

# A Systematic Review of Interaction in Teaching and Learning with Artificial Intelligence (AI)

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*Addressing a knowledge gap in higher education pedagogical research, this study examines student and teacher interaction with Artificial Intelligence (AI) following the rise of tools like ChatGPT. Through a systematic review of 33 studies from SCOPUS and Web of Science, the research utilizes established frameworks to codify the types, factors, and effects of AI-driven interaction in teaching and learning. Results indicate that while AI and distance education are becoming standard, there is a critical need for further research into the challenges and diversity of these interactions, specifically through the lens of established theories. Current trends show that AI is frequently utilized for personalized learning; however, findings suggest this may inadvertently diminish social interaction and collaborative engagement. Furthermore, the review reveals that AI is often relegated to relationship building or basic dialogue, highlighting a need for more robust applications in feedback and instructional guidance roles. This work contributes to the field by decomposing interaction into measurable variables and providing a holistic map of the current landscape. Ultimately, it identifies essential areas for future research to ensure that AI integration enhances, rather than isolates, the pedagogical experience.*

*Keywords: Interaction; Artificial Intelligence; Teaching and Learning; Education; Pedagogy*

## Introduction

In this systematic review, we present the research designs, findings, challenges, and research potentials on interaction apropos teaching and learning. Education has witnessed several changes in recent years. (Lo, 2023; Zhao & Watterston, 2021). The world pandemic sent schools and institutions into remote learning modes, and the release of open-access software such as ChatGPT caused a rift between real-time and human-to-human interactions. (Mhlanga, 2023; Zhao, 2020). Such changes may have impacted interactions, as we saw more isolation and learning with educational technologies instead of just face-to-face interactions between teachers and students. Here, we focus on interaction, which is all communication between the learner and teacher throughout a course. (Moore, 1989). A gap is the examination of the role of interactions in present technology-mediated settings. (Zawacki-Richter et al., 2019).

Recent research on student-teacher interaction with AI presents complexities and limitations. (Guilherme, 2019). We find the impact of interaction on pedagogy is overlooked in the literature. Relationships may have different effects on the quality of teaching and learning. If successful, it may cultivate a healthy and educationally flourishing environment. If unsuccessful, the learning environment may become dire, distancing the teacher and students, and impacting the quality of pedagogy and educational culture. We find a systematic review of interaction research to be timely and informative for a new era of interaction that contains advanced educational technologies such as AI. Here, we assume that teachers, students, and technologies such as AI may interact in diverse modalities, such as online or in-person, with or without other types of technology. This work thus aims to take stock of studies investigating the role of interaction. In doing so, we strive to examine the following overarching goal to explore the state of interaction research considering technologies such as AI.

To achieve this, we aim to answer the following research question:

1. What are the key areas of work studied in interaction research with AI in higher education? To achieve this, we provide a thematic summary surrounding the foci of the reviewed literature.
2. What is the landscape of work studied on interaction research with AI in higher education? To achieve this, we use established frameworks to classify the interaction landscape by (1) types, (2) factors, and (3) effects of the reviewed literature.

The field of interaction research is wide and all-encompassing. Various domains, such as information studies, human-computer interaction, and sociology, have presented theories and frameworks for the study of interactions of humans with humans or technologies. Symbolic interaction, for example, is a well-cited field in literature. (Carter & Fuller, 2015). Symbolic interaction concerns the interactions enacted in symbolic and natural environments and the result of communications between entities such as humans or technologies. (Aksan et al., 2009). This field may be attributed to three broad schools of thought, namely Chicago, Iowa, and Indiana:

- Chicago: Blumer suggests that social institutions exist only as individuals interact (Blumer, 1986).
- Iowa: Kuhn suggests that interaction should be studied in networks and in more systematic and measurable ways (Katovich, 2003).
- Indiana: Stryker suggests ideas should be tested through both qualitative and quantitative lenses (Stryker, 2001).

