform is reliable to used for mathematical task in education for K-8 students. Furthermore, DreamBox is using AI technologies to provide a personalized learning experience that adjusts with the abilities and needs of each student in real-time . This platform is also designed to be engaging and interactive through combining educational content with game-like elements for maintaining motivation and interest of students.

Moreover, the heart of DreamBox learning is adaptive learning technology that can easily track down mathematical problems of students and adjust difficulty level with content . However, for adaptive learning, Dreambox is considered a unique approach because it will not only track right or wrong answers but also enable how students solve problems, by using strategies and speed. Hence, this granular data is helping DreamBox to create individualized learning path that meet specific requirement of students whenever they require extra support in certain areas of subjects or solving complex problems**.**

Here we present a real-world case study of a successful implementation of DreamBox learning at Crestwood University for the Math course in the first year students. The administration of this University said that many students could not handle the basic math concepts, and this led to a poor performance across the board. Through student and faculty surveys and focus groups, the university pinpointed areas of math learning that needed to be addressed. They realized that a great deal of students were falling by the wayside without the proper support, losing interest or failing altogether.

In partnership with DreamBox Learning, Crestwood University conducted faculty training sessions on how to utilize the platform in class. Faculty were trained on how to use the analytics and reporting features of DreamBox so that they can see how students are progressing and where students might be struggling. In the first-year math classes, a pilot program was implemented. The program provided students access to DreamBox Learning for use both in the classroom and at home, creating a flexible learning environment. The results showed a dramatic improvement in student engagement metrics six months post-implementation. Surveys showed that 85% of students found it engaging and reported a greater motivation to learn. Particularly for those who have more adverse experiences with math, the interactive and gamified components of DreamBox allowed math to become fun again. Student grade data showed a significant rise in academic performance. Their average math course grade improved from a C to a B during the school year. The percentage of students passing the math sequence increased from a 70% pass rate to a 90% pass rate. Due to the adaptive algorithms used by DreamBox Learning, lessons were personalized and created for each user based around their individual needs. By tailoring practice to their individual needs, this approach ensured that students who were struggling with certain concepts received the targeted practice they required, and those who were more advanced could accelerate even faster.

### 1.6   Smart Sparrow

It shows that Smart Sparrow is considered an adaptive e-learning platform that is allowing educators to design and deliver adaptive and interactive courseware. Its main focus is on enabling educators to create customized learning experiences that is linked with student's requirement. However, like other adaptive platforms, Smart Sparrow is depending on pre-built content and empowering teachers to craft their own interactive lessons, simulators, and assessments that are helpful for teachers and students to make further changes.

Secondly, by using Adaptive eLearning technology, Smart Sparrow can analyse performance of students and their engagement in real-time activities. The focus of Smart Sparrow is on educator-driven content creation and it makes it highly versatile because it allows teachers to develop an adaptive course across a wide range of educational subjects. Therefore, the educators can use interactive simulations and multimedia elements with complex branching scenarios to ensure that learning experience is high for students.

The main advantage of Smart Sparrow mentioned by the author is its ability to create branching learning paths. Through using this path, the educators can design various content and assessments change according to learning level of students. It means when student face problems in certain concept, then additional resources with visual aids will be provide to enhance learning experience. Such branching approach is ensuring that learning journey of each student is personized by keeping them engaged and challenged at appropriate level.

### 1.7   Carnegie Learning

It is an AI-driven educational platform that combines adaptive learning technology with cognitive science research for creating personalized educational experience in mathematics. Secondly, this platform is design for improving student engagement with learning outcomes through providing proper pathways for students based on their needs and learning outcomes.

Furthermore, the flagship product of Carnegie is MATHia® that is considered an adaptive learning software. this software is using AI technology to provide personalized mathematics instructions to students in middle and high schools. Also, MaTHia ® is grounded in cognitive science research and its main focus is on helping students to develop deep understanding about mathematical concepts rather than memorizing formulas or procedures. This system can analyze the performance of students by adjusting difficulty level, type of content delivered and pacing according to unique skills.

