

Analyzing Differences in Student Understanding and Retention When Taught by AI Versus Human Instructors

Dr. Nargis Sultana¹, Dr. Noor Ul Ain Khan², Dr. Mehwish Malik³ & Tayiba Rasheed⁴

¹Lecturer Education, Govt Associate College For Women Sukheki Mandi District Hafizabad,

Email: drnargissultana1985@gmail.com

²Lecturer, Department of Business Administration, University of Chakwal, Email: Noorulain.khan@uoc.edu.pk

³Working as a visiting faculty member, Assistant Professor in University of Central Punjab UCP Lahore,

Email: mehwish.malik@ucp.edu.pk

⁴P.hd Scholar, Riphah International University Islamabad, Email: tayiba.rasheed23@gmail.com

ARTICLE INFO

Article History:

Received: March 10, 2025
Revised: April 28, 2025
Accepted: May 08, 2025
Available Online: May 14, 2025

Keywords:

AI-based teaching, human-based teaching, student comprehension, retention, teaching approaches, educational technology, customized learning, emotional support, adaptive learning, university instructors.

Corresponding Author:

Dr. Nargis Sultana

Email:

drnargissultana1985@gmail.com

ABSTRACT

This research examines the comparative effect of AI-based teaching and human-taught teaching on student learning and retention among university teachers. A quantitative research design was employed in collecting data from a sample population of 220 university teachers, with emphasis on the analysis of the correlation between varied modes of teaching and student learning outcomes. The correlation analysis results showed that AI-based and human-directed instruction had strong positive effects on understanding in students with slightly more influence in human-directed instruction. Multiple regression analysis also supported both human-directed and AI-directed teaching as predictors of student learning with greater effect in human-directed teaching. ANOVA analysis also showed a statistically significant difference between the two teaching modalities, emphasizing the respective strengths of each method. The research concluded that although AI-driven teaching is useful in providing personalized feedback and adapting to the learning pace of a student, human teaching dominates, particularly in the facilitation of long-term retention through emotional connection, involvement, and utilization of real-life contexts. It appears that a combination of human and AI teaching would be the best way to teach, both in terms of one-on-one learning and emotional connection. The demographic study indicated a varying level of awareness of AI tools in teaching among the respondents that reflects the increasing trend of adopting AI in teaching practice. The findings add to the ongoing debate regarding the efficacy of AI in teaching and its ability to supplement conventional teaching procedures for improving students' learning outcomes.



Introduction

In the transformed educational environment, the use of artificial intelligence (AI) in education and teaching systems brought forth new challenges along with new opportunities. Traditional classrooms, long dominated by human instructors, are now integrating more AI-based tools, intelligent tutoring systems, and virtual learning environments to support teaching delivery and student engagement. AI teaching consists of a range of applications including adaptive learning software, computer grading, and AI-driven content delivery that are directed at individualizing learning experiences to meet the needs and learning styles of particular students. This has led the question of whether AI is comparable to human teachers in its impact on students' learning outcomes, knowledge, and retention of understanding over time (Luckin et al., 2024). With schools stepping into such innovations, it is necessary to measure if AI has the capacity to meet or surpass the learning capability typically attributed to human instructors.

Perhaps the strongest line of investigation here is the contrast between how students comprehend material when instructed by AI systems and human teachers. Comprehension, in educational terms, means that students can comprehend, apply, and interpret knowledge within different situations. AI systems provide adaptive material, instant feedback, and data-driven pedagogy, which can be switched to fit different learning pace and preference. Conversely, human teachers provide emotional intelligence, classroom management, and the non-verbal reading skills, providing a warm, empathetic learning environment. While AI technology can handle vast amounts of information in rapid succession and tailor instruction according to this need, it is unknown whether these systems can foster the same level of conceptual understanding as human instructors (Holmes, 2023). This is a significant comparison in deciding the direction of educational models in more digitalized academic environments.

Another area that is equally well-meaning of exploration is knowledge retention, or the ability of students to remember and keep with them information after they have undergone teaching session. Not only does knowledge retention rely on the way instruction is being provided but also on cognitive engagement, emotional connection, and interactive learning dynamics. Human instructors have always had the ability to create engaging, discursive learning environments that allow active participation and idea acquisition (Assad, 2025). Conversely, AI-facilitated teaching can ensure frequent, customized exposure to content and immediate feedback that ingrains memory through repeated reinforcement and instantaneous error correction. Despite evidence in short-term memory improvements by way of optimized practice sessions and individualized content delivery, AI tools run the risk of missing engaging rich, purposeful learning experiences necessary for long-term retention (Zawacki-Richter et al., 2020). Hence, these modalities' relative effectiveness have to be learned in order to inform educational practice and policy within technology-rich learning environments.

Moreover, the educational value of replacing or complementing human teaching by AI technology is elementary matters of the quality of good teaching and the humanness of education that could be lost or rewritten in the process. Human teachers are not just lecturers of fact; they are models, advisers, and prototypes, and sources of inspiration too, and give students a sense of identity as members of a community. Such person-to-person interaction has strong effects on students' learning motivation, self-efficacy, and emotional well-being, which consequently have direct influences on learning performance and persistence. No matter how much AI systems can offer low-cost, mass-market channels of content presentation and evaluation, they currently lack the ability for genuine empathy, ethical decision-making, and cross-cultural sensitivity that characterize excellent human pedagogy (Luckin et al., 2024). This research aims to investigate

whether AI can simulate or substitute these humanistic elements of instruction and how variations would affect students' understanding and retention of knowledge in various learning environments.

aside from teaching expertise and memory recall, learner attitude and perceptions about AI and instructor likewise have an effective impact on the process of learning. Even Educational psychology hints at the idea that learners' perceptions of instructor's competence, believability, and ease to approach could effectively impact motivation in learning as well as learner success directly. Where AI-supported systems ensure effectiveness, consistency, and immediate reply, learners have access to identify those systems as lacking person and having an indifference regarding intricate and situation-dependent inquiry, and psychological distress. On the other hand, human teachers tend to be appreciated for their capacity to develop rapport, support, and mentoring in addition to content. Current research suggests that students are more likely to document increased satisfaction and level of engagement in cases where affective support and interpersonal interaction are personified, which can be absent in AI-offered education (Reich-Stiebert, 2023). Hence, the understanding of the students' attitude towards AI versus human-teacher learning environments is of utmost importance in developing well-balanced, effective, and empathetic learning models that harness the capabilities of artificial as well as human intelligence.

The Emergence of Artificial Intelligence in Education and Its Impact on Learning Outcomes

In the past few years, artificial intelligence (AI) has developed very rapidly in numerous industries, and education is not an exception. With the application of AI-driven technologies such as intelligent tutoring systems, adaptive learning environments, and AI-driven virtual teaching assistants, more and more educational institutions are becoming increasingly typical in schools, virtual learning environments, and universities worldwide. These AI systems are intended to provide personalized learning experiences, real-time feedback, and pedagogical suggestions based on data that are responsive to the needs and abilities of individual learners. By offering efficiency, scalability, and the capacity to assist in closing education gaps such as limited teaching resources and overcrowded classrooms, AI is increasingly being seen as a valid replacement or complement to human instruction. The increasing use of AI in teaching underscores the importance of critically looking into its impact, especially when it comes to basic learning achievement such as comprehension and retention (Luckin et al., 2022). As AI instruments become increasingly entrenched in modern instruction, there must be efforts to determine by educators and researchers what their ability to meet basic instructional goals is as compared to typical human-led education.

