

Analysing the Nexus Between Artificial Intelligence and Students' Learning

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The study examined the process of student learning by employing the constructivist approach in an artificial intelligence interface. We have adopted a qualitative enquiry followed by the contextual triangulation of the dimensions of constructivism in the AI platform. It was found that cognitive, social, and radical constructivism through the help of AI, ensures students, more effective learning. The study has a significant, practical implication by embedding social dynamics, fostering conceptual changes, and facilitating student learning. This paper has theoretical significance in the investigation of evolving teaching and learning through constructivist approach with AI-assisted pedagogy.

Keywords: artificial intelligence, constructivist approach, student learning, cognitive, social, radical

INTRODUCTION

Artificial intelligence (AI) has evolved substantially beyond its traditional association with routine automation and standardized operational tasks (Sawney, 2016). Contemporary advancements now enable AI systems to deliver highly individualized services tailored to specific user needs (Wan et al., 2021), as well as to facilitate emotionally responsive interventions that support psychological and affective well-being (Xu et al., 2024). In particular, AI excels in environments driven by big data and analytics, enabling it to identify user needs with precision and deliver tailored solutions accordingly (Ra'ne et al., 2024; Haleem et al., 2022). By supplying individuals with accurate, customized information, AI significantly enhances consumer decision-making processes (Sidlauskiene, 2022). Through comprehensive analysis of user behaviors, preferences, and historical choices (Grummon et al., 2023), AI systems generate highly specialized recommendations suited to each consumer's unique profile (Sharma et al., 2021). These capabilities contribute greatly to improved customer satisfaction by optimizing the quality and efficiency of services delivered (Hsu & Lin, 2023). Furthermore, AI has demonstrated valuable contributions in affective domains, offering functions such as counselling, human behaviour, and emotional assistance (Huang & Rust, 2024; Song & Wu, 2021; Lemken et al., 2024; Xu et al., 2024). As a data- and goal-driven technology, AI is considered one of the most effective tools available today (Paschen et al., 2019). Nonetheless, its mechanistic nature can occasionally raise concerns about trust and reliability (Dwivedi et al., 2019). Despite this, research consistently highlights AI's unparalleled speed and accuracy in performing complex tasks (Gartner, 2020).

AI is bringing transformative changes to education through knowing students need, gaps, resource requirements etc (Popenici & Kerr, 2017; Wang & Jiang, 2025; Kasneci et al., 2023; Chen et al., 2020; Holmes et al., 2019; Hwang et al., 2020; Ouyang & Jiao, 2021). In science and technology as well as in innovation, AI has transformed the personalised learning landscape (Chen & Lin, 2020, Pratama et al., 2023; Atanasova, 2024) by designing the perfect curricula, a structured and robust evaluation system, and a lucid delivery system (George & Wooden, 2023; Kothari & Verma, 2022). In many learning management systems(LMS), the AI robots and nuggets are now inbuilt (Costa et al., 2017) to facilitate visualisation (Calvo et al., 2011), group discussion (Chen & Tsao, 2021), proctor examinations (Kong et al., 2009), conducting online examination (Tasci et al., 2014), and class room settings (Chiu & Tseng, 2021). Identification of the learning gaps and helping to fill up the gaps is another important dimension of AI (Liu et al., 2017). It can also generate the responses and suggestions of the students on various educational strategies (Hooshyar et al., 2015). This study is grounded in the theoretical framework of Constructivism (Driver, 1983; Fensham et al., 1994; Elliott et al., 2000), a paradigm that has been widely acknowledged for its educational relevance and empirical validity (Splitter, 2009). Constructivist theory asserts that learners play an active role in shaping their understanding, engaging directly in the decision-making processes inherent to their educational experiences. Through this lens, knowledge is not passively received but rather constructed by students as they develop individualized cognitive frameworks or mental schemas (Petraglia, 1998). In the context of this research, we examine how the integration of artificial intelligence (AI) influences student performance, interpreting the outcomes through a constructivist perspective. The following section presents an extensive review of the literature to inform the development of our hypotheses. Section three outlines the methodological approach adopted in this investigation, followed by an in-depth presentation of the results in section four. Finally, section five offers a discussion of the findings and concludes the study.