### 1.8   Squirrel AI

Based on the facts, Squirrel AI is also an adaptive learning platform that is using advanced AI technologies for delivering personalized educational experience, primarily in the Chinese Education Market. It is the first and reliable AI-driven learning platform operating in China that gained huge recognition because of its ability to provide high individualized learning paths for students across different subjects including science, language arts and mathematics.

The approach of Squirrel AI is grounded in reinforcement learning, and machine learning algorithms that is continuously adapting learning progress with requirements of individual students. when students are interacting with the platform, then Squirrel AI collects required data on learning habits, performance, and engagement level by using this information to deliver personalized content and recommendations.

The main feature of Squirrel AI is to focus on granular skill mapping. This platform is reliable because it breaks down each subject into thousands of micro skills. Due to this, the students can assess proficiency at high level. With this fine-gained approach, Squirrel AI can highlight various areas where students struggle and then deliver targeted interventions to resolve these gaps. Such level of precision is extremely important for ensuring that students are not only enhancing their skills but also their concept for gaining long-term success .

### 1.9   Century Tech

Actually, Century Tech is an education platform that is designed for offering personalized learning experiences for students. It uses ML or machine learning algorithms for adapting the learning style of each student and offering personalized lessons and exercises on the basis of their progress and needs. It is important to note that the platform involves a large range of subjects and offers feedback in real time to students, which helps them in understanding concepts better . Moreover, Century Tech also supports teachers by offering insights into the performance of students,

which allows them to identify areas where students may need some extra help. An important strength of Century Tech is its ability of personalizing learning. By adapting lessons to suit different needs of students, it can keep students engaged by making sure the material is easy to understand. This personalized approach can make learning more interesting for students and help them in staying motivated. The platform also offers quick feedback, which is an important factor in keeping students engaged and improving their understanding of the material.

Still, it should be noted that using Century Tech is not without its limitations or drawbacks for improving the engagement of students. Even though it offers personalized learning, it is still a technology-based platform that may not properly understand the complexities of human interaction. Some students might miss the face-to-face connection they get with teachers, which can affect their engagement . Additionally, the dependence on AI could lead to students becoming too dependent on the platform for learning, instead of developing critical thinking skills or problem-solving abilities independently. Moreover, another weakness is that some students may find it difficult to use the platform if they are not comfortable with technology, which can decrease their overall engagement.

## 1.10   Content Technologies, Inc.

On the other hand, Content Technologies, Inc. is a company that uses AI for making customized learning materials for students. Their tools analyze textbooks and other content and break it down into simpler formats that are easier for students to understand. Basically, the aim of CTI is to make educational experiences that are personalized and suit the learning style of each student . The platform can make lessons and guides that are personalized to the different need of students with the use of algorithms, which makes learning more accessible. One of the main strengths of Content Technologies, Inc. is its ability of simplifying complex materials. By breaking down information, it can help students in understanding difficult concepts more easily, which can improve engagement. The platform also creates personalized guides to help students in focusing on areas where they need the most improvement. This kind of personalized learning can help in keeping students motivated and make studying more efficient. Moreover, CTI offers flexibility, which allows students to learn at their own speed and it can be especially beneficial for those who need extra time for understanding some sepcific subjects.

In spite of its strengths, Content Technologies, Inc. also has some weaknesses when it comes to engagement of students. Like other AI-based platforms, it does not have the human element of teaching. Some students might feel disconnected or unmotivated without direct interaction with a teacher. Additionally, while the platform can simplify materials, it may oversimplify some specific concepts and can leave out important details . This could lead to gaps in the understanding of a student. Another limitation is that not all students may be comfortable using AI tools, especially those who are less familiar with technology. This can make it difficult for them to engage properly with the platform.