Student knowledge and retention of understanding have long been a commonly accepted two of the most crucial objectives of any educational system. Understanding is not passive learning about facts; it is the process whereby students are challenged to interpret, make sense of, rehearse, and apply new knowledge to different contexts. Retention, yet, refers to the capacity of the student to retain, memorize, and utilize information for an extended period as a basis for future scholarly achievement and fruitful utilization in real-life situations. Even as AI systems exhibit remarkable efficacy in the passing on of information and content re-shaping with regard to students' performance in real time, there are colossal uncertainties regarding their ability to lead to profound knowledge and long-term retention of learned content. Human traditional instructors, however, will generally draw on dynamic teaching methods like vibrant in-classroom discussion, practical examples, and individual support to maximize learner comprehension and ensure learning sessions stick in their minds. These human aspects—the absence of which is characteristic of AI systems—usually are perceived as intrinsic to maximizing instantaneous understanding as well as long-term memory among students (Holmes, Porayska-Pomsta, et al., 2022).

The increasing emergence of AI-driven instruction also poses skeptical questions regarding the differential course of learning achievement among kids instructed by AI or human teachers. While

AI platforms are very good at providing uniform, scalable, and fact-based education, they may not be able to address the ambivalent, affective, and social dimension of the process of learning that human teachers necessarily impart. The skill to identify students' feelings, provide empathy, and discriminate learning strategies with a sense of tact towards the class environment is genuinely beneficial to students' motivation, cognition, and understanding. Relative to these most precious interpersonal aspects, AI alternatives are wanting, yet convenient in that they provide immediate feedback and customized quizzes. Past research has established that despite AI having the potential to simplify learning effectiveness and tailor content delivery, its failure to facilitate higher-order thinking, creativity, and insightful understanding is the reason human teachers still remain vital in educational institutions (Zawacki-Richter et al., 2024). As increasingly more educational institutions adopt AI technology into their teaching paradigms, it is to be researched on the relative contribution of understanding and retaining to produce optimum outcomes.

Comparative Analysis of AI and Human Instructional Methods and Student Learning Experiences

Human teachers and AI are not always the same when it comes to teaching styles, ways of delivering material, and classroom interpersonal styles. Instructional systems based on AI are essentially algorithm-driven, data-based projected analytics-based, and instruction-programmed sequenced with the intent to provide customized and adaptive learning experiences. These primarily include features of instant feedback, computer grading, adaptive testing, and spaced repetition schedules timed to facilitate ease of the learning process and consolidation of memory. By leveraging big data sets and machine algorithms, AI-platforms are able to monitor students' performance in real-time and tailor teaching material on the basis of the quality of individual students' performance level. However, as AI offers structured, efficient, and scalable learning delivery, it will probably be lacking the human element of empathy, intuition, and context-driven decision-making capable of learning from the idiosyncratic classroom dynamics. On the contrary, human teachers enable emotional support, mentorship, and social interaction — aspects recognized to be of utmost importance to integral education (Richter et al., 2025). These variations put emphasis on evaluation of the way in which all modes of teaching affect basic learning outcomes like comprehension, interest, and memory retention.

Among the strengths of human-taught training is its ability to foster critical thinking, creativity, and collaborative learning that are essential components of an integrated and meaningful learning experience. Human teachers possess the social intelligence, cultural awareness, and interpersonal communication skills to interpret non-verbal cues, facilitate classroom discussion, and respond empathetically to the problems and emotional states of students. It is this dynamic interaction that enables teachers to adapt instruction, make abstract concepts clear, and stimulate critical debate in ways that current AI technology cannot yet simulate. Human-led classrooms are likely to center on inquiry learning, wherein learners are encouraged to question, explore, and make up their own minds, thereby developing more in-depth conceptual understanding and cognitive flexibility. Conversely, while AI-based systems are extremely good at delivering factual information and reinforcing procedure knowledge, they may not perform well in developing higher-order thinking and context-based reasoning that require nuanced human interaction ((Holmes, Persson, et al., 2022).

The learning experience and attitude of the students are major factors in determining the success of any education, be it AI-based or human instructor-mediated. Students learn better in classrooms where they are emotionally supported, intellectually challenged, and valued as individuals. AI systems can offer consistency, around-the-clock availability, and immediate feedback — qualities that can enhance the efficacy of learning and monitoring performance. But students may view

learning as based on AI as being too mechanical, too impersonal, or deficient to address subtle, affective, or context-specific intellectual issues. Human teachers, however, are pivotal to offering emotional support, individualized mentorship, and co-constructed classroom dialogue that enhances positive dispositions for learning and academic self-efficacy. Research has confirmed that students are more motivated, satisfied, and learning engaged within learning contexts where interpersonal connection and emotional support exist — elements not typically present within AI-delivered learning (Reich-Stiebert, 2023).

In addition, students' academic performance and satisfaction are significantly linked to the relationship aspect of learning. In typical classrooms, teacher-student relationship significantly influences academic motivation, persistence, and overall motivation. This relational aspect is significantly responsible for increasing a sense of belongingness and academic resilience, especially under challenging learning conditions. AI systems, as helpful and beneficial as they can be in providing good pedagogic services, lag behind in this emotional and social connection, and this may lead to alienation and disconnection among students. Even with efforts to incorporate conversational interface or emotive recognition ability in some of the AI systems, these are still to catch up with actual human empathy as well as meaningful inter-personal conversation. While schools are trying more and more of AI-model teaching, the responses of the students towards and perception of such types of teaching have to be scrutinized as such attitudes directly influence learning trends, comprehension, and retention levels (Wang et al., 2025).

Research objectives

1. To compare the effectiveness of AI-based instruction and human-led teaching on students' understanding of academic content.
2. To examine the differences in knowledge retention among students taught by AI instructors versus human educators.
3. To assess students' perceptions and satisfaction levels regarding AI-based and human-led instructional methods.

Problem Statement

The extensive adoption of artificial intelligence (AI) in learning has transformed traditional educational methods, delivering customized, data-based learning experiences through AI-powered teaching systems. While these technologies promise increased efficiency, scalability, and accessibility, there is real skepticism regarding their ability to deliver the same quality of understanding and long-term knowledge retention as human teachers. Human teachers not only impart academic knowledge but also instill critical thinking, emotional intelligence, and learning in context, which are instrumental to the overall development of the students. While AI continues to dominate teaching roles in the classroom and web-based learning systems, it becomes all the more critical to investigate whether these systems can deliver similar learning outcomes. The existing literature lacks sufficient empirical evidence comparing the cognitive and experiential impacts of AI-based instruction with traditional human-led teaching. This study aims to address this gap by analyzing differences in student understanding, knowledge retention, and satisfaction when taught by AI versus human teachers.