LITERATURE REVIEW

Education require imparting teaching and learning with precision which can be accomplished by AI (Lin & Lai, 2021). It was argued by many studies that AI has the ability to augment the pedagogical and instructional potential (Wang et al., 2011; Zampirolli et al., 2021). It was also observed that AI has improved the performance of students (Wang, 2014), it also increases the interest of students (Liu et al., 2022), and it has improved their concentration (Rong et al., 2022).

AI and students' cognitive constructivist learning

Constructivist theory posits that learning is fundamentally a cognitive activity occurring within the learner's mind, wherein students actively construct internal conceptual frameworks by interpreting their experiences and engaging with the surrounding reality (Piaget, 1977; Driscoll, 2000). This process is driven by an innate sense of curiosity, which acts as a catalyst for learners to form their own perceptual and conceptual understandings (Jonassen, 1994). Within this paradigm, educators are responsible for identifying and building upon students' pre-existing knowledge structures, tailoring instruction to facilitate meaningful and personalized learning experiences (Oliver, 2000). In recent years, a growing body of research has examined the role of Artificial Intelligence in Education (AIED), exploring its accuracy and effectiveness in enhancing cognitive learning processes (Chen et al., 2020; Duong et al., 2019). In this theoretical background we propose that:

***H1:** AI helps in students' cognitive constructivist learning process*

AI and students' social constructivist learning

Social constructivism believes that learners relate learning to social situations and events (Vygotsky, 1986; Routh, 2000). AI has played a significant role (Xu et al., 2021) in the adaptive AI tutors (Kose & Arslan, 2017) to accommodate between teaching and learning as well as the adoption process of the students (Ayeni et al., 2024). AI helps to customize the educational performance of students' progress trends,

learning outcomes (Tan, 2023). Culture and context have a significant in the social constructivism process of the learner (Derry, 1999).

h2: AI helps in students' social constructivist learning process

AI and students' radical constructivist learning

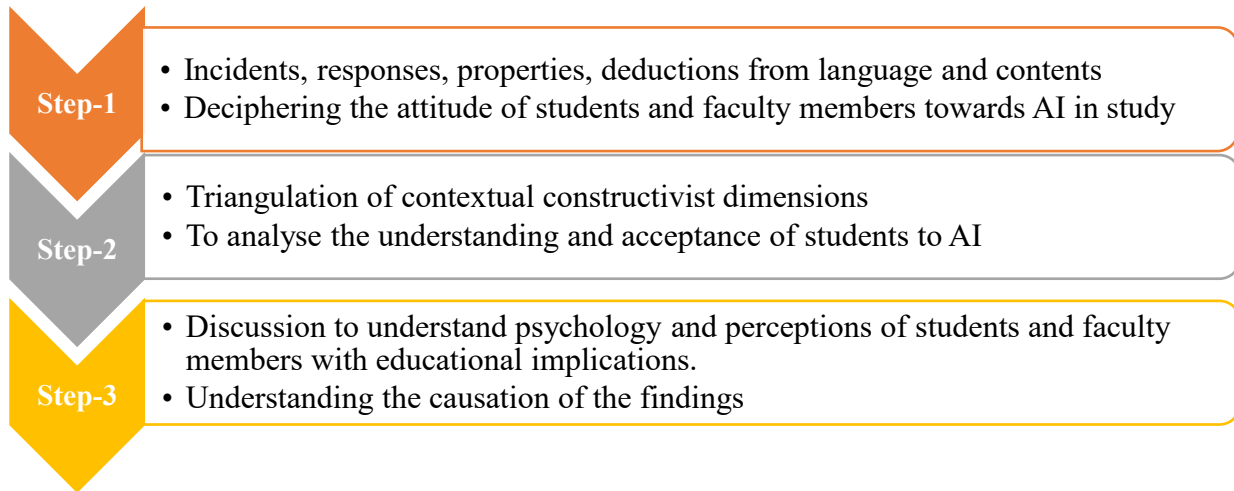
It emphasizes that students learn and form their own way of interpretation of their world through an active experiential learning process (Bereiter, 1994). AIED helps in delivery of teaching and learning (Nwana, 1990), as a learning companion (Chou et al., 2003), and detecting the learning styles of the students (Garcia et al., 2007). It was suggested that AI provide more effective and engaging learning environment and experience to the learners (Wang et al., 2024). It provided an enriched learning experience with value addition to the educator through feedback and designing new learning strategies (Zhai et al., 2021). Moreover, it enhanced the learning experiences significantly (Bicknell et al., 2023). These reviews made us to draw the following hypotheses:

