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Exploring the Impact of Artificial Intelligence (AI) on Learner-Instructor Interaction in Online Learning (Literature Review)

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Abstract

The utilisation of Artificial Intelligence (AI) technology has caused remarkable changes that have taken place in the educational landscape. Through the integration of AI in online learning systems, an entirely new educational experience has been introduced, altering the ways learners and educators can interact. The emergence and evolution of AI technology have increased efficiency and productivity, enhancing teaching and learning outcomes. AI in online learning provides a distinct advantage by providing real-time feedback to learners. Traditional learning environments often suffer from the limitation of delayed feedback, impeding learners' progress and demotivating them. However, AI-powered online learning systems excel in delivering immediate feedback to learners, enabling them to promptly identify and rectify mistakes and enhance their performance in real-time. This timely feedback fosters a supportive learning environment that encourages learners to engage in the learning process actively. The research by Vanlehn, Lynch, Schulze, Shapiro, Shelby, Taylor et al. (2005) on the Andes physics tutoring system serves as a valuable resource for understanding the lessons learned from utilising AI to support learner-instructor interaction. In contrast to traditional learning environments that offer delayed feedback, impeding the progress of learners and possibly dampening their motivation, AI-powered online learning systems provide real-time feedback. With real-time feedback, learners can instantly correct mistakes and improve their performance, thereby advancing their learning outcomes (Zhou & Mei, 2021). This literature review explores the impact of AI on learner-instructor interaction in online learning environments. The review considers how AI technology enhances and diversifies the learning process, focusing on personalised learning, real-time feedback provision, and content delivery.

Keywords: Artificial Intelligence (AI); Distance education; Educational Technology; e-Learning Technology; Online Learning.

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1. Introduction

The utilisation of Artificial Intelligence (AI) technology has caused remarkable changes that have taken place in the educational landscape. Through the integration of AI in online learning systems, an entirely new educational experience has been introduced, altering the ways learners and educators can interact. The emergence and evolution of AI technology have increased efficiency and productivity, enhancing teaching and learning outcomes.

AI in online learning provides a distinct advantage by providing real-time feedback to learners. Traditional learning environments often suffer from the limitation of delayed feedback, impeding learners' progress and demotivating them. However, AI-powered online learning systems excel in delivering immediate feedback to learners, enabling them to promptly identify and rectify mistakes and enhance their performance in real-time. This timely feedback fosters a supportive learning environment that encourages learners to engage in the learning process actively. The research by Vanlehn, Lynch, Schulze, Shapiro, Shelby, Taylor et al. (2005) on the Andes physics tutoring system serves as a valuable resource for understanding the lessons learned from utilising AI to support learner-instructor interaction.

In contrast to traditional learning environments that offer delayed feedback, impeding the progress of learners and possibly dampening their motivation, AI-powered online learning systems provide real-time feedback. With real-time feedback, learners can instantly correct mistakes and improve their performance, thereby advancing their learning outcomes (Zhou & Mei, 2021).

This literature review explores the impact of AI on learner-instructor interaction in online learning environments. The review considers how AI technology enhances and diversifies the learning process, focusing on personalised learning, real-time feedback provision, and content delivery.

Research question(s)

RQ 1. How do students and teachers recognise the impact of AI systems on learner- teacher interaction (along with other features: communication, support, and attendance) in online learning?
RQ 2. What ethical considerations involve using AI to enhance learner-instructor interaction in online learning?

Literature review methodology

The study employed a systematic literature review to analyse and understand the impact of AI technology on students and instructors in online learning. Kyoungwon Seo et al. (2021) explored the impact of AI systems on learner–instructor interaction in online learning by proposing a theoretical framework based on studies on learner–instructor interaction in online learning. They reviewed the AI systems currently in use in online learning environments.

Theoretical Framework

Effective interaction plays a vital role in achieving success in online learning (Banna et al., 2015; Nguyen et al., 2018). Through interaction, students share information and knowledge, and engage in collaborative learning to construct new knowledge (Jou et al., 2016). Moore (1989) categorised online learning interactions into three types: learner–content; learner–learner; and learner– instructor. These interactions can enhance students' engagement and activity in their online courses (Seo et al., 2021; Martin et al., 2018), and can contribute to building a sense of community, which is crucial for sustained usage of online learning platforms (Luo et al., 2017). Robinson et al. (2017) identified communication and support as crucial factors in the learner- instructor interaction for creating effective online collaborative learning experiences. Furthermore, Richardson et al. (2017) found that a perceived presence during learner-instructor interaction positively influences student motivation, satisfaction, learning, and retention in online courses.

Kang and Im (2013) synthesised findings and concluded that communication, support, and presence are the most important factors for improving student achievement and satisfaction compared to other factors. Therefore, this review focuses on communication, support, and presence between students and instructors. While AI systems are likely to affect the way learner- instructor interaction occurs in online learning environments (Guilherme, 2019), concerns about the impact of these systems on the interaction may hinder their use, despite their perceived benefits (Felix, 2020).