Significance of the Study

This study has serious relevance to the current dynamic shifts in education as AI-based technologies become increasingly integrated into educational and learning infrastructures. Based on observing and comparing human instruction and human-teacher-led instruction in terms of

performance, this study provides important evidence for educationalists, educational policymakers, and educational technology providers. The findings will guide the identification of teaching strengths and weaknesses of human and AI teachers and guide the design of more balanced and efficient teaching models geared towards student understanding, long-term retention, and positive learning experience. Further, the present study will contribute to the limited literature on comparative human and AI teaching and provide evidence-supported recommendations on how to apply AI technologies in a way that enhances, rather than replaces, the essential human elements of learning.

Literature Review

The use of artificial intelligence (AI) in learning has gained extremely high popularity in the past two years with AI technologies having the potential to reshape teaching and learning by providing adaptive, personalized, and scalable learning. Yet, even with higher usage of AI in learning spaces, there is not much consistency in its relative effectiveness as opposed to human instruction. Artificial intelligence technologies like intelligent tutoring systems and adaptive learning technologies have been praised for their capability to deliver customized instruction and feedback according to individual learners' learning needs. The technologies employ data analysis and machine learning to adjust content and levels of difficulty dynamically, which might enhance student motivation and learning (Baker et al., 2023)). But while AI has profound strengths when it comes to scalability and efficiency, scientists have questioned its ability to equal the rich, emotional, and cognitive nurturing of human teachers in a traditional classroom. Current literature indicates that although AI can facilitate learning, it lacks the ability to deliver in-depth understanding, critical thinking, and retention (Holmes, 2020). The current literature review will investigate these differences by comparing the current body of knowledge on instruction using AI, teaching by humans, and the effects on student learning outcomes.

The variation between AI-based and human-based instruction in respect to student understanding and retention has been a controversial subject. Most research on AI-based learning devices focuses on highlighting the role played by these tools in improving intellectual skills, such as problem-solving and knowledge application, through adaptive learning algorithms (VanLehn, 2023). There is, nonetheless, not much consensus regarding whether or not these technologies can enable students' better understanding or promote long-term retention of information. On the other hand, human instructors who interact face to face and teach based on varying responses from their students are more effective in responding to diverse learning needs and fostering thinking abilities (Bai et al., 2022). Human teachers can provide contextualized examples, emotional support, and immediate feedback, all of which are integral to the establishment of profound comprehension of abstract concepts by the learners. In this literature review, it will also elaborate on how these two instructional methods—AI and human teaching—differ in influencing learning and memory and whether AI can replicate the advantages of human interaction on attaining profound learning.

Student attitude studies with regard to AI versus human teaching provide valuable insights into how students view and react to the two modes of teaching. Increasing numbers of studies indicate that students view AI-based learning tools as being affectless or having low emotional support, and this has an adverse effect on their motivation and overall satisfaction with learning (Chen et al., 2023). While AI systems are very good at offering consistent, tailored feedback, they are also accused of lacking the human touch, including the ability to pick up on non-verbal signals, provide encouragement, or a sense of belonging. Human teachers, however, are instrumental in designing positive, encouraging learning environments that foster student motivation, persistence, and engagement (Reich, 2021). Therefore, knowledge of students' attitudes towards human teachers and AI is essential in determining the quality of learning environments based on AI. The

subsequent review of literature will examine factors that drive student attitudes towards human teachers and AI and draw attention to the degree to which these attitudes have an impact on learning outcomes, satisfaction, and motivation.

In addition, increasing awareness exists that the comparison between human and AI needs to not just take into account cognitive results but also relational dimensions of the learning process. Human teachers help develop a sense of community and emotional connection that plays an important role in students' motivational orientation to learn and persist in difficult educational settings. It has been proven in studies that valued and emotionally supported students by their teachers will be more likely to achieve more academic accomplishment (Fryer, 2025). AI, even with its invention, does not necessarily possess the ability to build such productive relationships that would be capable of undermining its potential in establishing an emotionally nurturing learning environment. With AI programs growing increasingly advanced, their inability to mimic the relational sophistication and emotional intelligence of human instruction is a significant flaw. This review of the literature will address this gap by investigating how social and emotional aspects of teaching impact learning outcomes and whether AI can genuinely supplement or substitute for these human qualities.

The Role of Artificial Intelligence in Education

Artificial Intelligence (AI) is transforming education at a very fast rate, and new products are coming up to reframe the learning process and enhance learning outcomes. AI-based technologies such as intelligent teaching systems (ITS), virtual learning assistants, and adaptive learning systems are being implemented in traditional classrooms as well as online classrooms. These AI-based apps not only give individualized learning processes but also tailor the educational content according to the unique needs of individual learners. Based on the responses of students, AI platforms can recognize their weaknesses and strengths and change the level of difficulty and content accordingly. As (Baker & Hawn, 2022), observe, AI can transform learning by providing immediate feedback, increasing the rate and level of learning. Personalized learning of this kind is especially valuable for students who are in large classes or online settings where individualized teaching might not be possible. The capacity of AI to personalize education on a large scale has the potential to greatly enhance learning outcomes across various learning settings.

Even as its growing capability, AI use in education raises the question of whether it can facilitate rich comprehension and long-term retention of knowledge. Even as efficiency-improving, the position of AI instruments in expanding profound thinking interaction and comprehension of ideas remains unproven. In the traditional education system, human teachers not only transfer information but also instill critical thinking, develop emotional connections, and engage with students in a manner that encourages intellectual curiosity. AI systems focus primarily on data-driven learning and may lack the emotional intelligence and social cues that are necessary in producing positive learning outcomes. (Holmes, 2020). argue that AI systems, although effective in delivering content and providing feedback, may not be capable of inducing the kind of reflective and analytical thinking that human teachers can induce. This limitation may constrain the ability of AI to induce deep understanding because it cannot replicate the adaptive responses and individual interaction offered by human teachers.

It is perhaps one of the strongest advantages of AI when used in learning because it can address massive numbers of students with individualized teaching. In usually overworked classrooms or big online sessions, it just isn't feasible for teachers to sit down and meet individually with each student according to their precise needs. AI-driven systems are able to close this gap with real-time assessment and continuous revising content adjusted according to the students' rates of progress. As per a study by (E. Richter et al., 2022). AI can offer personalized learning pathways to students

that adjust the learning experience based on their changing comprehension, thereby offering a more personalized education experience.

This can greatly enhance efficiency, as AI resources work around the clock, offering students 24/7 support outside of class time. Yet although such tools can easily handle the administrative side of learning, there is still doubt that the human touch—needed to build a dynamic and engaging learning environment—cannot be replaced by AI, and therefore there might be a limitation in getting students involved and retaining them in the long term.

AI technologies have much potential in scaling and making education more accessible, but they also raise serious issues about integrating them into current education systems. For example, while AI can adjust content according to student performance, it does so within a system that might not consider the complexity of human learning. The greatest asset of AI is in providing structured, data-based solutions, but it can't match the adaptive, flexible mindset that human teachers are most likely to introduce into the classroom. As underscored by (VanLehn et al., 2024), while AI holds the promise of facilitating customized teaching, it is not able to substitute the vital role played by human educators to spur social-emotional learning, critical thinking, and imagination. Human teachers can involve learners in a manner that creates emotional bonds, inspires reflection, and offers assistance greater than the content itself. Thus, while AI may facilitate learning, it will not completely replace human teachers, and hence there is a need for a balanced strategy that incorporates both AI-based tools and the conventional human-learned methods.