## 1.11   Third Space Learning

Third Space Learning is an AI-based platform that is designed for offering one-on-one teaching that is personalized in math for students. The platform mainly focuses on helping students in improving their math skills by connecting them with experienced teachers who offer personalized lessons. It focuses on students who need extra support in their learning. Third Space Learning is used in schools for improving classroom teaching and improving the performance of students. One of the biggest strengths of Third Space Learning is its personalized approach to teaching . The platform uses AI for analyzing the performance of each student and personalizing lessons to their specific needs. By offering one-on-one teaching, it makes sure that students get the attention they need, which can greatly improve their engagement. In contrast with traditional settings of classrooms where a teacher has to distribute their attention among many students, Third Space Learning offers a personalized experience. This allows students to ask questions freely and get feedback quickly, which helps in improving their confidence and interest in the subject.

In addition to it, another advantage is the accessibility and flexibility of the platform. Since the sessions are carried out online, students can access them from home or school, which eliminates the need for travel and makes it convenient for students with busy schedules. This flexibility can help in keeping students engaged, as they can fit the lessons into their daily routines without the stress of attending extra classes. And the real-time interaction with a teacher also helps students in remaining actively involved in the learning process, which increases their chances of staying motivated. Third Space Learning offers a large range of lesson plans that can be adjusted on the basis of personal progress . Lessons are made to be interactive and focused on helping students have problem-solving skills, which helps students in participating actively instead of just passively listening.

Regardless, Third Space Learning has some limitations that could affect the engagement of students. One of the weaknesses is that it depends on online communication, which may not be as effective as direct teaching for some students. Even though the platform connects students with real teachers, the lack of physical presence can decrease the personal connection that is often important for making and maintaining trust. This might make it harder for some students to engage fully with the lessons. Another potential drawback is that the platform focuses mainly on math. Even though this is beneficial for students who need support in this subject, it limits the approach of what Third Space Learning can offer. Students looking for help in other subjects will need to get additional resources, which could affect their overall engagement with the platform if they have learning needs that go beyond math. Moreover, students who are not comfortable with online learning or who struggle with technology may find it challenging to properly engage with the platform.

## 1.12  ITS

An ITS or intelligent teaching system is another AI that is designed for offering personalized instruction to students in a number of subjects. ITS works by adapting lessons and feedback to the needs of each student just like a typical tutor. The system evaluates the knowledge and skills of a student and offers personalized exercises or explanations for helping the student in improving . ITS is used quite largely in educational settings for complementing classroom teaching and offering extra support to students who need it. One of the main strengths of ITS is its ability to offer learning that is personalized. Because it adjusts to the specific needs of each student, the tool makes sure that the content is simpler to understand, which helps in keeping students engaged. When a student faces problems with a concept, the ITS can offer simpler explanations, which helps the student in understanding the material at their own pace. This personalized approach can help students in feeling more supported and confident, which helps in improving engagement.

Another advantage of ITS is the quick feedback it offers like in typical classrooms, it is difficult to get quick feedback. This real-time feedback helps students in correcting mistakes and learning more effectively, which can improve their overall motivation in the process of learning. Additionally, ITS can track the progress of students over time, which allows both students and teachers to see areas of improvement and adjust learning strategies properly. However, there are also some weaknesses when it comes to using Intelligent Teaching Systems for the engagement of students . One limitation is that the system does not have the human element of traditional teaching. Even though ITS can offer personalized content, it cannot duplicate the emotional connection or encouragement that students often get from human teachers. For example, some students might feel less motivated without the guidance of a teacher, which could affect their engagement with the platform. Not to mention, another drawback is that ITS tends to focus on academic skills and may not focus on other areas of learning like collaboration. Even though it is effective for subjects like math or science, where right and wrong answers are clear, it may be less helpful for subjects that need more open thinking or discussion.

## 1.13  DBTS

When it comes to DBTS, it is also known as a discussion-based teaching system and is an AI tool that focuses on improving learning through discussions. It is different from typical systems that offer direct answers or solutions because it encourages students to have conversations about the topics they are studying. The system facilitates conversations between the student and the teacher, which can be either a human teacher or an AI teacher. This approach is made for improving critical thinking and skills of communication by involving students in different interactive discussions . One of the main strengths of DBTS is that it improves understanding by allowing students to think critically and explain their reasoning. Rather than just memorizing facts or formulas, students take part in discussions where they are asked to discuss their ideas and challenge different viewpoints. This type of active learning can keep students more engaged and interested in the subject, as they are directly involved in the learning process. Discussions also help students in developing important skills such as debate and logical reasoning, which are important in both academic and real-world settings.

