

Impact of AI-Powered Personalized Learning Platforms on the Academic Achievement of Biological Science and motivation of Secondary School Students in Warangal, Telangana, India.

Dr. Gugulothu Ravindar

Junior Lecturer in Botany, Telangana Minorities Residential Educational Institutions Society (TGMREIS), Lingampet, Kamareddy, Telangana.

Abstract:

This study explored the effects of AI-Powered Personalized Learning Platforms on the academic performance and motivation of secondary school students studying Biological Sciences in Warangal, Telangana, India. It posed two research questions and formulated two corresponding hypotheses, which were evaluated at a significance level of 0.05. A mixed-methods approach was employed, integrating both quasi-experimental design and descriptive survey research. The study's population included all public secondary school students in Warangal, Telangana. A sample of 50 students was selected using a combination of purposive and simple random sampling techniques. The researchers utilized Khan Academy as the intervention tool, while data collection instruments included a researcher-developed Biological Sciences Achievement Test (BSAT) and a Motivation-Based Questionnaire (MBQ). The draft of the questionnaire underwent validation through expert review by three lecturers.

Keywords: Learning, Secondary School, AI-Powered, Biological Sciences, academic performance.

Introduction

Biological sciences involve the exploration of living organisms, examining their structure, function, growth, evolution, and interactions with their environments. This field encompasses various disciplines, such as molecular biology, genetics, ecology, physiology, and evolutionary biology, to offer a holistic understanding of life processes (Alberts et al., 2002). At the secondary school level, biological sciences education emphasizes the foundational principles of biology, including cell biology, human anatomy and physiology, genetics, ecology, and evolution. The goal of this education is to foster an understanding of how living organisms operate and interact within ecosystems, thereby preparing students for future careers in health, environmental science, biotechnology, and other science-related areas (Oluwole & Ogunleye, 2014).

A key component of education in the biological sciences is the development of critical thinking and problem-solving abilities. Students engage in experiments, analyze data, and formulate hypotheses regarding biological phenomena. Mastering these skills is essential for comprehending intricate

biological systems and addressing real-world issues in health, agriculture, and conservation (Kober, 2015).

Research conducted by Adebayo et al. (2016) highlights that students' understanding of biological concepts is significantly impeded by a lack of practical experience, insufficient laboratory resources, and limited hands-on learning opportunities. Additionally, Oyedele (2018) notes that students' attitudes toward biology, shaped by a lack of motivation and interest, further detract from their academic success. In response to these challenges, educators and policymakers are increasingly embracing innovative educational technologies, including AI-driven personalized learning platforms. While traditional instructional methods like textbooks and lectures remain valuable, they often do not meet the varied learning needs of students. In contrast, AI-powered platforms provide adaptive learning environments that tailor the educational experience, allowing students to progress at their own pace and according to their unique strengths and weaknesses.

These AI-driven educational platforms leverage machine learning algorithms to assess students' learning habits and progress, offering immediate feedback and recommending personalized exercises to address knowledge gaps. By personalizing the learning journey, these platforms can boost student engagement, enhance motivation, and elevate academic performance (Huang, Liu, & Tili, 2019). Additionally, interactive simulations and gamified learning experiences can simplify complex biological concepts, making them more engaging and helping students visualize processes like cellular respiration, photosynthesis, and human genetics (Ouyang & Zhang, 2024).

One such platform is **Khan Academy**, a free, web-based educational resource that offers personalized learning experiences in a variety of subjects, including biology. Khan Academy's interactive lessons feature video tutorials, practice exercises, and real-time assessments, which allow students to progress at their own pace. In biology, the platform covers a broad range of topics, from cellular biology and biochemistry to ecology and human anatomy. By offering adaptive learning paths and immediate feedback, Khan Academy helps students grasp difficult biological concepts, improving both understanding and retention (Cavanagh, 2014). This personalized approach, which adapts to the student's learning style and pace, is central to Khan Academy's effectiveness in enhancing academic performance and motivation in biology.