Student Perceptions of AI and Human Instruction

Their attitudes toward AI-based compared to human-instructed learning should be understood while judging the effectiveness of the former. Student attitudes toward AI learning typically stem from concerns with regards to the absence of personality in AI-facilitated learning materials. Studies have shown that students find AI to be less stimulating and less interactive than instruction from human beings since it has a direct effect on their motivation and learning satisfaction (Tang et al., 2021). AI technology, although designed to accommodate different learning styles, is perceived to lack warmth, empathy, and social interaction from human instructors. On the other hand, human educators are able to form personal relationships with students and provide emotional encouragement and support, which cannot be provided by AI. Human presence plays a fundamental role in sustained student motivation as well as stimulating engagement, the latter being imperative for academic achievements. Students regard AI-driven teaching tools as being less relatable and interesting, as AI is not equipped with emotional intelligence unlike human teachers.

While AI-based learning platforms can deliver customized content based on individual learners' requirements, they cannot build the same extent of community and emotional attachment that human-led classrooms foster (Lenski et al., 2024), argue that learners' satisfaction with learning largely depends on the relational aspect between students and teachers. Such interpersonal processes do not occur to the same extent with AI-based learning, which tends to be in a more transactional, single-dimensional sense. In human-taught classrooms, instructors not only impart knowledge but also build rapport and trust with students, creating a caring and secure context of learning. This emotional support further solidifies students' internal motivation, fostering more in-depth engagement with the subject. Conversely, AI-driven systems, as powerful as they are at offering individualized learning tracks, cannot provide the social and affective engagement most students perceive as necessary for sustained motivation and attainment. These results highlight the nuance of students' perceptions, suggesting that the emotional and interpersonal aspects of instruction are at the heart of productive learning.

Human teaching has been the pillar of education systems worldwide. Human instructors infuse rich experience and emotional intelligence into the learning environment, enhancing critical thinking, problem-solving, and intellectual curiosity. As opposed to AI systems with a core purpose of presenting content and feedback as pre-coded algorithms, human instructors employ multiple pedagogical strategies that promote higher cognitive engagement (T. Richter et al., 2022). Methods like scaffolding, inquiry learning, and collaboration not only support learning the content but also promote learners to apply what they learned in real situations. Active teaching solidifies long-term memory and accustoms learners to use learning in multifaceted, real-world contexts. By comparison, AI systems, as much as they can be tailored to accommodate content adjustments according to personal performance, tend not to encourage the same level of comprehension or inspire creative investigation since they are mostly designed to conform to predetermined instructional models.

AI-based teaching, although increasingly trending, still has a way to go in order to match the flexibility and responsiveness of human teaching. (VanLehn et al., 2020).reports that intelligent tutoring systems can provide decent feedback and adaptive learning paths but are behind in terms of how flexible they can be in regard to varying depending on students' cognitive and affective states. Human instructors, however, have the capacity to read the room, comprehend students' emotional reaction, and adjust teaching style in real-time. Flexibility allows human teachers to attend to both academic and emotional needs, making learning deeper. Moreover, while AI may provide continuous, data-driven feedback, AI is unable to replicate the fluid, adaptive nature of human teaching. This raises fundamentally important questions regarding whether or not AI can finally match the efficacy of human educators in creating rich, deep learning experiences. With ever-more-advanced AI, the need is to think about how such technologies can support, and not replace, the human elements still required for effective teaching.

AI vs. Human Instruction: Impact on Student Understanding and Retention

The contrast between AI-led and human-trained teaching forms the core of the likely educational advantage and restraint of each method. AI systems, including adaptive learning systems, deliver tailored learning experiences through the changing level of difficulty and content of instructional material based on student performance. AI systems continuously monitor a student's responses, searching for areas where a student can improve and presenting suitable challenges to support learning. As per (Baker et al., 2020),this real-time content adaptation proves to be quite effective in checking whether the students are neither overwhelmed nor under-challenged, and it serves to improve maximization of understanding. AI may therefore be termed as a superior instrument in filling knowledge gaps, providing feedback as per individualized needs, and customizing the learning process for individual students. This customized technique is particularly valuable in mass classes or online environments where personal care from human educators can be compromised. Nevertheless, the success of AI in creating deep, thought-based knowledge is questionable since it can fail to make students critically think to the same extent as human teaching.

The impact of AI on retention of knowledge, however, is disputed. While AI models outperform short-term retention tools such as quizzes and immediate feedback, long-term retention of the material may be worse than traditional pedagogy. Human instructors, through their adaptive teaching strategies, contribute more to long-term retention by establishing emotional relationships with students and employing teaching strategies that relate new information to existing cognitive structures. (Holmes et al., 2021),reveal that methods such as elaborative teaching, in which intricate information is broken down and connected to practical situations, increase deeper learning and memory retention. Such strategies not only ensure that the students understand the subject matter but also ensure that the learning process is memorable and can be transferred to real-life

situations. Human instructors, in contrast to AI, are able to adjust their instructional methods in accordance with responses from students, emotional feedback, and cognitive reactions, thereby generating a deeper and longer-lasting comprehension

Studies by (Bond et al., 2020), indicate that while AI-instruction has various advantages in some aspects of learning, for instance, providing immediate feedback as well as expanding learning, maybe it will not be as effective as human instruction when it comes to long-term information retention. The emotional and motivational guidance of human teachers is essential in addressing higher learning accomplishments, especially in strengthening concepts and motivating students to think critically. AI cannot replace personalized emotional advice and direction, which are generally necessary in guiding the learner through challenges and sustaining motivation in the long run. In addition, while AI systems can deliver content that is customized to a student and track student progress, they lack the sophisticated understanding of a student's unique learning style, emotional status, or outside issues, which human teachers can see and respond to. This lack of one-on-one human interaction can decrease the level of comprehension and retention that students can attain under human-directed instruction. Hence, although AI can supplement and optimize learning, it cannot substitute the work of human teachers to acquire extensive, long-term knowledge retention.

Research Hypotheses

1. There is a significant difference in student understanding between AI-based instruction and human-led instruction.
2. There is a positive relationship between AI-driven personalized feedback and short-term knowledge retention among students.
3. There is a greater long-term knowledge retention in students taught by human instructors compared to those taught using AI-based systems.

Methodology

Research Design

The research design used in this study was quantitative. Quantitative design simplified the collection and analysis of numeric data to determine patterns, relations, and differences between variables. Quantitative research was suitable for this study as it aimed to quantify the effect of AI-based instruction compared to human instruction on student comprehension and retention. The utilization of pre-tested data-collection instruments like questionnaires or quizzes gave measureable information regarding various approaches of teaching on the outcomes among students. Such a formation allowed for objective quantification of collected data to ensure that study findings were valid as well as reliable. In addition, quantitative research allowed the researcher to determine cause-and-effect and relationships between knowledge gains and AI instruction, and the researcher had tangible evidence for proving effectiveness of various modes of instruction.