Selection Criteria

Inclusion criteria:

- Keep the scope wide, allowing for research into:
  - accessibility for higher education/college students.
- Relate to the following keyword combinations that are tied to the research questions: "Artificial Intelligence (AI)", "e-Learning Technology", "Educational Technology", "Distance education" and "Online Learning".

Exclusion criteria:

- Non-English language literature.
- It cannot be accessed through any database.
- Irrelevant to the topic (per the author's discretion).

The literature search will be performed in the following databases and search facilities:

- Google Scholar.
- Lancaster University's OneSearch.
- Web of Science Core Collection.
- Other Education Resources (Seminars, Exhibitions and Conferences).

Data analysis

This literature review uses the systematic review guidelines named PRISMA (PRISMA, 2020) to avoid potential bias. The author has used PRISMA to identify potential literature, screen the literature, examine the eligibility of the literature, then compile a final list of literature to take forward (see details in Table 1). The PRIMSA approach offers a useful structure and process (see Appendix 1):

1. Identification: This phase involved conducting searches using the specified study search terms outlined as follows to identify relevant literature.
2. Screening: In this stage, duplicates and literature that did not meet the exclusion criteria were removed from the initial search results.
3. Eligibility: During this step, literature directly related to the research question or rationale was identified based on predefined inclusion criteria.
4. Inclusion: The final pool of literature included articles that met the eligibility criteria. However, additional exclusions may have been made based on other justifications or specific requirements of the study.

Table 1: Details of the PRISMA process

Process	Total Articles	Details
1. Identification	20,419	Preliminary searches were conducted before removing duplicate entries and implementing additional exclusion criteria whenever feasible. **Databases:** I. "Artificial Intelligence (AI)" and "e-Learning Technology" and "Educational Technology" and "Distance education" and "Online Learning" - Google Scholar: 81 - OneSearch: 0 II. "Artificial Intelligence (AI)" and "e-Learning Technology" and "Educational Technology" - Google Scholar: 174 - OneSearch: 1 III. "Artificial Intelligence (AI)" and "Online Learning" - Google Scholar: 18,000 - OneSearch: 150 IV. "Artificial Intelligence (AI)" and "Online Learning" and "Learner" and "Instructor" and "Impact" - Google Scholar: 2,010 - OneSearch: 3 - Google Search engine: 35,300 (Not used in this review because of repetition and copyright protection.)

2. Screening	46	The titles and abstracts of the sources retrieved from each database search were carefully scrutinised. In this process, any literature that was deemed irrelevant to the

Sampling procedure

The review's sampling methodology involved a comprehensive search on ways to cover the targeted audience. The present literature review investigates the impact of AI on students of varying genders (male and female), academic majors, and ages between 18 to 21 years. Kyoungwon Seo et al. (2021) utilised storyboards and speed dating to gain insights into the influence of AI on students. Additionally, interviews were conducted with instructors from diverse academic disciplines and with varying levels of teaching experience to capture their perspectives and sentiments regarding integrating AI technology in the learning environment.

Review of Literature and Discussion

The literature has been considered by the author and then identified according to the Research Questions. Some of the literature analysed focused on the impact of AI on education in general while other literature referred to, more specifically, the impact of AI on instructors and learners in online learning.

RQ 1. How do students and teachers recognise the impact of AI systems on learner-teacher interaction (along with other features: communication, support, and attendance) in online learning?

According to both research articles "The Impact of artificial intelligence on learner–instructor interaction in online learning" by Kyoungwon Seo, Joice Tang, Ido Roll, Sidney Fels, and Dongwook Yoon (2021) and "The Impact of Artificial Intelligence on Learning, Teaching, and Education" by Tuomi, Ilkka (2018), the findings show and relate to other literature as follows:

- The study by Seo et al. (2021) highlights that AI systems in online learning have both positive and negative impacts on learner-instructor interaction. While AI systems have been acknowledged for improving communication quality and quantity, providing personalised support, and enhancing the feeling of connection, concerns regarding responsibility, agency, and surveillance have also been identified.
- Students and instructors appreciate AI's immediate communication but worry about misunderstandings and misleading information. They value personalised support but fear it may hinder independent learning. Social interaction cues from AI are valued, but extensive data collection raises privacy concerns (Seo et al., 2021).
- The findings align with the growing body of literature on the impact of AI on learner-instructor interaction in online learning. Other studies such as Seo et al. (2020b), Popenici and Kerr (2017), and Zawacki-Richter et al. (2019) have also contributed to the understanding of the functionalities and potential benefits of AI systems in education.