h3: AI helps in students' radical constructivist learning process

RESEARCH METHOD

This study employed both qualitative research (denzin et al., 2011), and contextual triangulations of all the constructivist dimensions on the impact of AI on the performance of college students from twelve different colleges. In the first case, the collection of data is mostly in the form of collections of qualitative data through a semi-structured questionnaire from students. We have employed the qualitative methodology as for the changing dynamic nature of evolving teaching and learning process the interpretative research is the most suitable method. It allowed comprehensive exploration of the conditions of respondents, and provided an in-depth analysis of the situations, emotions other subjective dimensions (Maitlis, 2005). It helped us to restructure and refine the existing theory in a proper manner (Whetten, 1989). The qualitative studies were conducted for 21 students and 12 faculty members through a semi-structured questionnaire that lasted for an average 45 minutes for each participant. The questionnaires were in English language as students were either in graduation or post-graduation. They were given a free, relaxed environment to answer the questions without any compulsions or pressures. The answers were written and coded during the interview itself by preparation of notes and brief write-ups, in the second step these codes were decoded and thematic categories were prepared according to various themes, these are said to be the first-order codes, in the third step broad theoretical categories were formed by combining various thematic categories, in the fourth step generalized categories as aggregate theoretical categories that were formed to generate theory. The data deduction was done through an inductive and iterative process in a constant comparative method (Fendt and Sach, 2008; Lincoln, 2019). The students were from different classes of six different colleges, and between the age group of 18-23 years. The average age of the student participants was 20 years. The age of faculty members is from 32 years to 54 years and the average age faculty members was 38 years for both the cases. This study was approved by the Institutional Review Board (IRB). In the second case, the contextual triangulations were made by analysis of different constructivist dimensions of teaching-learning on the AI interface.

FIGURE 1
SCHEMA OF RESEARCH



Data Analysis

In search for the effectiveness of AI in the process of teaching learning we employed the constant comparative method (Glaser & Strauss, 2021). The data were analyzed in an iterative manner by constant comparison between the transcription and the categorization simultaneously (Ladge et al., 2012; Pratt et al., 2006). We have followed the all the four steps of comparing incidents, integrating the categories, delimiting theory and writing the theory as per the sequence of qualitative approach as prescribed by earlier studies (Glaser & Strauss, 2021). This method was found to be the most effective method as we generated theory by collecting data from qualitative interviews, interpretation, and analysis. The first step of analysis included creation of categories and first-order codes; the second step was integrating first-order codes and creating theoretical categories and the third step was to delimited the theory by aggregating the theoretical dimensions, in the fourth step the theory was written. We have taken care to interpret the emotions and sentiments through narratives which was conveyed through the interviews. In case of any differences in opinion, we resolved it through mutual discussion, logical solution, proper analysis, and depicting past literatures.