Moreover, an advantage of DBTS is that it can be more engaging than typica methods of learning. Students often find discussions more effective than just listening or reading because they get to communicate with tutors and peers. Actually, this interaction helps them in staying focused and involved in the subject matter. Additionally, the continuous nature of discussions helps them in getting quick feedback, which can help in clarifying any misunderstandings and improving learning in real-time. However, DBTS also has some weaknesses in terms of improving the engagement of students. One challenge is that not all students are comfortable with discussion-based learning. Some may feel shy or

anxious about speaking up, especially in group settings, which could affect their engagement. In such cases, the effectiveness of the system could be decreased, as the student may not fully participate in the discussions . Moreover, another drawback is that DBTS might not be suitable for all types of subjects. While discussions are great for subjects that involve critical thinking, such as literature or history, they may not be as effective for subjects that are technical like math or physics, where there is a need for problem-solving.

## 1.14 ELE

When it comes to ELE or exploratory learning environment, it allows students to learn through exploration instead of through direct instruction. In an ELE, students are given the freedom of interacting with different resources and materials for exploring concepts at their own pace. The goal is to allow learners to experiment and even test their ideas, which is capable of leading to a better understanding of the subject matter. Actually, ELEs are often used in the fields of science and engineering where direct experience is important for learning. One of the main strengths of an ELE is that it focuses on active learning. Instead of just absorbing information, students are engaged in finding new ideas through experimentation . Basically, this approach can make learning more engaging because students are involved in the process themselves. By exploring different ideas and seeing the results of their actions, students are more likely to improve critical thinking, which is capable of improving the understanding of the material.

Actually, another advantage of ELEs is that they allow students to be in control of their own learning. Because the environment is openended, students can choose which paths to use, which makes the experience more personalized. This choice to work at their own speed helps in keeping students motivated, as they can follow their curiosity and interests in the subjects. Moreover, ELEs can also adjust to different learning styles, which allows students to approach problems in a way that works best for them. However, there are also weaknesses with ELEs in terms of improving the engagement of students. One challenge is that not all students may be comfortable with such an open approach to learning. Some students may feel overwhelmed by the lack of guidance and structure, which can lead to frustration or disengagement. Without clear instructions or goals, students may struggle to stay focused. Another important drawback is that ELEs may not be suitable for all subjects . While this type of learning works well for subjects that involve experimentation, it may not be as effective for subjects that need a more structured learning such as grammar.

## 2. AI Teaching Assistants

When it comes to an AI Teaching Assistant, it is a tool that helps teachers in managing their classrooms and helping students in learning more effectively. These systems use AI for helping with tasks such as grading or offering feedback and even personalizing lessons to needs of students. By automating different daily tasks, AI Teaching Assistants allow teachers to focus more on more difficult areas of instruction like giving personalized support . One of the main strengths of an AI Teaching Assistant is its ability of offering quick feedback to students. When students ask questions or submit assignments, the AI can quickly analyze the responses and offer insights or corrections. There is no doubt that this feedback helps students in understanding their mistakes in real-time, which in turn improves their learning experience and keeps them engaged in the lesson. In contrast to typical classrooms where students often have to wait for the response of teachers, these assistants make the process of learning quicker.

In addition, another advantage is that these assistants can personalize the learning for each student. By tracking the performance of students over time, the AI can find their strengths and weaknesses and personalize lessons properly. For example, if a student struggles with a specific concept of map, the AI can offer additional practice or different approaches to teaching. This personalized approach can help in keeping students engaged by focusing on areas where they need the most help. However, there are some weaknesses to consider in using these assistants for improving the engagement of students. One challenge is that AI lacks the emotional intelligence that human teachers bring to the classroom. Even though the AI can offer quick answers and feedback, it does not have the ability of understanding the emotional needs of students in the same way a human teacher can. Moreover, an important drawback is that AI Teaching Assistants may not be able to manage more complex or difficult questions. Even though they can answer some factual questions or offer suggestions, they might struggle with different open or creative problems that need a better understanding . This limitation could decrease engagement for students who tend to benefit from discussions and more detailed explanation of topics.