- In “Building intelligent interactive tutors: Student-centered Strategies for Revolutionising e-learning” (Woolf, 2009), the author highlights the success of intelligent tutoring systems (ITS) in limited and clear domains such as mathematics and physics. These systems utilise a knowledge-based approach and have served as valuable data sources for research on learning.
- A study by Ritter, Anderson, Koedinger, and Corbett (2007) titled “Cognitive Tutors: Lessons Learned” emphasises the evolution of pedagogical models within intelligent tutoring systems. The models have expanded from instructive approaches to incorporate social learning and knowledge construction, fostering a more comprehensive learning experience.
- In “Scaffolding deep comprehension strategies through Point&Query, AutoTutor, and iSTART” (Graesser, 2005), the authors discuss how intelligent tutoring systems can provide support for deep comprehension strategies. They highlight the potential of these systems, including the use of conversational agents and personalised learning experiences, which are expected to be areas of focus for educational AI start-ups in the future.
- Regarding the impact of AI on learning, Porayska-Pomsta and Kaska (2015) present the application of AI in special needs education, particularly in the early detection of conditions such as dyslexia, autism spectrum disorder, and attention deficit hyperactivity disorder.
- Nkambou, Azevedo, and Vassileva (2018) discuss the advances in intelligent tutoring systems, highlighting the integration of AI and machine learning for generating teacher interfaces, learning monitoring, and diagnostics. This development, known as learning analytics and educational data mining, aims to reduce teacher workloads through automatic test generation and assessment.
- In the research article “Analyzing collaborative learning processes” (Rosé et al., 2018), the authors emphasise the importance of large-scale learning analytics in online environments for objectively assessing student learning. They note that while AI systems excel at combining data from various sources for real-time pattern recognition, it is crucial to distinguish between measuring individual development and average performance in standardised tests to ensure meaningful learning outcomes.

RQ 2. What ethical considerations involve using AI to enhance learner-instructor interaction in online learning?

According to the research articles “The Impact of artificial intelligence on learner–instructor interaction in online learning” by Kyoungwon Seo, Joice Tang, Ido Roll, Sidney Fels and Dongwook Yoon (2021) and “Ethical Considerations of Artificial Intelligence in Learning Analytics in Distance Education Contexts” by Leona Ungerer and Sharon Slade (2022), findings realting to other literature is as follows:

- Study findingsfrom Seo et al. (2021) reveal that students and instructors perceive AI systems as double-edged swords when it comes to learner-instructor interaction in online

learning. While AI systems are recognised for improving communication, providing personalised support, and enhancing the feeling of connection, there are concerns related to responsibility, agency, and surveillance.

- The study identifies ethical concerns regarding AI in online learning. Students and instructors are concerned about responsibility when AI decisions result in negative outcomes. The reliability of AI answers is questioned due to the nature of AI systems. The study suggests providing human-understandable explanations for AI output or procedures (Seo et al., 2021).
- There is a risk of over-standardising the learning process through AI systems, which may limit student agency and hinder exploration and discovery. Instructors express concern about students missing opportunities to learn new skills or learn from their mistakes. The study proposes involving instructors in the learning process to balance AI support and preserve student agency (Seo et al., 2021).
- Privacy and surveillance issues arise from measuring unconscious behaviour, such as facial expression analysis or eye tracking, which can make students uncomfortable. Establishing clear and transparent data norms and agreements regarding the nature of collected data and its presentation to instructors is an important consideration (Seo et al., 2021).
- Emphasising ethical considerations needs to balance the benefits of AI-enhanced learner-instructor interaction and the potential risks associated with privacy, responsibility, and student agency in online learning (Seo et al., 2021).
- Privacy and monitoring issues associated with the use of artificial intelligence in online learning have provided additional insights centred on the broader context of the impact of AI on learner-teacher interaction and highlight the need for careful implementation and consideration of ethical concerns (Bajaj & Li, 2020; Lee, 2020; Popenici & Kerr, 2017; Seo et al., 2020b; Seo et al., 2021; Zawacki-Richter et al., 2019).
- According to Braunack-Mayer et al. (2020), ethical considerations arise when using AI to enhance learner-instructor interaction in online learning. These considerations encompass privacy, data security, informed consent, and the ethical use of collected data. To address these concerns, the authors suggest implementing data governance measures, supportive systems, organisational structures, and clear policy guidelines within higher education institutions.
- The article “Student and Staff Views” (Braunack-Mayer et al., 2020) highlights the need to include students and staff in data governance and policy decisions. Avoiding their input can erode trust and cause harm when using student data and learning analytics without their knowledge. Incorporating their perspectives improves the design and implementation of learning analytics systems.