FINDINGS

Qualitative Analysis

We employed the qualitative method as prescribed by Denzin et al. (2011). The qualitative research also followed the qualitative research guidelines (Tong et al., 2007; Wu et al., 2016).

In the responses R = Student Respondents, F= Faculty

Presupposition 1. AI helps in students’ cognitive constructivist learning process

In this study, we depicted how the learners were actively involved in the process of developing their knowledge and understanding through AI. We have divided the cognitive constructivist learning process into four different groups 1. Assimilation, 2. Accommodation, 3. Equilibration, 4. Information Processing.

Assimilation

In the interviews of the students and the faculty members, we study how they were able to incorporate the fresh information in the existing schema in the mediation of the AI. It was to the question whether AI

aligned or disrupt your prior understandings of subjects there were mixed responses received from the students

[...] I was comfortable with the traditional way of teaching, where teachers were more involved, and it was more interesting also as stated by one of the respondents (R3: Male).

While, there were also positive responses to this questions given by the students

[...] I think AI should be made mandatory for all the classes at least from sixth class as it was giving a wide range of ideas for the students to approach a question. (R6: Male)

When asked the faculty members about whether AI-driven educational technologies reinforces or challenges students' existing cognitive structures majority of them responded positively

We found that the classes were more interactive and informative in this process. It also made the student understand the earlier concepts better [...] as responded by a senior faculty member (F5: Female).

Accommodation

In this case we have tried to analyse that how the students and faculty members have tried to modify their existing mental schema in accordance to the new information. The change in their thinking and behavioural process. When we asked the students whether they can describe a moment when an AI-based learning tools led them to restructure their understanding of the concept they previously thought they have understood, the responses were mostly encouraging in nature, one respondent told

We have very narrow opinions on some concepts of organisational behaviour which got a major change by learning through AI [...], the combinations of faculty teaching in the classrooms along with AI tools is required for better understanding of the concepts. (R4: Female)

Similarly, the responses of the faculty members to “How do you design AI-enhanced learning experiences to intentionally provoke conceptual change and support students in accommodating new, complex ideas?” were found to be thought-provoking

I used to incorporate these AI tools in my lesson plans from the beginning, so that it would be more impactful [...], these tools can be used intermittently in between the classrooms’ teaching-learning process (F4: Male)

Equilibration

We analysed how the students relied on past experiences to align the new experiences in it through the process of equilibrium in cognitive constructivism from the responses of the question whether the AI-powered educational tools helped them maintain a balance or confusion between their prior knowledge and new information. One of the students responded that

It was really difficult in our part to align prior knowledge to the fresh information particularly in case of complex subjects, mathematical subjects and difficult concepts, where we required someone to make us understand what was happening. (R23: Male)

When asked to the faculty members that in their experience, do AI-driven learning platforms support or destabilise students in achieving cognitive equilibrium majority of the responses from the faculty members were in its favour

[...] I believe that AI as a helping tool is great as I can improvise my level of teaching with its help but at the same time I think AI can never replace the educator. As stated by another senior faculty member. (T12: Male)

Information Processing

It was observed that the respondents felt the stimuli, analysed, and interpreted those stimuli based on prior experiences, goals, and knowledge. As one respondent told that

[...] I could very well relate those experimentations through AI as it has provided the feel effect more effectively. (R.14: Female)

The comprehensive analysis depicted that there was a significant impact of AI on the students’ cognitive constructivist learning process. Students relied on experience and information processing through AI-powered educational tools.