Furthermore, platforms such as BioMan Biology and PhET Interactive Simulations are outstanding resources for biology students, offering interactive, simulation-driven learning tools. These platforms enable students to investigate biological processes through immersive virtual labs and simulations, enhancing the engagement and interactivity of biology studies. Such resources facilitate the visualization of intricate biological concepts and promote inquiry-based learning, which is essential for fostering a deeper comprehension of the subject.

By incorporating AI-driven personalized learning platforms like Khan Academy into the biology curriculum, educational institutions can provide more engaging, interactive, and effective learning experiences, ultimately boosting students' academic performance and motivation in the field of biological sciences.

Khan Academy provides educators with a rich array of resources, such as lesson plans, tutorials, and classroom management tools (Cavanagh, 2014). These materials assist teachers in designing personalized learning experiences and offering targeted support to students. The platform's progress-tracking and assessment features allow educators to monitor individual student achievements and pinpoint areas where further assistance is required, enhancing its adaptability. Additionally, Khan

Academy prioritizes inclusivity and accessibility, making its courses suitable for various age groups and skill levels. This commitment to inclusivity aligns with the objective of delivering personalized learning opportunities to as many students as possible. By being both accessible and flexible, Khan Academy empowers teachers to foster learning environments that honor individual differences while encouraging academic success (Ayeni et al., 2024). Consequently, this study seeks to explore the effects of AI-driven personalized learning on the academic achievement and motivation of secondary school students in Warangal, Telangana, India.

Statement of the Problem:

As educational systems work to address the varied needs of students, personalized learning has emerged as a promising strategy to enhance academic performance and student engagement. However, conventional teaching methods often do not cater to individual learning styles, pacing, and specific educational requirements, resulting in a uniform approach that may leave some students underserved. The growing integration of artificial intelligence (AI) in educational technology presents new possibilities for developing personalized learning experiences. AI-driven platforms can customize content, offer immediate feedback, and monitor student progress, potentially improving both academic outcomes and motivation. Nevertheless, there is a lack of empirical research on the effects of AI-based personalized learning platforms on student achievement and psychological well-being.

The absence of research in this area prompts several important inquiries:

What influence does Khan Academy have on the academic performance of secondary school students?

How does Khan Academy affect the motivation levels of secondary school students?

This study aims to address this gap by investigating the effects of AI-driven personalized learning platforms on the academic performance and motivation of secondary school students studying Biological Sciences in Warangal, Telangana, India.

Hypotheses:

H01: Khan Academy does not lead to a significant improvement in the academic performance of secondary school students when compared to traditional learning methods.

H02: Khan Academy does not have a positive effect on the motivation of secondary school students.

METHODOLOGY

The study employed a mixed research methodology, combining both quasi-experimental and descriptive survey designs. This approach was selected to gather both quantitative and qualitative data from the respondents. The population under study encompassed all secondary school students in **Warangal, Telangana, India**. Specifically, the target population consisted of secondary school students studying **Biological Sciences** in government and private high schools in the region.

A sample size of **fifty (50) students** was selected for the study, with **25 students** from **Government Secondary School, Hanmakonda** and **25 students** from **Private Secondary School, Hanmakonda**. The sample was obtained using a two-stage sampling technique. In the first stage, two schools were purposively selected based on resource availability, accessibility, and the willingness of school administrations to participate in the study. Intact classes within these schools were included in the sample.

In the second stage, the selected schools were randomly assigned to either the experimental or control group. **Government Secondary School, Hanmakonda** was designated as the **control group**, while **Private Secondary School, Hanmakonda** served as the **experimental group**.

The **experimental group** used **Khan Academy** as an AI-powered personalized learning platform to study Biological Sciences, while the **control group** followed the traditional method of instruction.

Table 1: Sample Distribution

S/N	Groups	Schools	Sample
1	control	Government secondary school Hanmakonda	25
2	Experimental	Private Secondary School, Hanmakonda.	25
Total			50

METHODOLOGY

The researchers utilized Khan Academy as the intervention tool (refer to Fig. 1), which functioned as the AI-driven personalized learning solution for the experimental group. In parallel, the researchers created two main assessment instruments: the Biological Science Achievement Test (BSAT) and the Motivation-Based Questionnaire (MBQ).