Discussion

Gaps and limitations

Gaps and limitations in the impact of AI on learner-instructor interaction

1. There is a dual nature of AI impact: The literature review, particularly highlighting the research by Seo et al. (2021), indicates that AI systems in online learning have both positive and negative impacts on learner-instructor interaction. While AI enhances communication quality, provides personalised support, and enhances the feeling of connection, concerns regarding responsibility, agency, and surveillance have been identified. However, the extent and specific manifestations of these limitations require further investigation.
2. There is need for verification of AI-generated output: Students and instructors express concerns about the reliability of AI-generated answers. Seo et al. (2021) suggest that providing human-understandable justifications for AI systems' output or procedures could address this concern. However, the effectiveness and feasibility of such explainability mechanisms need to be explored further.
3. There are privacy and surveillance concerns: The measurement of unconscious behaviour, such as facial expression analysis or eye tracking, raises privacy and surveillance concerns among students. Establishing clear and transparent data norms and agreements regarding the nature and use of collected data is crucial. The study by Seo et al. (2021) suggests addressing these concerns to ensuring student agency and alleviating privacy-related anxieties. However, exploring effective strategies and guidelines for managing privacy concerns in the context of AI-enabled learner-instructor interaction is necessary.

Gaps in the existing literature

1. There is limited understanding of data analytics: The literature review reveals limited awareness and understanding of data analytics among students and staff, as identified by Braunack-Mayer et al. (2020). Further research is needed to investigate the knowledge gaps and develop appropriate educational initiatives to enhance data literacy and promote informed decision-making regarding the use of student data in analytics.
2. There are ethical considerations in AI adoption: While ethical considerations are acknowledged in the literature, there is a need for more comprehensive exploration of the ethical implications of AI adoption in online learning. The studies by Seo et al. (2021) and Braunack-Mayer et al. (2020) provide initial insights into ethical concerns such as responsibility, privacy, and consent. However, further research should delve deeper into the ethical dilemmas associated with AI systems, considering the perspectives of various stakeholders.

Conclusion

Based on the literature review and analysis, students and instructors recognise the dual nature of AI systems in learner-teacher interaction. While AI can enhance communication and support, concerns regarding responsibility, agency, and privacy must be addressed. By focusing on explainability, involving instructors and students, studying and covering ethical concerns, and establishing transparent data norms, the potential of AI systems to improve learner-teacher interaction in online learning can be maximised.

Recommendations

Based on the answers to the Research Questions, the following recommendations can be made:

1. Enhance Explainability: AI systems should provide human-understandable justifications for their output or procedures to enable students to verify the accuracy of AI-generated answers. Explainability plays a crucial role in building trust and acceptance among students.
2. Balance Standardisation and Student Agency: Instructors should actively use AI systems to avoid over-standardisation of the learning process. AI should be utilised to enhance human thinking and augment the learning process, striking a balance between AI's capabilities and human flexibility.
3. Manage Privacy Concerns: Clear and transparent data norms and agreements should be established to address discomfort related to the measurement of unconscious behaviour. Students' agency and consent for data sharing should be ensured to alleviate concerns about privacy and surveillance.
4. Improve Data Literacy: Efforts should be made to enhance student and staff awareness and understanding of data analytics in online learning. Educational initiatives should be developed to promote data literacy and informed decision-making regarding using student data in analytics.

Consider Ethical Implications: Further research is needed to explore the ethical considerations associated with AI adoption in online learning. Stakeholders' perspectives should be considered, and comprehensive guidelines and policies should be developed to address ethical dilemmas related to responsibility, privacy, and consent.

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Appendices

Appendix 1

PRISMA 2020 checklist

http://prisma-statement.org/

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics.	
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	
	23b	Discuss any limitations of the evidence included in the review.	
	23c	Discuss any limitations of the review processes used.	
	23d	Discuss implications of the results for practice, policy, and future research.	
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	
Competing interests	26	Declare any competing interests of review authors.	
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

Appendix 2

Final Literature List

Main Sources			
N.	Title	Author	Year
1.	Students, faculty express concerns about online exam invigilation amidst COVID-19 outbreak	Bajaj, M., & Li, J.	2020
2.	The Impact of Artificial Intelligence on Learning, Teaching, and Education	Tuomi, Ilkka	2018
3.	Ethical Considerations of Artificial Intelligence in Learning Analytics in Distance Education Contexts	Leona Ungerer, & Sharon Slade	2022
Supportive Sources			
N.	Title	Author	Year
1.	The impact of artificial intelligence on learner–instructor interaction in online learning, International Journal of Educational Technology in Higher Education	Kyoungwon Seo, Joice Tang, Ido Roll, Sidney Fels & Dongwook Yoon	2021
2.	Proctorio CEO releases student's chat logs, sparking renewed privacy concerns	Lee, S.	2020
3.	AutoTutor: An Intelligent Tutoring System with Mixed-Initiative Dialogue	Graesser, A. C., P. Chipman, B. C. Haynes, & A. Olney	2005
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