TABLE 1
AI HELPS IN STUDENTS' COGNITIVE CONSTRUCTIVIST LEARNING PROCESS

Statements (Initial Coding)	Theoretical Categories (Intermediate Coding)	Aggregate- Theoretical Dimensions (Advance Coding)
Whether AI aligned or disrupt your prier understandings of subjects? (for students)	Assimilation	Cognitive Constructivism
Do AI-driven educational technologies reinforce or challenge students' existing cognitive structures? (for faculty)		
Can you describe a moment when an AI-based learning tool led you to restructure your understanding of a concept you previously thought you understood? (for students)	Accommodation	
How do you design AI-enhanced learning experiences to intentionally provoke conceptual change and support students in accommodating new, complex ideas? (for faculty)		
Have AI-powered educational tools helped you maintain a balance or confusion between your prior knowledge and new information? (for students)	Equilibration	
In your experience, do AI-driven learning platforms support or destabilise students in achieving cognitive equilibrium? (for faculty)		
Do AI-based learning systems help you process and organize complex information more effectively or burdened you with data? (for students)	Information Processing	
How do you evaluate whether AI tools in your teaching environment are enhancing students' information processing capabilities without leading to cognitive overload? (for faculty)		

Presupposition 2. AI Helps in Students' Social Constructivist Learning Process

AI helped students learning in a socially mediated environment. It facilitated social learning by providing a socially interactive learning environment. It considers the influences of the socio-cultural interventions in the active learning of students. Social constructivism dimensions can be categorised into 1. Social interaction and collaboration, 2. Cultural and contextual embeddedness, 3. Active constructive learning.

Social Interaction and Collaboration

Students as well as professors responded positively to this aspect. AI facilitate group discussions, team work, and dialogues.

[...] we have many fruitful group-discussion classes with effective feedbacks and recommendations from AI. (F.15: Male)

The effectiveness of the result was seen from the responses of the students as they were happy and very enthusiastic on their responses.

We have less load and the classes also very interesting [...] as described by the another professor. (R.21: Female)

Cultural and Contextual Embeddedness

We came across the interface (AI) and interaction through our cultural events. It made that event more entraining [...] described by another student. (R.24. Male)

It was observed that embedding AI in festive occasions, cultural fests, and other events makes those events more entertaining for students. It was also a learning experience for many as they first encountered this kind of interaction.

As told by one of the young professor: Students learn more through activities and interventions rather than classroom teachings [...] and AI is an effective helping tool for these types of activities. (F.11: Male).

Active Constructive Learning

The process of active learning is augmented extraordinarily by the introduction of AI, as stated by the students and professors.

[...] Instead of only giving the lectures, I used to make small groups of the students for interactions through an AI environment, and found it very helpful for them as explained by one professor. (R.1: Male)

It was also observed from the responses of the students that AI was effective in providing a constructive learning environment, as narrated by Akhil, a final year student

[...] The last year was most effective for our study as in personal front I have developed my communication by the help of AI enabled training by the faculty members, and the career development centre (R.13: Male).

TABLE 2
AI HELPS IN STUDENTS' SOCIAL CONSTRUCTIVIST LEARNING PROCESS

Statements (Initial Coding)	Theoretical Categories (Intermediate Coding)	Aggregate- Theoretical Dimensions (Advance Coding)
How do AI-based learning platforms incorporate cultural tools that reflect your background and help you engage more meaningfully with the content? (for students)	Through Cultural and Contextual Embeddedness	Social Constructivism
To what extent do you find that AI educational tools integrate culturally relevant resources or practices that support diverse learners in constructing shared understanding? (for faculty)		
In what ways have AI-powered platforms facilitated or limited your ability to collaborate, communicate, and learn with peers or instructors? (for students)	Through Social Interaction and Collaboration	
How effectively do AI systems in your teaching environment support meaningful social interactions among students, and how do you address any gaps in collaborative learning? (for students)		
How do AI-powered learning platforms shape the way you express your ideas and engage in academic discussions with peers and instructors?	Through Active Constructive Learning	
In what ways do AI tools influence the types of discourse students engage in, and how do you ensure that these tools promote inclusive and critical dialogue?		

Presupposition 3. AI Helps in Students' Radical Constructivist Learning Process

In this type of learning process students actively involved in constructing their learning through experimentation, activities etc. It can be 1. Active Construction of Knowledge, 2. Active Problem-Solving, 3. Contextualisation.