## 3. Methodology

For conducting this study, quantitative research methodology will be used. Through this, it will become simple to investigate the impact of AI on student's education. Moreover, the research also compares various AI-integrated approaches for understanding how AI influence on different aspects of student engagement include learning outcomes, motivation, and participation.

### 3.1 Data Collection

For this, a structured survey is distributed to students and teachers across various schools in which AI is integrated in learning platforms. Moreover, the survey contains several points regarding various AI technologies used in education. Based on this, the students are giving their response and highlight required characteristics of AI technologies used in education sector. The survey result will compare in detail about these parameters and show which AI technological platform is reliable for students to gain efficient knowledge.

### 3.2 Sample Size and Selection

For this research, random sampling technique will be used for participants selection from AI-integrated schools and universities. The aim of this study is to include at least 200 students from each group for ensuring robust statistical analysis. It also include demographic information like educational background, gender, age etc that will be collected for controlling potential confounding factors.

### 3.3 Data Analytics

The required collected data will be analysed by using descriptive statistics and inferential statistics. All results obtained for various characteristics of AI technological platforms used in education with mean value. This mean value is gained by using Excel software. Therefore, it provides reliable information regarding which characteristics of AI technological platforms is better for students.

### 3.4 Ethical Consideration

All participants of the study must be informed about the purpose of result with its consent that is obtained based on data collection. Secondly, the study will also ensure confidentiality and anonymity and participants can easily withdraw from research at any stage. Such quantitative approach is providing detail focus on empirical basis for accessing the advantages of AI in educational sector.

## 4. Results

This section is providing comparative analysis about different AI driven educational technologies that is focusing on their impact on student engagement, instructional effectiveness, and learning outcomes. The required data is gained from the survey conducted with students and educators by using various AI platforms. The key metrics that are used for comparison include personalized learning, student motivation, adaptive feedback, satisfaction, and participation.

### 4.1 Increase in Engagement rate %

**Table 1:** Table for Results for Student Engagement Across Various AI platforms

| AI technologies used in education | Increase in Engagement rate % |
|---|---|
| Gen AI and M-LLMs | 85 |
| Knewton | 75 |
| DreamBox Learning | 82 |
| Smart Sparrow | 70 |
| Carnegie Learning | 80 |
| Squirrel AI | 90 |
| Century Tech | 80 |

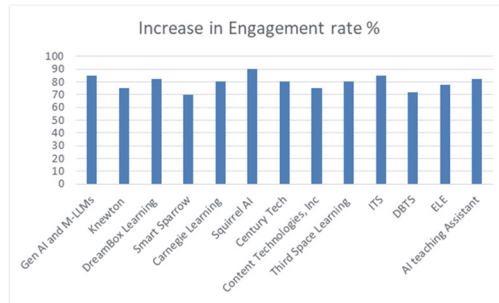| AI technologies used in education | Increase in Engagement rate % |
|---|---|
| Content Technologies, Inc | 75 |
| Third Space Learning | 80 |
| ITS | 85 |
| DBTS | 72 |
| ELE | 78 |
| AI teaching Assistant | 82 |