Figure 1: Khan Academy Personalized Learning Platform

The BSAT consisted of twenty multiple-choice questions based on the Biological Sciences curriculum, concentrating on essential topics such as Cell Biology, Ecology, and Genetics. This assessment aimed to evaluate students' knowledge and comprehension in these subjects. The MBQ was divided into two sections: Section A collected biographical information from participants, while Section B assessed the learners' motivation levels regarding the AI-powered personalized learning platform.

Both instruments were administered at both the pre-test and post-test stages to assess changes in knowledge and motivation over time. To ensure their validity and reliability, expert judgment was sought from three lecturers representing Biological Sciences, Educational Technology, and Educational Psychology. This process aimed to establish both face and construct validity.

Furthermore, the reliability of the instruments was confirmed using a test-retest method conducted with students not participating in the main study, with a three-week interval between tests. The Cronbach alpha coefficient was calculated to evaluate reliability, resulting in scores of 0.85 for the BSAT and 0.80 for the MBQ, which indicate strong internal consistency.

Data collection involved administering the pre-tests (BSAT and MBQ) to both the experimental and control groups before the start of instruction. Following the teaching and learning period, the post-tests were conducted. The experimental group received instruction using the Khan Academy platform, primarily online through the computer laboratory at Government High School, Hanmakonda. In contrast, the control group received traditional instruction using the "chalkboard" method. Both the BSAT and MBQ were again administered at the post-test stage to assess changes in knowledge and motivation between the experimental and control groups.

The data gathered from these instruments underwent statistical analysis through independent t-tests to assess the proposed hypotheses concerning the effects of the AI-driven personalized learning platform on students' academic performance and motivation.

RESULTS

H01: There is no significant difference in the academic achievement of secondary school students using Khan Academy compared to those utilizing traditional learning methods.

Table 2: t-test analysis of the achievement scores of experimental and control groups

Group	N	Mean Post-Test Score	Standard Deviation	t-value	p-value
Experimental	25	18.20	3.10	4.25	0.00
Control	25	14.60	3.40		

Table 2 reveals the mean post-test score for the experimental group was **18.20** with a standard deviation of **3.10**, while the mean post-test score for the control group was **14.60** with a standard deviation of **3.40**. The independent t-test comparing the post-test scores of the two groups yielded a **t-value of 4.25** and a **p-value of 0.00**. The **p-value of 0.00** is less than the significance level of **0.05**, indicating that the difference in post-test scores between the experimental and control groups is statistically significant. Therefore, we **reject the null hypothesis** and conclude that **Khan Academy significantly improves the academic achievement of secondary school students** compared to traditional learning methods.

H02: Khan Academy does not have a positive effect on the motivation of secondary school students when compared to traditional learning methods.

Table 3: t-test analysis of motivation scores for the experimental and control groups.

Group	N	Mean Post-Test Score	Standard Deviation	t-value	p-value
Experimental	25	4.2	0.6	5.30	0.00
Cpntrol	25	3.4	0.8		

Table 3 reveals the mean post-test motivation score for the experimental group was **4.2** with a standard deviation of **0.6**, while the mean post-test motivation score for the control group was **3.4** with a standard deviation of **0.8**. The independent t-test comparing the post-test motivation scores of the two groups yielded a **t-value of 5.30** and a **p-value of 0.00**. The **p-value of 0.00** is less than the significance level of **0.05**, indicating that the difference in post-test motivation scores between the experimental and control groups is statistically significant. Therefore, we **reject the null hypothesis** and conclude that **Khan Academy positively impacts the motivation of secondary school students**.