To date, interaction research is impacted by the mentioned schools of thought. However, changes to the notion of interaction are likely on the horizon. Several more recent factors may impact the quality of interaction in educational settings. Online interaction, interaction in times of crisis, and interaction with technologies such as AI are a few examples. Educational interaction in online settings may have its demands and characteristics. For example, integrating student-teacher interactions has been noted as one of the most difficult aspects of teaching online. (Krishnamurthi, 2000). Face-to-face interaction comes with multisensory, multimodal, and multi-tasked attributes that come naturally to humans. Online interaction, on the other hand, may be impacted by: the type of interaction, number of people involved, mode of interaction, language and tone of interaction, timing and volume, and frequency of education. (Krishnamurthi, 2000). Further interaction issues in online and non-face-to-face settings may be brought up in times of crisis. The latest example is the global COVID-19 pandemic that sent everyone back home and mandated social isolation and distancing. The COVID-19 pandemic is known to cause a significant shift to online and blended learning and requires educators to incorporate new technologies into their pedagogy. (Ng & Chu, 2021; Ng et al., 2023; Sartika et al.2021). The mentioned research (Krishnamurthi, 2000; Ng & Chu, 2021; Ng et al., 2023; Sartika et al., 2021). The interaction type between teachers and students may be impacted by two variables, namely:

- Presence spanning from fully in-person to fully distant.
- Technology use spanning from no technology to full integration of technology, such as AI

Besides interaction types, interaction factors carry meaning and add value to the goal and outcomes of interaction. Kan and Im (2013) built on concepts from (Anderson, 2003) and (Kanuka, 2011). Moreover, the authors proposed a five-factor model of learner-instructor interaction in online learning environments, as presented in Table 1. The interaction may be perceived as little as a facial gesture, such as a nudge, dialogue, conversations, and feedback, and as strong as a relationship, containing multiple factors of interaction (Hornbæk & Oulasvirta, 2017). The literature (Anderson, 2003; Hornbæk, K., & Oulasvirta, 2017; Kang, M., & Im, 2013; Kanuka, 2011) Thus, it suggests that the support factor may impact the interaction it provides: Feedback that is one-directional, two-dimensional dialogue, or a combination of feedback and dialogue that may lead to relationship building between the teacher and student actors.

Table 1  
*Five-factor model of interaction adapted from Kan and Im (2013)*

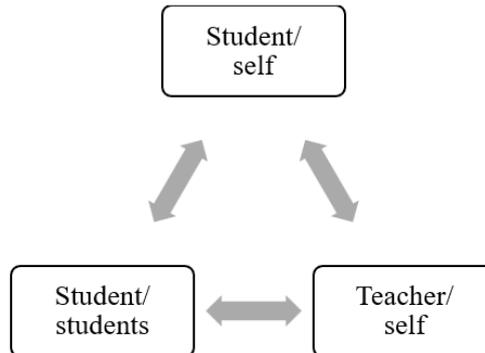
The factor of Interaction	Definition
Communication	Instructional communication (Q & A)
Support	Instructional management by the instructor
Presence	Perceived connectivity
Guidance	Guidance by the instructor
Social Intimacy	Social interaction by the instructor

Besides interaction type and factors, the interaction effects must also be studied. Moore proposed one of the early accounts of interaction. (1989) who suggested three types of interaction: learner–content, learner-learner, and learner–instructor. Learner–instructor interaction may significantly impact students’ satisfaction and achievement in learning. (Andersen, 2013; Kang & Im, 2013). This three-type model of interaction is well-established in the literature. (Anderson, 2003; Baber, 2020; Garrison et al., 2003; Moore, 1989). Informed by the three-level framework, Kanuha (2011) proposed an interaction effect model as shown in Figure 1. This model aims to present the different facets of interaction that come into play in education. Broadly, the interaction effects may be divided into two groups:

- Personal: interaction effect on individual learners and educators
- Social: interaction affects social and group dynamics.

Figure 1

Interaction models from (Kanuka, 2011)



The interaction type, factor, and effect can provide insight into the interaction climate. We are thus motivated to use established theories from prior research to survey the literature and classify the state of interaction in light of technologies such as AI.