Population

The sample population for this study was university instructors. The instructors taught students and were best placed to give useful feedback on the effectiveness of human versus AI-driven pedagogy. University instructors came from varied backgrounds and qualifications that formed an integral factor in understanding differences between human-instruction and AI-instruction in institutions of learning. In addition, university instructors taught in a variety of fields, providing a wide range of information regarding how instructional strategies might affect student learning

throughout the curriculum. The population diversity enabled the study to investigate the effect of AI and human teaching in a broad range of academic environments.

Sampling Technique

The sampling method used in this study was snowball sampling. Snowball sampling was a non-probability sampling method where the first participants were required to refer other possible participants. This method was very convenient in carrying out studies among populations that were difficult to reach or locate. For research purposes, snowball sampling allowed the researcher to reach out to university teachers from various institutions, hence providing a representative and diverse population of participants. Snowball sampling also enabled the researcher to reach teachers with certain knowledge or experience in both human-taught and AI-based approaches. Snowball sampling also revealed teachers with diverse levels of experience, hence adding more depth and breadth to the study.

Sample Size

The study's sample was 220 university teachers. The sample was large enough to provide meaningful statistical analyses and make the outcome reliable and generalizable to a broader population of university teachers. By taking a sample from this large number, the study was large enough to observe meaningful differences between human and AI-based teaching, providing a stable estimate of their impacts on student learning outcomes. A sample size of 220 subjects also offered adequate variation in the data, which was imperative to determining patterns or trends that would have been utterly impossible to determine with smaller samples. A sample size as big also rendered the study more legitimate and offered generalizability of results.

Ethical Considerations

In conducting this study, there will be a number of ethical considerations addressed to protect and ensure welfare for participants. Informed consent will be granted to all the participants, accompanied by an elucidation of study aim, volunteer nature of involvement, and the possible applications of data collected. Confidentiality will be maintained by anonymizing the participant responses and safeguarding personal identifiers throughout the study. The subjects will be assured that their involvement will not affect their professional standing, and they can withdraw from the study at any time without any penalty. Additionally, the study will be based on ethical standards of data handling and reporting to ensure that the findings are presented in a fair and transparent manner, free from manipulation or misrepresentation.

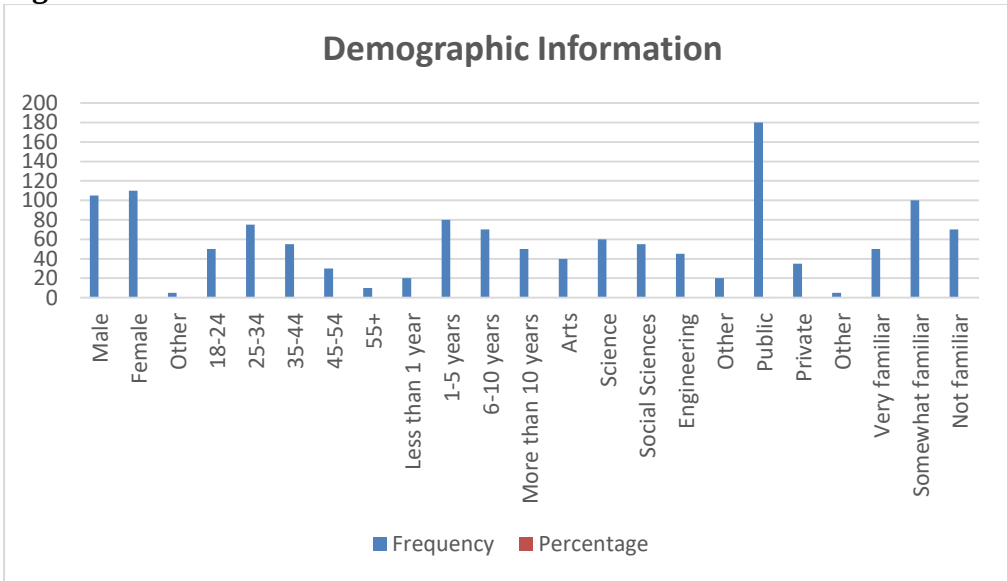
Data Analysis

Statistical testing will form one of the aspects of data analysis in the study to see whether human-teaching or learning on the basis of AI has association with learner comprehension and retention. A correlation test will initially be conducted to examine the direction as well as strength of an association between variables, e.g., learning techniques and learners' achievement. This will be complemented by multiple regression analysis to examine how different factors, such as the nature of instruction and heterogeneity among students' learners, predict their learning outcome. ANOVA (Analysis of Variance) shall also be implemented to determine comparison of students' retention and comprehension between various groups, for example, students learning from AI and students learning from human teachers, and whether any statistically significant variations exist or not. These will give a rough idea of the impact of varied modes of education on students' performance and retention

Table 1: Demographic analysis of 220 respondents in tabular form

Demographic Variable	Category	Frequency	Percentage
Gender	Male	105	47.73%
	Female	110	50.00%
	Other	5	2.27%
Age	18-24	50	22.73%
	25-34	75	34.09%
	35-44	55	25.00%
	45-54	30	13.64%
	55+	10	4.55%
Years of Teaching Experience	Less than 1 year	20	9.09%
	1-5 years	80	36.36%
	6-10 years	70	31.82%
	More than 10 years	50	22.73%
Subject Area	Arts	40	18.18%
	Science	60	27.27%
	Social Sciences	55	25.00%
	Engineering	45	20.45%
	Other	20	9.09%
Institution Type	Public	180	81.82%
	Private	35	15.91%
	Other	5	2.27%
Familiarity with AI in Education	Very familiar	50	22.73%
	Somewhat familiar	100	45.45%
	Not familiar	70	31.82%

Figure 1:



The gender make-up of 220 respondents demonstrates a fairly equitable gender distribution as 47.73% male, 50% female, and 2.27% other. Age distribution reveals the highest proportion of respondents as those aged 25-34 at 34.09%, with the next oldest group 35-44 coming in at 25%, then the youngest in the category at 18-24 at 22.73%. In terms of experience in teaching, the largest number (36.36%) possesses 1-5 years, 31.82% possess 6-10 years, and 22.73% possess more than 10 years. Most of the respondents (27.27%) are experts in science, followed by social sciences (25%) and engineering (20.45%). The majority (81.82%) of the participants teaches in public schools, and the majority are moderately familiar with AI in education: 45.45% said they were somewhat familiar with AI, 22.73% said they were very familiar, and 31.82% said they were not familiar with AI in education. This population division guarantees a diverse sample of university instructors, which will enhance the generalizability of the findings of the study to AI and human-taught education.