Active Construction of Knowledge

In this process students in the class actively involved through a process of learning by doing as stated by one student

[...] I remembered we explored the people, planet, and profit concept and its impacts on the company through AI intervention by constructing a live model. It was very interesting. (R. 20: Male).

Active Problem-Solving

We solve the mathematical problems more effectively with the help of AI, and its explanations are also easily understandable (R. 18: Female).

It was found that students developed problem-solving skills by applying AI in their learning process. They found it interesting as well as very easily available source of assistance for them.

Contextualisation

[...] We understand the customer involvement and engagement process through online gamification process in AI assisted interface which we can never forget, as told by another student about his marketing class (R.4: Male).

Students learn through simulation of online games in AI platform enjoy the real life marketplace scenario. Students can take real-time decisions in this learning process assisted by the AI.

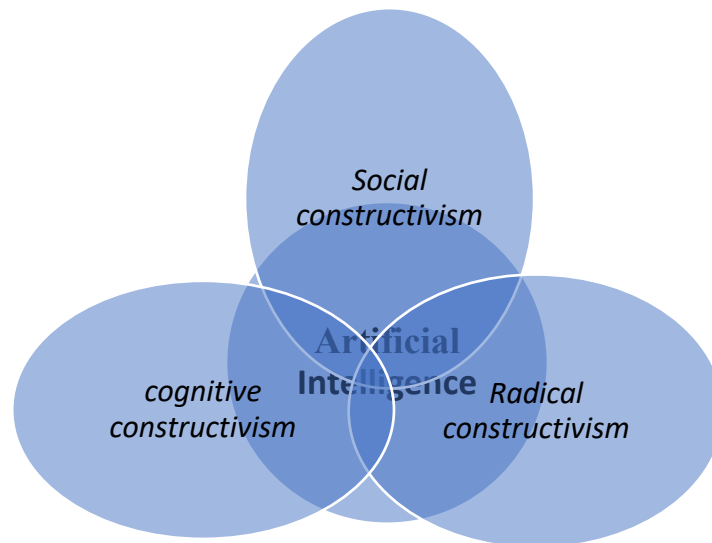
TABLE 3
AI HELPS IN STUDENTS' RADICAL CONSTRUCTIVIST LEARNING PROCESS

Statements (Initial Coding)	Theoretical Categories (Intermediate Coding)	Aggregate- Theoretical Dimensions (Advance Coding)
How have your personal experiences with AI-based learning environments shaped your unique understanding of the subject matter, regardless of traditional or standardized interpretations? (for students)	Active Construction of Knowledge	Radical Constructivism
To what extent do you believe AI tools allow students to construct knowledge based on their own experiences, and how do you accommodate diverse interpretations in your teaching practice? (for faculty)		
How do AI learning tools support you in reflecting on your personal learning journey, including how your understanding evolves over time? (for students)	Contextualisation	
In what ways do you use AI technologies to encourage students' critical reflection on their thinking processes and how they construct their own knowledge? (for faculty)		
How do AI-based tools help you focus on the process of learning such as exploring, experimenting, and revising		

ideas through self-problem solving rather than just the final outcomes? (for students)	Active Problem-Solving	
How do you leverage AI technologies to emphasize students' learning processes over correct answers or fixed content, in line with constructivist pedagogical goals through live problem solving? (for faculty)		

Contextual Triangulations of Constructivism Dimensions of Learning in an AI Interface

FIGURE 2
CONTEXTUAL TRIANGULATION: AN AI INTEGRATED FRAMEWORK



The contextual triangulation illustrates the intentional orchestration of three interdependent paradigms within the architecture of an AI-mediated interface, wherein each dimension both sustains and enriches the functionality of the others. The **cognitive dimension** foregrounds the interface’s capacity to scaffold the internal construction of learners’ schemas through individualized activities, adaptive feedback, and responsive prompting mechanisms. The **social dimension** reflected the interface’s affordances for fostering dialogic engagement, negotiation, and collaborative knowledge-building, not only among human interlocutors but also in interactions mediated through AI agents. Finally, the **radical dimension** emphasizes the interface’s recognition of learners’ idiosyncratic processes of meaning-making, thereby enabling the personalization of learning trajectories, accommodating learner-generated pathways, and affirming the coherence of individualized understandings.