## Methods

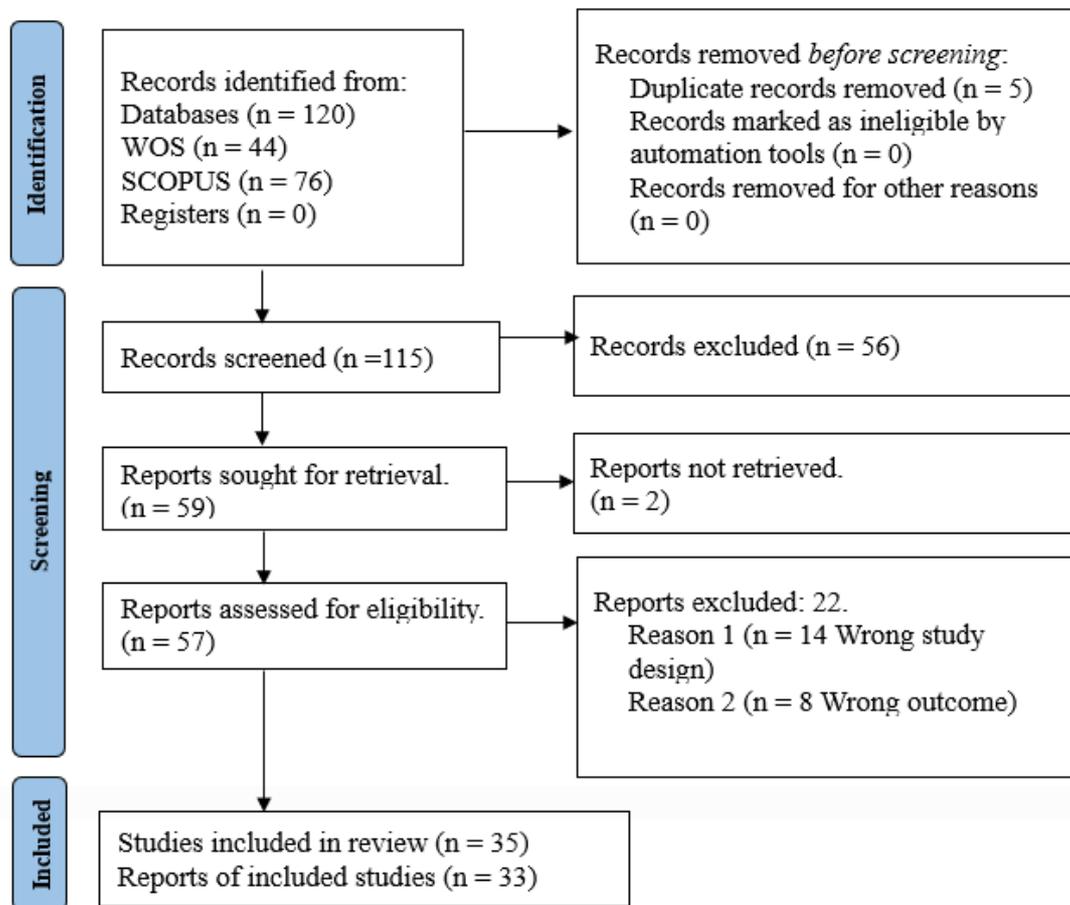
The methods section outlines the search process and analysis approach employed in summarizing and synthesizing the literature.

### Search Process

An overview of the PRISMA chart is shown in Figure 2. We searched the following databases: Web of Science or WoS and SCOPUS to find journal and conference publications on our research topic. The following strings are searched: *Interaction, education, and role, and (AI OR artificial intelligence)*

First, the titles and abstracts of studies identified from the search are examined. Second, the full text of each study is reviewed to find if it contains sufficient data for our research questions. A total of 33 studies were used in this review. We sought to include all studies that mentioned one or multiple AI or Artificial Intelligence terms, hence using the OR operator. We include these terms via the AND operator since we focus on AI, education, interaction, and role. The overview of our search process is summarized in the PRISMA chart shown in Figure 2. A total of 120 (44 from WOS, 76 from SCOPUS) were included for screening. Our initial screening examined the titles and abstracts of 115 studies.