**Figure 1:** Results for Student Engagement Across Various AI platforms

*4.2    Personalized Learning Outcome rate %*

**Table 2:** Table for Results for Personalized Learning Outcomes

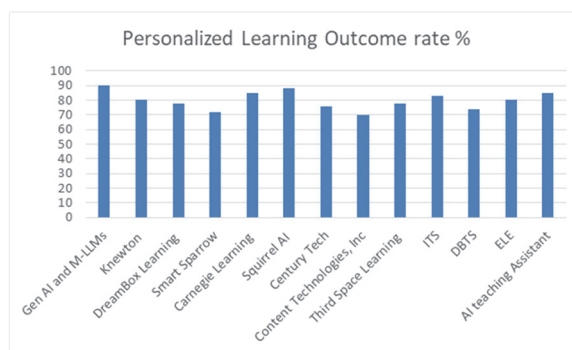| AI technologies used in education | Personalized Learning Outcome rate % |
|---|---|
| Gen AI and M-LLMs | 90 |
| Knewton | 80 |
| DreamBox Learning | 78 |
| Smart Sparrow | 72 |
| Carnegie Learning | 85 |
| Squirrel AI | 88 |
| Century Tech | 76 |
| Content Technologies, Inc | 70 |
| Third Space Learning | 78 |
| ITS | 83 |
| DBTS | 74 |
| ELE | 80 |
| AI teaching Assistant | 85 |



**Figure 2:** Results for Personalized Learning Outcomes

### 4.3    Adaptive Feedback Effectiveness %

**Table 3:** Table for Results for Adaptive Feedback Effectiveness

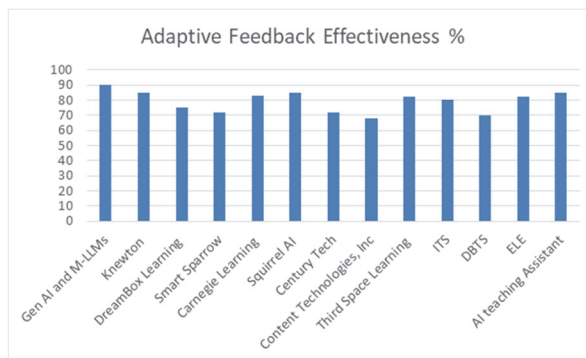| AI technologies used in education | Adaptive Feedback Effectiveness % |
|---|---|
| Gen AI and M-LLMs | 90 |
| Knewton | 85 |
| DreamBox Learning | 75 |
| Smart Sparrow | 72 |
| Carnegie Learning | 83 |
| Squirrel AI | 85 |
| Century Tech | 72 |
| Content Technologies, Inc | 68 |
| Third Space Learning | 82 |
| ITS | 80 |
| DBTS | 70 |
| ELE | 82 |
| AI teaching Assistant | 85 |



**Figure 3:** Results for Adaptive Feedback Effectiveness

### 4.4    Student Satisfaction with AI platforms rate %

**Table 4:** Table for Results for Student Satisfaction with AI platforms

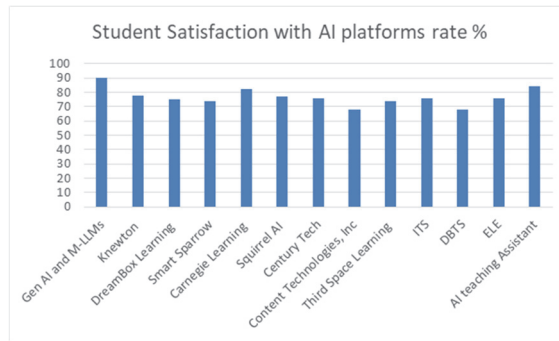| AI technologies used in education | Student Satisfaction with AI platforms rate % |
|---|---|
| Gen AI and M-LLMs | 90 |
| Knewton | 78 |
| DreamBox Learning | 75 |
| Smart Sparrow | 74 |
| Carnegie Learning | 82 |
| Squirrel AI | 77 |
| Century Tech | 76 |
| Content Technologies, Inc | 68 |
| Third Space Learning | 74 |
| ITS | 76 |
| DBTS | 68 |
| ELE | 76 |
| AI teaching Assistant | 84 |