Operationalizing the Triangulated Model in AI Learning Interfaces

Intelligent Tutoring Systems (ITS)

ITS often incorporates a **cognitive model** that emulates expert problem-solving strategies and monitors learner progression, offering context-sensitive feedback (model tracing, knowledge tracing. Embedding **social dimensions** for instance, through peer-review mechanisms or collaborative dialogue systems can enable negotiation of meaning and scaffolding within the interface. Assimilating **radical constructivist principles**, interfaces can foreground learner-driven exploration, permitting multiple solution paths and affirming personal conceptual constructs not just correct answers.

Hybrid AI Architectures

Hybrid AI approaches, such as retrieval-augmented generation (RAG), combine symbolic accuracy with generative flexibility. These systems offer grounded, reliable content while allowing adaptivity and contextual nuance. Such architectures support cognitive alignment through accuracy, social scaffolding via contextual dialogue, and radical constructivist validation by affording user-shaped meaning-making in open-ended tasks.

TABLE 4
CONSTRUCTIVIST TRIANGULATION IN AI INTERFACE WITH
EDUCATIONAL IMPLICATIONS

Constructivist Dimension	AI Interface Features	Educational Implication
Cognitive	Personalization, error diagnostics, scaffolds.	Promotes internal schema refinement and structured growth
Social	Chatbots, peer forums, collaborative modeling	Fosters co-construction, debate, and shared meaning
Radical	Open-ended tasks, learner paths, personalized goals	Validates individual constructions and encourages autonomy

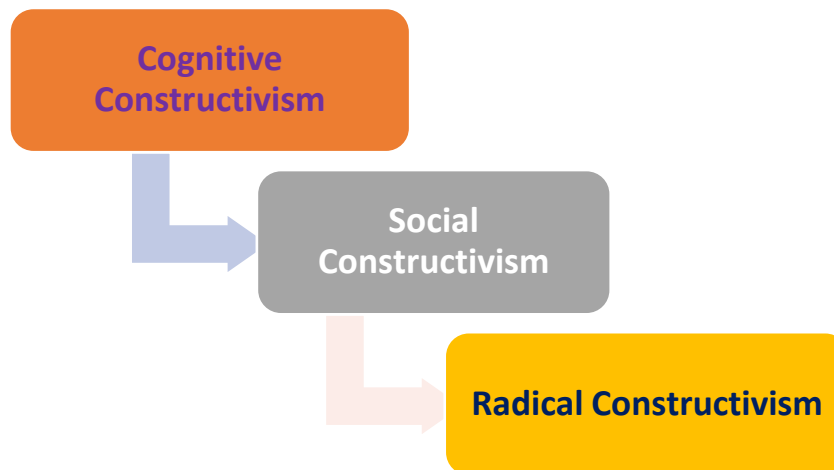
Toward Contextually Triangulated AI Interfaces

An AI interface that thoughtfully weaves cognitive, social, and radical constructivist strands can transcend singular pedagogical paradigms. It can offer nuanced, learner-centered experiences that are scaffolded yet exploratory, socially enriched yet autonomy-supportive, and epistemologically aware yet personalized. Future research must empirically test such triangulated designs examining learner engagement, conceptual development, and adaptability across diverse educational contexts. This triangulated constructivism model aligns pedagogical theory with AI capabilities, and invites interdisciplinary study from interface design to educational psychology and epistemology.