Figure 2  
PRISMA flowchart of primary study selection. \*Excluded if search terms were not targeted in the title or abstract



Our initial inclusion criteria contained review articles focusing on the role of AI and interaction in higher education (Table. Our initial exclusion criteria contained publications focused on the healthcare or non-higher education industries, leading to 59 papers sought for retrieval. Of these, we could not retrieve two studies, and a total of 57 studies were assessed for eligibility. Of the 57, 8 had the wrong outcome, and 14 had the wrong study design. This resulted in a total of 35 studies included in the review. We excluded two papers during the extraction process as they lacked information regarding our research questions.

Studies in university contexts are considered for this review. Any study that considered interaction as the main or independent variable is considered for inclusion. Outcomes were not considered part of the eligibility criteria if they pointed to educational outcomes (e.g., learning outcomes, satisfaction, etc.). The interaction may have happened in traditional face-to-face settings, online, with technology, or in times of crisis. Comparisons may have been present in some studies that included no interaction, some interaction between humans, or interaction with technology. The primary findings in the reviewed studies may include learning gains (e.g., understanding, performance, behavioral, attitudinal), and generally an improved teaching and learning experience. The data insight may have been derived via self-reported methods or more objectively measured, which motivates exploring these factors.

Table 2  
Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Journal article and conference	Book interviews or studies regarding public policy
Studies shared in English	Studies not shared in English
Engineering or STEM education foci	Studies not on Engineering or STEM education

## Search Protocol and Data Analysis

Our protocol included the following steps:

- Used the input string of search in both SCOPUS and WoS.
- Download the full records of all the papers.
- Upload the full records to Covidence.
- Covidence to identify duplicate studies and remove them.
- Review the title and abstract of each article and decide if it is relevant.
- Download and review the full text of each article and decide if it is relevant.
- Gather the full demographic records of studies selected for review.
- Create a synthesis of future recommendations and challenges in the discussion section based on the full review of each article.

We utilize existing theories as guiding frameworks to classify and synthesize literature on interaction, refer to 1.2 for a detailed description. We codify as follows:

1. What is a thematic summary of the areas of reviewed research? We thematically review the studies and provide a summary of key emergent areas.
2. What are the interaction model-type trends in the reviewed studies? We examine the type of model on two ordinal dimensions:  
Presence: 1) Face-to-face, 2) Distant  
Use of technology: 1) No technology like AI, 2) With Technology like AI
3. What are the interaction factor trends in the reviewed studies? Interaction factors on one nominal dimension with three levels:  
1) Feedback and guidance, 2) Dialogue and bidirectional communication, 3) Combination of feedback and dialogue.
4. What are the interaction model effect trends in the reviewed studies? Interaction model on one nominal dimension with two levels:  
1) Personal (e.g., a student with self, a teacher with self), 2) Social interactions (e.g., student with students, classroom collaboration, and dynamics as a whole)
5. Putting it together:  
Putting into perspective: interaction model types, factors, and effects, and descriptively summarizing the landscape of research on interaction.

Once the coding is done, we utilize thematic as well as tabular and descriptive summarizations to tap into the state of interaction research in education.

## Results

The results section outlines a thematic summary of the reviewed studies grouped based on their focus areas. Further, a descriptive summary of the interaction type, factor, and effects, followed by an aggregated summary, is provided.

### Thematic Analysis of the Reviewed Studies

This subsection outlines a summary of the reviewed studies grouped based on their areas of focus from most to least frequent as follows:

- Studying technology for new types of interaction (N=17/33)
- Studying the challenges of interaction (N=6/33)
- Studying the diversity of interactions (N=6/33)
- Studying interaction through theories and frameworks (N=4/33)

### ***Studying technology for new types of interaction***

Studying technology for new types of interaction was seen in 17 out of 33 studies and is described next. Bentivoglio (2009) shares the importance of web forums in building new knowledge among students. Posted messages by the students may create a relationship network that can support two types of interactions. The interactions are between the students and between the teachers and students. A multi-agent system is used to monitor the evolution and state of the forum using textual and social network analysis fed into a rule engine.