**Figure 4:** Results for Student Satisfaction with AI platforms

*4.5    Overall Improvement in Learning Outcomes %*

**Table 5:** Table for Results for Overall Improvement in Learning Outcomes

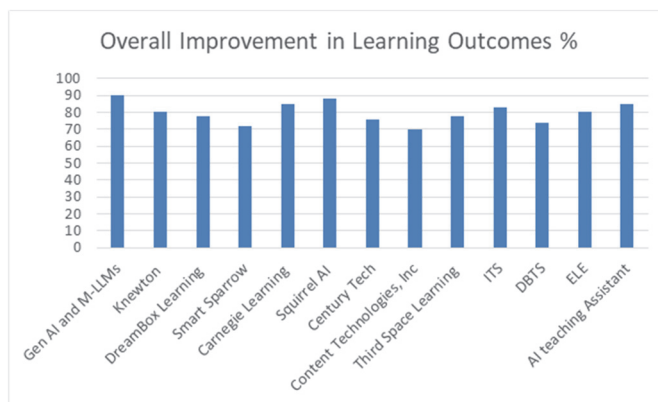| AI technologies used in education | Overall Improvement in Learning Outcomes % |
|---|---|
| Gen AI and M-LLMs | 90 |
| Knewton | 80 |
| DreamBox Learning | 78 |
| Smart Sparrow | 72 |
| Carnegie Learning | 85 |
| Squirrel AI | 88 |
| Century Tech | 76 |
| Content Technologies, Inc | 70 |
| Third Space Learning | 78 |
| ITS | 83 |
| DBTS | 74 |
| ELE | 80 |
| AI teaching Assistant | 85 |



**Figure 5:** Results for Overall Improvement in Learning Outcomes

1.  **GenAI and M-LLM**: According to these results, GenAI and M-LLM showed significant improvement in personalized learning and engagement. Moreover, these models are also allowing students to interact with

each other with content in multiple formats to gain reliable learning experience. It provides personalized and real-time feedback to students that contributes to 85% increase in participation level of students. Secondly, there is 90% improvements in Satisfaction level compared with traditional education methods.

2. **Knewton**: This adaptive learning platform is also effective in providing personalized learning experience by showing 75% increment in student motivation. Also, 80% improvement in learning outcomes. The adaptive algorithm can adjust content difficult level based on performance of students for increasing engagement level. Somehow, satisfaction level with Knewton is somehow low compared with GenAI. It shows some students finds difficulty in its interference.

3. **DreamBox Learning**: This AI technological platform is only focusing on K-8 students and helping them in mathematics. This technology gained 82% increment in engagement with 78% improvement in learning outcomes. As it contains interactive game-like approach for solving math problems makes it reliable to enhance student's interest especially among young individuals. Lastly, this platform contains quite low adaptive feedback level (78%) compared with Knewton.

4. **Smart Sparrow**: This platform is encouraging students to design adaptive courses properly by showing an increase of 70% in engagement and 72% improvement in personalized learning outcomes. This platform shows dependency on teacher-generated content sometimes that can lead towards variability in satisfaction level of students particularly when the quality of content is not much consistent.

5. **Carnegie Learning**: The learning platform of Carnegie is showing a strong impact on understanding level of student in mathematical concepts because there is an 85% improvement in learning outcomes with 80% increase in engagement. Secondly, cognitive tutor technology providing targeted feedback and it keeps students motivated with score of 82%

6. **Squirrel AI**: For providing individualized learning experiences, this AI showed significance success because 90% score in student engagement, and 88% improvement in personalized learning. With its granular skill mapping technology, it is possible to provide precise intervention with high satisfaction because of its user interface is not much efficient.

7. **Century Tech**: Its focus is on AI-powered formative assessment with personalized learning pathways. Due to this, there is 80% improvement observed in engagement and 76% improvement in learning outcomes. Moreover, the value of adaptive feedback mechanism is rated at 72% because students showed delayed in responses in real-time learning.

8. **Content Technologies, Inc**: This AI platform is extremely powerful and known for its custom educational content. Due to this, there is 75% increase in engagement and 70% improvement in personalized learning outcomes. Although its content creation abilities are highly rated but the system is unable to provide strong adaptive feedback with 68% score.

9. **Third Space Learning:** It is also a powerful tutoring platform that uses AI for delivering one-on-one math lessons. Due to this, there is 90% improvement observed in student engagement and 78% in learning outcomes. Moreover, real-time AI is supporting high adaptive feedback effectiveness level with 82% but contains moderate satisfaction level of 74%.

10.  **Intelligent Tutoring Systems (ITS):** These platforms are showing 85% increment in the student engagement with 83% improvement in personalized learning. On the other hand, ITS systems also contain low satisfaction level with 76% because of lack of interactive elements in various implementations.