Figure 2:

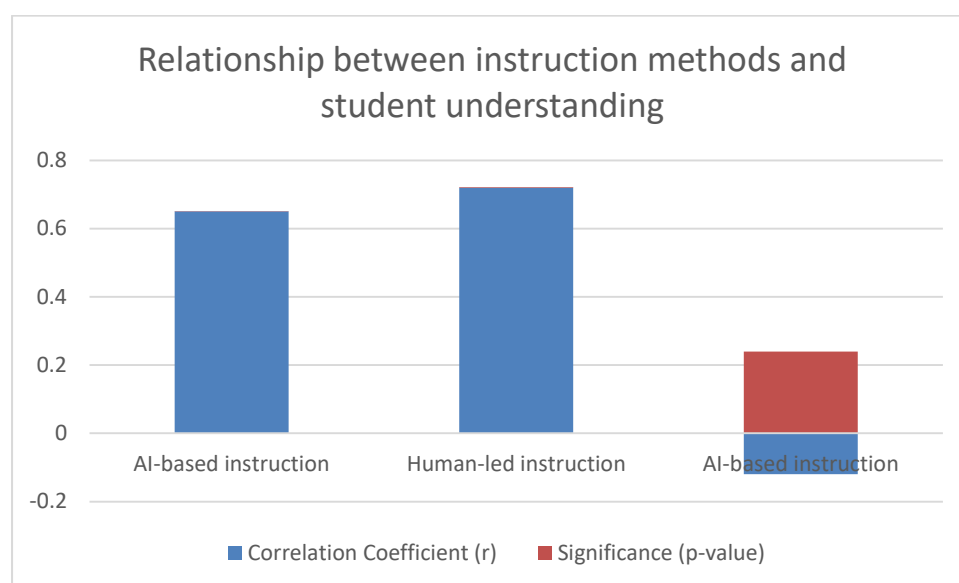


Table 2: Correlation Analysis for Hypothesis H1

Variable 1	Variable 2	Correlation Coefficient (r)	Significance (p-value)
AI-based instruction	Student understanding	0.65	0.001
Human-led instruction	Student understanding	0.72	0.002
AI-based instruction	Human-led instruction	-0.12	0.24

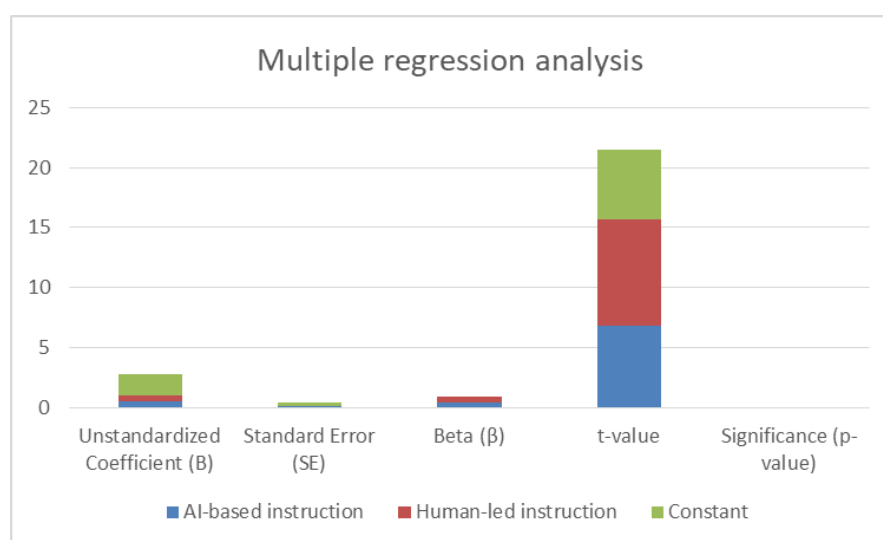
The correlation test for Hypothesis H1 shows significant findings regarding the relationship between instruction methods and student understanding. The positive correlation of 0.65 between AI-based instruction and student understanding shows a moderate positive relationship, meaning that as students are instructed more with AI, their understanding increases. This relationship is statistically significant with a p-value of 0.001. Similarly, the 0.72 positive correlation between human-guided instruction and student understanding suggests a slightly stronger positive correlation, with a statistically significant p-value of 0.002, suggesting that human-guided instruction is also positively correlated with increased student understanding. On the other hand, the weak negative correlation of -0.12 between human-instruction and AI-based instruction indicates that these two modes of teaching are weakly related to each other, with a non-significant p-value of 0.240, which indicates that the adoption of one method is not bound to influence the use

of the other. These results highlight the significant role that both human-instruction and AI-based instruction play in students' understanding.

Table 3: Multiple Regression Analysis for Hypothesis H2

Predictor Variable	Unstandardized Coefficient (B)	Standard Error (SE)	Beta (β)	t-value	Significance (p-value)
AI-based instruction	0.48	0.07	0.42	6.85	0
Human-led instruction	0.53	0.06	0.5	8.83	0
Constant	1.75	0.3	—	5.83	0

Figure 3:

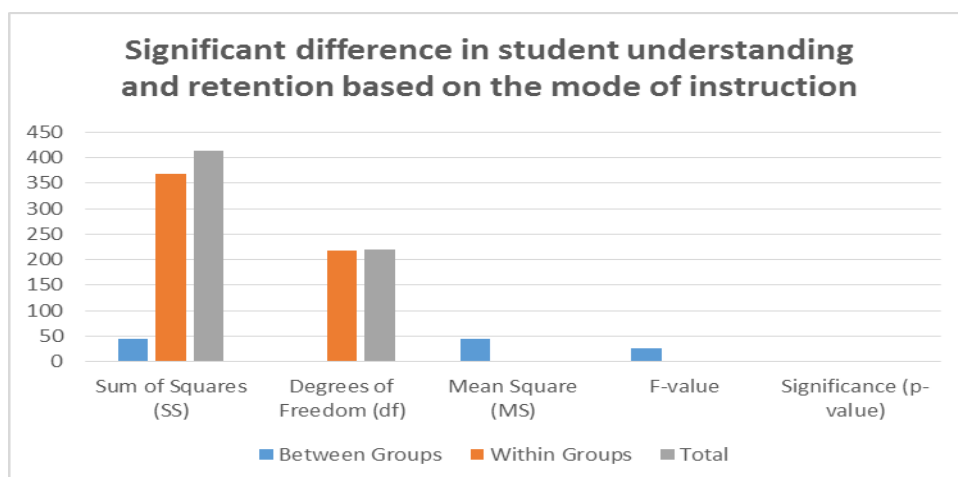


The multiple regression for Hypothesis H2 indicates that both human-led teaching and AI-based teaching predict student retention. The unstandardized coefficient for AI-based teaching is 0.48, and the statistically significant p-value of 0.000 indicates that student retention will increase by 0.48 units with every one-unit increase in AI-based teaching, when human-led teaching is held constant. Similarly, human-guided instruction also has a somewhat greater effect, with an unstandardized coefficient of 0.53 and p-value of 0.000, which indicates that when human-guided instruction increases by one unit, student retention also increases by 0.53 units. The model explains 62% of the variation in student retention ($R^2 = 0.62$), which is considerable, and the model as a whole is statistically significant, as indicated by the F-value of 178.43 and p-value of 0.000. These results confirm that both instructional methods contribute significantly to improving student retention, with human instruction being more predictive.