### ***Studying the challenges of interaction***

The interaction challenges were seen in 6 out of 33 studies and are described next. Arduin et al. (2021) examine the lack of physical interaction brought up by the COVID-19 pandemic and its impact on students' motivation and learning. The authors share that the nature of interaction behaviors may change during and beyond the pandemic. They particularly focus on the role of tacit knowledge transfer from the teacher to the students. They highlight the importance of information in tacit knowledge, its impact on behavior, and the lack thereof in settings imposed by a crisis, such as online education.

Chen (2022) brings forth stressors such as anxiety resulting from being a public speaker for English as a Foreign Language (EFL) learners. The author proposes that artificial intelligence, automatic speech analysis, and virtual reality may facilitate more personalized learning. EFL learners are shown to have significantly reduced anxiety upon using VR-facilitated learning, and that technology has led to compensating for more individual differences in the learners and leading to convergence.

Edwards and Cheok (2018) make the case that the shortage of teachers, along with advanced technologies, calls for novel ways of addressing teacher roles. The authors share the needs and challenges of having robotic teachers as the only teacher autonomy in the classroom.

Kawabe et al. (2014) present the challenges of student participation, requiring both communication skills and a positive classroom atmosphere. The authors study the role of hand raising in student interaction and learning. Their findings reveal several bottlenecks to students' normalized interaction behaviors, such as hand raising in class.

Martins and Martins (2014) warn of the challenges in learning brought up by replacing the human teacher with technology. Namely, the educational experience may become passive, limited, and alienated by the technology-driven environments.

Vinichenko et al. (2020) The aim is to determine the role of a teacher in the AI-teacher system and identify the nature of AI's influence on students and communication within the teacher system. Findings show the teacher's advantage over AI in teaching technique and social influence, as well as the negative effect of AI on students' well-being.

### ***Studying the diversity of interactions***

The diversity of interactions was seen in 6 out of 33 studies and is described next. Aziz et al. (2019) examine the contributors to students of low vision critical thinking skills in mathematics. Students with low vision are naturally disadvantaged because of their limited vision abilities. Two-way communication between students and teachers is deemed an important factor and may be achieved via effective content. The authors emphasize that the diverse models for low-vision learners may mean nothing to them if the design principles of the proposed models do not meet the low-vision learners' learning needs. The affective 4D mathematical model is suggested with a four-dimensional learning model that evokes a) feelings, b) thoughts, c) emotions, and d) actions in learning activities of low vision learners, particularly in Mathematics.

Chen et al. (2002) examine the impact of student roles on team dynamics and performance. The authors develop a tool to collect the roles a student plays in their learning group and examine the impact of the role on team performance using machine learning for analytics and data analysis. The study's findings reveal that role theory can open a new window to predicting and discovering team performance.

Karumbaiah et al. (2023) study the spatiotemporal factors of interaction with an AI agent and human teacher. Findings reveal that teacher visits were more associated with student-in-the-moment indicators such as idleness. However, findings also suggested that there could be a potential mismatch between students visited by the teacher and those who may have needed it more at that time (e.g., students who were disengaged for much longer).

Rosanda and Istenic Starcic (2020) explore teaching with a teacher and a robot having a shared presence in the classroom. In such an instance, the robots perform a social role by interacting with the students.

Velentza et al. (2021) bring out the importance of perceived personality in educational technology. Their findings of studying robots with the presence and absence of cheerfulness lead to different human perceptions. Their findings reveal no consistent and linear relationship between the personality traits of robots and human preferences in collaborating with them.

Zhang (2022) explores the types and contents of teacher-student interaction that can lead to the subjective feeling of curriculum education, promotion of learners' active participation in classroom teaching activities, and maintenance of smooth interaction with teachers.

### ***Studying interaction through theories and frameworks***

Studying interaction through theories and frameworks was seen in 4 out of 33 studies and is described next. Ala and Wegner (2019) present a theoretical paper on the optimal combination of human-human interaction and human-computer interaction in education. The authors draw from the sociocultural theory of education and suggest that well-planned collaboration with a human or AI is key to high-quality education. The authors further proposed a framework for instructor-AI collaboration in a student-centered entrepreneur education environment. The key feature of the framework is in supporting decision-making for using AI in pedagogy.