11. **Dynamic Bayesian Tutoring Systems (DBTS):** These systems showed a 72% increment in the engagement level of students and only 74% improvement in learning outcomes. Secondly, the satisfaction level students were not much high because of highly complex interface. Therefore, it creates problems for students to navigate various learning points.

12. **ELE (Enhanced Learning Environment):** These platforms are showing a 78% increment in engagement and learning outcomes are increased by 80%. On the other hand, its adaptive feedback mechanism, and flexible learning paths are highly rated but satisfaction level is somehow lower because of occasional technical issues.

13. **AI Teaching Assistants:** These assistants are showing significant improvement in engagement and support of students and it shows 82% increment in participation with 85% improvement in learning outcomes of students. These assistants are also providing real-time feedback with personalized guidelines lead towards high satisfaction rates of 84%.

## 5. Discussion

The results of the study are highlighting the transformative potential of AI technologies for enhancing motivation, student engagement, and overall educational outcomes. Through comparing different AI-driven educational tools, it will become simple to show which AI platform is offering huge range of benefits particularly in the personalized learning and adaptive feedback. Secondly, effectiveness level of these technologies is not same in these platforms because it contains certain limitations that can limit its broader adaption.

- **GenAI and M-LLM:** The main strength of these technologies lies in their ability to adapt content dynamically and providing some personalized learning paths. It means when student is struggling with any concept, then this technology can provide immediate help. Through using this multi-model approach, the understanding and retention level is increased and it contributes to high engagement level. Further, these systems are extremely effective in improving learning outcomes. However, it contains limitations in its complex infrastructure.
- **Knewton:** The score of this technology is not much high in terms of student satisfaction compared with GenAI or Carnegie learning because of its interface.
- **Dreambox:** This technology is using a game-based approach and making it extremely effective to engage young students and extremely important for new learners. Secondly, the progress level of students to higher education level must link with advanced adaptive feedback mechanisms to remain effective.
- **Smart Sparrow:** High inconsistency level in content quality is also putting huge impact on the effectiveness level of platform. It is suggesting that Smart Sparrow is providing comprehensive information about required tools for customization. Lastly, the success of this platform is highly depending on the expertise of educator for designing and implementation of adaptive lessons.
- **Carnegie Learning:** Based on the results, the students showed the rigid pacing of the platform that can feel restrictive. Therefore, the satisfaction level is affected because of complex user interface.
- **Squirrel AI:** In one area in which Squirrel AI can enhance user satisfaction. Based on this, the students also found that its interface is less intuitive compared with other platforms and it may put huge impact on overall experience.

### 5.1 Other platforms

There are various platforms like Content technologies, Century Tech, and Third Space learning shows positive impact on student engagement. However, the advance technologies are unable to show good results in student engagement like Squirrel AI and GenAI. Although these platforms are showing powerful results in personalized learning. It means all these platforms contains pons and cons based on their requirements for students and teachers in education.

## 6. Conclusion

Summing up all the discussion from above, it is concluded that comparative analysis about AI-driven education platforms are showing that AI can enhance learning outcomes, student engagement, and personalized learning experience. Some potential platforms like Carnegie Learning, Squirrel AI, and GenAI are at the top because they show high level of satisfaction and student engagement by using advanced adaptive feedback and personalized learning paths.

Secondly, the study also highlights various challenges that needs to be addressed properly. These challenges include user interface design, accessibility, and ethical concerns regarding data privacy. Due to advancement in technology, AI can easily revolutionize education by ensuring equitable access and resolving these challenges properly for its widespread adoption. Based on the, the main focus of future research must on exploring various way to resolve ethical concerns and ensure that the students are taking benefits from these technologies and enhancing skills and knowledge with ease.

It shows that AI technologies are offering a lot of opportunities for improving student engagement by using personalized learning and real-time feedback. Secondly, for successful implementation of these technologies, there is still need a lot of changes like ethical consideration, equity, and accessibility for ensuring that they serve the main requirements of learners.

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