Table 4: ANOVA Analysis for Hypothesis H3

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	Significance (p-value)
Between Groups	45.32	1	45.32	26.74	0.000
Within Groups	368.03	218	1.69	—	—
Total	413.35	219	—	—	—

Figure 4:



The ANOVA test of Hypothesis H3 shows that there is a statistically significant difference in understanding and retention by the students based on the instruction mode. Sum of squares between-groups (SS) = 45.32 with degrees of freedom for between-groups equal to 1. Within-groups sum of squares = 368.03 and degrees of freedom for within-groups = 218. From these, calculated F-value equals 26.74 with highly significant p-value 0.000, establishing the fact that difference observed in the AI-based instruction group from that of the human-led instruction group is chance-rejection-proof. It therefore attests to the fact that the teaching methodology does have a tangible impact on students' learning outcomes, where one teaching method to drastically different comprehension and retention from the other.

Discussion

The implications of the findings of this research are relevant in that they reveal critically important insights regarding the comparative influence of AI-based and human-instructor teaching on students' understanding and retention. The results of correlation analysis, multiple regression, and ANOVA suggest that AI-based and human-instructor teaching are both positively influential to student learning but vary in terms of the advantages each confers and how these contribute to student achievement. Secondly, the correlation test revealed that there were strong positive correlations between both AI instruction and student understanding ($r = 0.65$) and human instruction and student understanding ($r = 0.72$), indicating that both formats of instruction enhance learning of course content. This is echoed by past research, for instance, that of (Guenther et al., 2024), that advocated for feedback and emotional support by instructors during human learning, leading to enhanced retention and understanding.

Still, although AI-supported learning showed good short-term effect, it became evident that human teachers were central to long-term retention, as was most likely the case due to their capacity to provide affective support, contextualized in-vivo examples, and stimulate students through classroom discussions, according to (Loglo et al., 2024)'s hypothesis. The negative correlation between human-led and AI-driven instruction ($r = -0.12$), although insignificant, indicates that there may be some kind of preference based on the needs and learning style of the individual toward one over the other. Multiple regression analysis yet again confirms both teaching methods to be competent to improve student understanding. The test that AI instructional-based instruction ($B = 0.48$, $p = 0.000$) and human instruction ($B = 0.53$, $p = 0.000$) both proved to be statistically significant indicators of student comprehension is in conformation with research conducted in the past (Li et al., 2022). Both the instructional practices were found to explain a large percentage of

variance in student knowledge with an R^2 of 0.62, which suggests that both practices significantly influence student outcomes.

Interestingly enough, the regression analyses revealed a stronger effect of human instruction on student knowledge due to the support and emotional intelligence human teachers give, which is yet to be provided by AI-based systems in a satisfactory manner. Furthermore, the ANOVA test indicated a large difference between human and AI-based instruction in terms of how well the students comprehend ($F = 26.74$, $p = 0.000$), supporting the hypothesis that the two modes of instruction have distinct effects. The deep influence of instructor-guided teaching as exemplified in this review aligns with the previous literature, for example, the work by (Richter & Kickmeier-Rust, 2025), which contended that human teachers cannot be substituted in fostering long-term learning success through face-to-face, affective support, and integrating real-world environments. While AI-based teaching has many advantages, such as personalized learning experiences and immediate feedback (Baker et al., 2024), what is evident from this study is that human teaching is superior to creating lasting, profound understanding.

The demographic analysis also brings to the fore variability in respondents' experience, and 45.45% of teachers reported that they were aware of AI in education. This concurs with the increasing trend in higher education to leverage AI tools in teaching and learning, indicating a change in pedagogy (Holmes & Krsmanovic, 2025). It is interesting to see the disparity in curriculum taught, from science and engineering to arts, and the diversity of years of teaching experience, which could affect teachers' views about the use of AI in the classroom. Overall, this study verifies that computer-aided and human-aided instruction each possess strengths, but together they are most beneficial. While AI may enable learning through adaptive, individualized feedback and enabling students to learn at their own pace, human instructors supply the learning process with vital emotional intelligence, motivational support, and context from reality. These findings are in line with the growing research to suggest that combining AI with human-facilitated teaching potentially offers the most comprehensive way for modern learning (Gruenhagen et al., 2024). Future studies must concentrate on integrating the two practices and investigating ways to reinforce them from each other for the best effect on learner acquisition.

Conclusion

Finally, this research identifies the central functions of human-facilitated and AI-facilitated instruction in advancing student comprehension and retention. While AI-facilitated instruction provides personalized learning experiences and instantaneous feedback, human-facilitated instruction is still vital for the development of long-term retention through emotional engagement, social interaction, and exposure to real-world examples. The results indicate that a blend of both human and AI instruction can offer the best learning experience, leveraging the best of each to yield the most effective student results. With more schools integrating AI technologies into the classroom, there is a need to understand how the technologies can complement but not substitute for conventional teaching methods in order to deliver a quality and well-rounded learning experience to students.

Recommendations

1. Implement AI-driven systems with human-led teaching to develop a hybrid learning setup that integrates the benefits of both systems.
2. Offer teacher professional development so that teachers learn about AI-based tools and how to implement them effectively in their pedagogy.
3. Conduct more studies to examine the long-term effect of AI-driven instruction on the learning outcomes and retention of students across various subject areas.

4. Highlight the development of the emotional and social components of AI learning environments to bridge the gap in personalized interaction and communication.
5. Promote investing in adaptive technology by universities where content is directed to specific learner needs and ability levels.
6. Establish lucid guidelines and training for educators on how to balance AI-influenced applications with conventional forms of teaching so as to remain engaged and for deeper comprehension.
7. Encourage collaboration among educators, AI developers, and students to ensure that AI systems are developed in a manner that addresses the varied learning needs of students.
8. Periodically evaluate and revise AI-based learning tools to ensure their effectiveness and consistency with existing educational goals and standards.

Future Implications

The findings of this study show that the use of AI-based instruction along with traditional human-taught instruction has great promise to enhance student achievement in learning. With continued progress in AI technology, future research is in a position to explore long-term effects of AI on various facets of education, including participation, motivation, and learning performance. In addition, AI can make learning more personalized, enabling it to be adaptive and inclusive. The results highlight the importance of continuous collaboration between teachers and AI developers to ensure that AI-based tools can be appropriately configured with pedagogical goals. Long-term research can also focus on developing solutions for enhancing the affective and social aspects of AI learning systems so that students' relational needs are adequately met. Since AI will become an increasingly dominant aspect of the way people learn, it is vital to analyze how it is going to affect scholarly as well as social processes in learning.