Asok et al. (2017) explain the need for engineering students' attainment of higher-order thinking skills that require complex judgment and problem-solving. An active learning environment is proposed, which uses information and communication technologies, focusing on a discussion between teachers and students. Examples include role play, jigsaw, brainstorming, debate, mind map, etc., for concept understanding and group assignments, combined mini projects, discussion on topics, Quizzes, and puzzles for concept application. The authors suggest that higher-order thinking skills are improved through interactions with improved interpersonal and lifelong learning skills.

Chen and Chen (2022) use social cognitive theory to study the impact of individual and organizational factors on teacher learning. The authors summarize their comprehensive method, finding that the interaction, among other variables such as teacher support service, peer feedback, and personal goal orientation, significantly impacts teachers' reflective practice skills, contributing to sustainable learning.

Duran et al. (2017) study the measurement of significant learning from the perspective of educators and learners. The study's findings at a Colombian university reveal that interaction between the learning cycles of educators and learners promotes shared mental model development and active learning practices.

## **Interaction Model Type, Factor, and Effect Trends in the Reviewed Studies**

The interaction model type trend from most to least frequent is:

- Distant presence and use of technology like AI ( $N=21$ )
- Distant presence and use of no technology like AI ( $N=1$ )
- Face-to-face presence and use of some technology like AI ( $N=8$ )
- Face-to-face presence and use of no technology like AI ( $N=3$ )

The interaction factor trend from most to least frequent is:

- Relationship building ( $N=20$ )
- Dialogue and bidirectional communication ( $N=7$ )
- Feedback and guidance ( $N=6$ )

The interaction model effect trend from most to least frequent is:

- Personal ( $N=19$ )
- Social ( $N=14$ )

Putting the findings together, the top three types of interaction reported in the reviewed studies are:

- Type= Technological and distant, Factor= Combination of feedback and dialogue, Effect= Personal achievement ( $N=9$ )
- Type = Technological and distant, Factor= Combination of feedback and dialogue, Effect= Social achievement ( $N=6$ )
- Type= Technological and distant, Factor= Feedback, Effect= Personal achievement ( $N=3$ )

## Discussion

In this section, we share our summary of findings and synthesis of challenges and future work based on the reviewed literature.

### Summary of Findings

Through a review of the literature, we were interested in examining the following research questions:

1. What are the key areas of work studied in interaction research with AI in higher education? To achieve this, we provide a thematic summary.
2. What is the landscape of work studied on interaction research with AI in higher education? To achieve this, we use established frameworks from the literature to classify the interaction landscape by 1. types, 3. factors, and 3. effects.

About our first research question, the findings suggested that most of the work is focused on using technology for a new type of interaction, and there is room for more work on studying the challenges of interaction, the diversity of interactions, and the examination of interactions through theories and frameworks.

Regarding our second research question, the findings suggested the interaction model type trend from most to least frequent is Distant presence and use of technology like AI, Distant presence and use of no technology like AI, Face-to-face presence and use of some technology like AI, and Face-to-face presence and use of no technology like AI. This highlights that interactions are often with or without AI in distance mode or use AI in face-to-face contexts. AI and distance education are becoming common components of today's education.

The interaction factor trend from most to least frequent is Relationship building, Dialogue and bidirectional communication, and Feedback and guidance. This highlights the need for more uses of AI in feedback and guidance roles, and not just for sole relationship building or dialogue.

The interaction model effect trend from most to least frequent is: Personal and Social. This highlights the increased interest in using AI for personalized purposes, which may lead to a diminished interest and engagement in social interaction and learning.

Putting the findings together, the top three types of interaction reported in the reviewed studies from most to least frequent are:

- Type= Technological and distant, Factor= Combination of feedback and dialogue, Effect= Personal achievement
- Type= Technological and distant, Factor= Combination of feedback and dialogue, Effect= Social achievement
- Type= Technological and distant, Factor= Feedback, Effect= Personal achievement

The review of studies shows that with the use of technology, the nature of teaching tends to become more blended or distant, as opposed to face-to-face.