DISCUSSION

Constructivism posits active involvement of learners in the learning processes, where an environment was provided to encourage a discovery mode of assimilation and accommodation of knowledge through subjective representation and comprehension of reality (Fosnot, 2013). Cognitive cognitivism involves large number of problem-solving, situated learning (Ertmer & Newby, 1993). Radical constructivism involves concrete experience, observation and reflection, and abstract conceptualization to testing concepts in new situations where the faculties acted as facilitators (Kolb & Kolb, 2012). There was a significant impact of technology in the constructivist educational paradigm (Siemens, 2014).

FIGURE 3
CONSTRUCTIVIST PROCESS FLOW IN AI-BASED PEDAGOGY



The study provided a comprehensive qualitative analysis of the impact of the implementation of different dimensions of constructivism in teaching and learning through analysing the responses of the students and faculty members. In case of cognitive constructivism, the theoretical consequence is that instructional design increasingly becomes a matter of designing adaptive “models of the learner,” where AI actively infers conceptual gaps and provides targeted interventions. Practically, this translates into systems that prompt learners to articulate hypotheses, reflect on misconceptions, and reorganize their understanding, thereby fostering deeper conceptual change rather than superficial performance gains. In social constructivism, implications are that human AI interaction is no longer unidirectional but dialogic, where knowledge emerges through co-construction. In practical terms, this calls for interface designs that explicitly embed social dynamics, assigning roles such as explainer, skeptic, or summarizer, while regulating the rhythm of collaborative inquiry to maintain productive tension between guidance and autonomy. Moreover, in radical constructivism, AI systems are not merely neutral conduits but participants that shape and are shaped by the epistemic norms of their users. For design, this entails developing interfaces that monitor emerging group conventions, visualize epistemic drift, and provide mechanisms for norm steering.

CONCLUSION

The present study explored the transition of AI-based learning of students from sensory inputs into phenomenological rich perceptions, imbued with emotional attributes (Dalglish, 2004). These qualitative dimensions were though, discussed in earlier studies (Rached & Perkusich, 2013), but needed to be explained by triangulating inside the AI interface. We observed that students actively involved in the process of knowledge construction through experiences in line with earlier studies (Guo et al., 2024). We also found the development of the students through stages (Grubaugh et al., 2023) through a process of active learning. The study elucidated that there was a significant impact of social and cultural interventions in the process of student development and growth (Vygotsky & Cole, 2018; Palincsar, 2012). Radical constructivism demonstrated the experiential reality can be constructed by making learning as an actively constructive activity where students learn through experience, modelling, and involvement. The study also explored that professors, and educators are also equally positive towards the effectiveness of AI-based constructivist learning. The triangulation reflected the common interface among the three overlapping constructivist dimensions in an AI paradigm. The evolving educational environment petition for an inclusive system with a level playing field for all dimensions for the holistic education of the students. The changing demand of industry for skilful employees will call for radical constructivist approach, the need

for team effort, team building, coordination, requires social constructivist approach, the requirement for knowledge construction through experiences made the student knowledge creators through cognitive constructivist approach and AI provided an inclusive platform for all these approaches for the holistic development of the students. The study has the inherent limitations of qualitative research and difficult to explain empirically. The sample space required to be comparatively high for generalising the findings. Quantitative and mixed-method research in the future can validate the findings. The future work can be done in other domains like industrial sector, agricultural sector, service sector, and the impact of AI. The future of AI in education and knowledge work lies in systems that scaffold, orchestrate, and co-evolve rather than instruct in a top-down fashion. What remains urgent is the development of robust methods to capture and measure constructivist processes tracking when conceptual reorganization occurs, when learners are moved effectively through their developmental zone, and when AI-mediated groups fall into unhealthy uniformity. Such directions point to a future in which constructivism functions not merely as a philosophical orientation but as a design principle for human AI interfaces, guiding the creation of systems that foster reflection, collaboration, and responsible co-construction of knowledge.

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