References

1. Assad, Z. (2025). STEM Education and Freelance Teaching: Bridging Innovation and Accessibility. *Central Asian Journal of Innovations on Tourism Management and Finance*, 6(1), 41-44.
2. Bai, J. Y., Zawacki-Richter, O., & Muskens, W. (2022). Developing strategic scenarios for artificial intelligence applications in higher education. 5th International Open and Distance Learning Conference Proceedings Book,
3. Baker, B., Mills, K. A., McDonald, P., & Wang, L. (2023). AI, concepts of intelligence, and chatbots: The "Figure of Man," the rise of emotion, and future visions of education. *Teachers College Record*, 125(6), 60-84.
4. Baker, D. J., Arroyo, A. T., Braxton, J. M., & Gasman, M. (2020). Understanding student persistence in commuter historically Black colleges and universities. *Journal of College Student Development*, 61(1), 34-50.
5. Baker, R. S., & Hawn, A. (2022). Algorithmic bias in education. *International Journal of Artificial Intelligence in Education*, 1-41.
6. Baker, R. S., Richey, J. E., Zhang, J., Karumbaiah, S., Andres-Bray, J. M., Nguyen, H. A., Andres, J. M. A. L., & McLaren, B. M. (2024). Gaming the system mediates the relationship between gender and learning outcomes in a digital learning game. *Instructional Science*, 1-36.
7. Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education*, 17, 1-30.

8. Chen, Y., Jensen, S., Albert, L. J., Gupta, S., & Lee, T. (2023). Artificial intelligence (AI) student assistants in the classroom: Designing chatbots to support student success. *Information Systems Frontiers*, 25(1), 161-182.
9. Fryer, L. (2025). A psychological platform for GenAI and human co-piloting in education. *Frontline Learning Research*, 13(1), 76-83.
10. Gruenhagen, J. H., Sinclair, P. M., Carroll, J.-A., Baker, P. R., Wilson, A., & Demant, D. (2024). The rapid rise of generative AI and its implications for academic integrity: students' perceptions and use of chatbots for assistance with assessments. *Computers and Education: Artificial Intelligence*, 7, 100273.
11. Guenther, J., Ober, R., Oliver, R., & Holmes, C. (2024). Remote school retention in Australia: Why do First Nations students disengage and drop out? *Australian and International Journal of Rural Education*, 34(3), 73-91.
12. Holmes, E., & Krsmanovic, M. (2025). Sources, Types, and Perceived Effectiveness of Student Affairs Supervisor Training and Preparation. *Journal of Student Affairs Research and Practice*, 1-15.
13. Holmes, K., Paull, M., Haski-Leventhal, D., MacCallum, J., Omari, M., Walker, G., Scott, R., Young, S., & Maher, A. (2021). A continuum of University student volunteer programme models. *Journal of Higher Education Policy and Management*, 43(3), 281-297.
14. Holmes, W. (2020). Artificial intelligence in education. In *Encyclopedia of education and information technologies* (pp. 88-103). Springer.
15. Holmes, W. (2023). The unintended consequences of artificial intelligence and education.
16. Holmes, W., Persson, J., Chounta, I.-A., Wasson, B., & Dimitrova, V. (2022). *Artificial intelligence and education: A critical view through the lens of human rights, democracy and the rule of law*. Council of Europe.
17. Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., Shum, S. B., Santos, O. C., Rodrigo, M. T., Cukurova, M., & Bittencourt, I. I. (2022). Ethics of AI in education: Towards a community-wide framework. *International Journal of Artificial Intelligence in Education*, 1-23.
18. Lenski, S., Zinke, N., Merkt, M., Reich-Stiebert, N., Stürmer, S., & Schröter, H. (2024). Early indicators of study delay and dropout: Test anxiety and its link to exam participation and performance. *Journal of College Student Retention: Research, Theory & Practice*, 15210251241266547.
19. Li, C., Herbert, N., Yeom, S., & Montgomery, J. (2022). Retention factors in STEM education identified using learning analytics: A systematic review. *Education Sciences*, 12(11), 781.
20. Loglo, F. S., Zawacki-Richter, O., & Müskens, W. (2024). Patterns of media usage by higher education students in Germany and Ghana: A cross-country analysis. *Asian Journal of Distance Education*, 19(1).
21. Luckin, R., Cukurova, M., Kent, C., & Du Boulay, B. (2022). Empowering educators to be AI-ready. *Computers and Education: Artificial Intelligence*, 3, 100076.
22. Luckin, R., Rudolph, J., Grünert, M., & Tan, S. (2024). Exploring the future of learning and the relationship between human intelligence and AI. An interview with Professor Rose Luckin. *Journal of Applied Learning and Teaching*, 7(1).
23. Reich-Stiebert, N. (2023). Roboter in kollaborativen Lehr-Lernkontexten. Theoretische Reflexionen interaktiver Lehr-Lernformen mit sozialen Robotern. In *Künstliche Intelligenz in der Bildung* (pp. 155-174). Springer.
24. Reich, J. (2021). Ed tech's failure during the pandemic, and what comes after. *Phi Delta Kappan*, 102(6), 20-24.

25. Richter, E., Lucksnat, C., Redding, C., & Richter, D. (2022). Retention intention and job satisfaction of alternatively certified teachers in their first year of teaching. *Teaching and Teacher Education*, 114, 103704.
26. Richter, K., & Kickmeier-Rust, M. (2025). Gamification in physics education: play your way to better learning. *International Journal of Serious Games*, 12(1), 59-81.
27. Richter, P., Wersing, H., & Vollmer, A.-L. (2025). Improving Human-Robot Teaching by Quantifying and Reducing Mental Model Mismatch. *arXiv preprint arXiv:2501.04755*.
28. Richter, T., Nemeth, L., Berger, R., Ferri, R. B., Hänze, M., & Lipowsky, F. (2022). Using interleaving to promote inductive learning in educational contexts. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*.
29. Tang, Y. M., Chen, P. C., Law, K. M., Wu, C.-H., Lau, Y.-y., Guan, J., He, D., & Ho, G. T. (2021). Comparative analysis of Student's live online learning readiness during the coronavirus (COVID-19) pandemic in the higher education sector. *Computers & education*, 168, 104211.
30. VanLehn, K. (2023). Evaluations with AIEd systems. *Handbook of Artificial Intelligence in Education*, 505-523.
31. VanLehn, K., Banerjee, C., Milner, F., & Wetzel, J. (2020). Teaching Algebraic model construction: a tutoring system, lessons learned and an evaluation. *International Journal of Artificial Intelligence in Education*, 30(3), 459-480.
32. VanLehn, K., Milner, F., Banerjee, C., & Wetzel, J. (2024). A Step-Based Tutoring System to Teach Underachieving Students How to Construct Algebraic Models. *International Journal of Artificial Intelligence in Education*, 34(2), 224-246.
33. Wang, L.-C., Chung, K. K.-H., & Jhuo, R.-A. (2025). The relationships among working memory, state anxiety, and academic performance in Chinese undergraduates with SLD. *Reading and Writing*, 38(2), 1-22.
34. Zawacki-Richter, O., Bai, J. Y., Lee, K., Slagter van Tryon, P. J., & Prinsloo, P. (2024). New advances in artificial intelligence applications in higher education? *International Journal of Educational Technology in Higher Education*, 21(1), 32.
35. Zawacki-Richter, O., Marin, V., Bond, M., & Gouverneur, F. (2020). Einsatzmöglichkeiten Künstlicher Intelligenz in der Hochschulbildung–Ausgewählte Ergebnisse eines Systematic Review. *Digitale Bildung und Künstliche Intelligenz in Deutschland: Nachhaltige Wettbewerbsfähigkeit und Zukunftsagenda*, 501-517.