### Future Conceptions

Overall, the interaction landscape in education is fragmented into special types, factors, and effects of interaction. We find that future work may benefit from more diverse research. According to the type, factor, and impact, we suggest areas of future research (Table 3).

Table 3

*Suggestions for work areas for future research*

	Area
AI's feedback of an individual who can only pursue education in a distant mode, for example, in rural areas, with accessibility needs, a mature student with other work obligations	Smart assessment
AI's two-directional communication with an individual in a distant mode	Chatbot

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AI's combination of feedback and bi-directional communication (e.g., smart learning analytics from a learning management engine) of an individual in a distant mode	Adaptive learning
AI's feedback of a social team, group, or classroom that can only pursue education in a distant mode (e.g., are located in different geographical locations)	Plagiarism Detection
AI's two-directional communication of a social team, group, or classroom in a distant mode	The team's virtual assistant
AI's combination of feedback and bi-directional communication of a social team, group, or classroom in a distant mode	Virtual instructor
Human teacher's feedback on an individual who can only pursue education in a distant mode	E-Assessment
Human teachers' two directional communication with an individual in a distant mode	One-on-one virtual support
A human teacher's combination of feedback and bi-directional communication with an individual in a distant mode	Learning management engine of an individual
Human teacher's feedback on a social team, group, or classroom that can only pursue education in a distant learning mode	E-assessment of teams
Human teacher's two directional communication (e.g., active learning) of a social team, group, or classroom in a distant mode	Active learning of teams online
Human teachers' combination of feedback and bi-directional communication of a social team, group, or classroom in a distant mode	Learning management engine of a social team, group, or classroom
A human teacher's feedback on an individual who can only pursue education in person	Traditional assessment
A human teacher's two-directional communication with an individual in person	Traditional office hours
A human teacher's combination of feedback and bi-directional	Traditional course
Human teacher's feedback on a social team, group, or classroom that can only pursue education in person	Traditional feedback on teams
A human teacher's two-directional communication of a social team, group, or classroom in person	Traditional classroom management
A human teacher's combination of feedback and bi-directional communication of a social team, group, or a classroom in person	Traditional course management
AI's feedback on an individual who can only pursue education in person	Personal AI assessor
AI's two directional communication with an individual in person	Language bot
AI's combination of feedback and bi-directional communication with an individual in person	Personal AI instructor
AI's feedback of social team, group, or classroom that can only pursue education in person	Smart Classroom or Behavior Management

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AI's two-directional communication of social teams, groups, or classrooms in person	Smart teams or classroom audio/visual
AI's combination of feedback and bi-directional communication of a social team, groups, or classrooms in person	Smart team management

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## Limitations of This Work

We acknowledge that this study comes with limitations. We reviewed studies that had specifically noted interaction in their articles and used technology such as artificial intelligence or AI. Other terms used for AI were not searched in this review. We anticipate that future developments may add to the technological terms and broaden the interaction types. Further, studies not conducted in English were excluded from this study.

## Conclusion

This work addressed the knowledge gap in higher education pedagogical research on interaction in light of technologies such as Artificial Intelligence or AI. The review aimed to identify themes, as well as use established frameworks to codify types (Krishnamurthi, 2000; Ng & Chu, 2021; Ng et al., 2023; Sartika et al., 2021), factors (Anderson, 2003; Hornbæk, K., & Oulasvirta, 2017; Kang, M., & Im, 2013; Kanuka, 2011), and effects (Anderson, 2003; Baber, 2020; Garrison et al., 2003; Moore, 1989) of interaction with technology, such as AI, in teaching and learning. Through a systematic review of SCOPUS and Web of Science databases, 33 studies were selected for review. Findings show that with AI, the nature of teaching tends to become more blended or distant, as opposed to face-to-face. The use of AI for personalized learning or feedback on social achievements is the two most frequently seen interactions. However, several areas of interaction have not been researched in the literature. This work contributes to decomposing interaction into some constituting variables for tapping into the landscape and areas of future work for AI interaction in education.

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