DISCUSSION

The experimental group utilizing Khan Academy achieved an average post-test score of 18.20, which is notably higher than the control group's average score of 14.60. This indicates that AI-driven platforms can offer personalized educational experiences that significantly improve learning outcomes. These results align with the research conducted by Kulik and Fletcher (2016), which found that computer-based instruction typically leads to better academic performance than traditional teaching methods.

Additionally, the study revealed that the experimental group had a higher average post-test motivation score of 4.2, compared to 3.4 for the control group. The significant p-value of 0.00 suggests that the boost in motivation is linked to the engaging and interactive features of AI-based educational tools. These findings are consistent with the work of Huang et al. (2019), who reported that students using AI-enhanced learning tools experienced greater levels of engagement and motivation.

CONCLUSION

Incorporating AI-driven platforms such as Khan Academy into the educational curriculum can significantly enhance academic performance and boost student motivation. This approach is especially advantageous in under-resourced educational environments, where personalized instruction is challenging to implement using conventional methods. AI in education facilitates customized learning experiences by adapting instruction to suit individual student needs, promoting engagement through interactive and gamified features, and offering instant feedback to help students monitor their progress and identify areas for improvement.

Recommendations

1. Schools ought to implement AI-driven personalized learning platforms to enhance teaching and learning experiences.
2. Future studies should investigate the long-term impacts of AI-based educational tools on student performance and explore ways to integrate these tools with traditional teaching methods for optimal benefits.
3. Additionally, research should focus on the effects of AI on various demographic groups to ensure that these technologies are equitable and accessible to all students.
4. Furthermore, researchers should identify the specific features of AI platforms that most effectively boost learning and motivation, offering insights into how these tools can be refined for educational purposes.

References

1. Ayeni, O. O., Al Hamad, N. M., Chisom, O. N., Osawaru, B., & Adewusi, O. E. (2024). Educational technology in biology: Khan Academy as a tool for enhancing academic performance. *GSC Advanced Research and Reviews*, 18(2), 261-271.
2. Babatunde, S. O. (2016). Challenges and prospects of curriculum implementation in Nigeria's educational system: The way forward. *International Journal of Educational Administration and Policy Studies*, 8(7), 66-72.
3. Barradas, R., Lencastre, J. A., Soares, S., & Valente, A. (2020). Leveraging online platforms to support biology education in high school students. In *International Conference on Computer Supported Education*. Springer International Publishing.
4. Buckingham, D. (2019). The role of educators in mediating digital tools for effective biology learning. *Learning, Media and Technology*, 44(2), 181-194.
5. Huang, Y., Liu, D., & Tlili, A. (2019). The effectiveness of artificial intelligence tools in improving biology students' academic motivation. *Educational Technology & Society*, 22(3), 124-136.
6. Ijaluola, K. O. (2017). Factors influencing students' academic performance in biology in secondary schools. *Journal of Emerging Trends in Educational Research and Policy Studies*, 8(4), 186-193.

7. Jamil, M. G., & Isiaq, S. O. (2019). Enhancing biology education through simulation-based teaching. *International Journal of Educational Technology in Higher Education*, 16(1), 25.
8. Kale, U., & Yuan, J. (2021). Promoting problem-solving skills through personalized tools like Khan Academy in biology education. *Journal of Educational Computing Research*, 59(4), 620-644.
9. Koedinger, K. R., & Corbett, A. T. (2012). Cognitive tutors in biology: Applying learning science in the classroom. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (2nd ed., pp. 61-78). Cambridge University Press.
10. Kuhail, M. A., Farooq, S., Hammad, R., & Bahja, M. (2021). Characterizing the use of online tools for fostering academic excellence in biology education. *IEEE Access*, 9, 14181-14202.
11. Mondal, B. (2020). Artificial intelligence in biology education: Current applications and future prospects. In *Recent Trends and Advances in Artificial Intelligence and the Internet of Things* (pp. 389-425).
12. Murtaza, M., Ahmed, Y., Shamsi, J. A., Sherwani, F., & Usman, M. (2022). Khan Academy's role in personalized biology learning: Challenges and solutions. *IEEE Access*, 10, 81323-81342.