Journal of Education and Learning Technology (JELT)
ISSN 2720-7730
Volume 6 Issue 12 2025 pp 1538 – 1554
Available online at: https://noyam.org/journals/jelt/
DOI: https://doi.org/10.38159/jelt.202561223

# Exploring AI Tools to Enhance Constructivist Pedagogy in 'Introduction to Classroom Research' Module

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## ABSTRACT

Higher Education Institutions are increasingly embracing Artificial Intelligence (AI) as they strive for innovative methods to enhance student engagement, facilitate deeper learning, and overcome ongoing learning challenges. Constructivist approaches that underscore self-directed learning and co-creation of knowledge are being re-envisioned through the integration of AI tools. Given this backdrop, the module 'Introduction to Classroom Research' (ICR) offers opportunities to investigate how AI can enhance understanding of intricate research concepts. However, understanding these concepts continues to be a challenge for students, resulting in underachievement in ICR. This challenge is exacerbated by lecturers' limited use of IA tools despite their availability. This theoretical study examines the integration of AI in the teaching of ICR for final year student-teachers. The study seeks to identify and explore AI tools that can be integrated into the teaching of ICR in constructivist classrooms, through a systematic literature review (SLR). This methodology entailed a thorough search, careful selection, and thematic analysis of academic literature in the last decade. This study was underpinned by Technological Pedagogical and Content Knowledge (TPACK), which emphasizes how technology can be incorporated to harness pedagogical activities as well as content knowledge to enhance academic achievement. Findings from literature revealed that AI tools such as ChatGPT, Google *Gemini and NotebookLM* can be strategically integrated to sustain constructivist environments that promote critical thinking, self-directed learning, and problem-solving. The study presents practical AI integration approaches to foster students' understanding of complex ICR concepts and recommends customized training for ICR lecturers to incorporate AI in their teaching.

*Keywords: Constructivist pedagogy, Artificial Intelligence tools, Introduction to Classroom Research.*

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**Publication History**
Received:
31st May, 2025
Accepted:
12th November, 2025.
Published:
30th December, 2025.

**To Cite this Article:**
Letuka, Mokete. "Exploring AI Tools to Enhance Constructivist Pedagogy in 'Introduction to Classroom Research' Module." *Journal of Education and Learning Technology* 6, no. 12 (2025): 1538 - 1554. https://doi.org/10.38159/jelt.202561223

## INTRODUCTION

Lecturers involved in the teaching of 'Introduction to Classroom Research (ICR)' at the Central University of Technology do not integrate Artificial Intelligence (AI) tools in their teaching methodologies. Studies have been carried out on the integration of Artificial Intelligence in higher education to enhance teaching and learning. This study seeks to explore potential AI tools that lecturers can integrate into AI-supported teaching of the module ICR, as well as potential challenges and opportunities thereof. Research has been conducted

on the impact of Artificial Intelligence on education in recent years; however, there has not been much investigation to identify the potential AI tools that lecturers can integrate inside and outside of their lecture halls while maintaining a constructivist learning environment, particularly for an undergraduate research-based module. General generative AI will not be discussed in this study, but specifically, only potential AI tools that may be integrated into the constructivist teaching and learning of ICR.

O'Connor conducted a study on the challenges raised by constructivist teaching and learning in higher education and reported that from a constructivist point of view, students learn more effectively by doing, rather than just listening and observing, which poses a challenge for lecturers whose background is that of teacher-centeredness.[1] In a constructivist classroom, students are engaged with the learning material, and they interact amongst themselves as well as with the lecturer. They are not passive recipients of knowledge or learning content but are involved in the construction of knowledge. A study on constructivism as a theory of knowledge done by Bodner revealed that one of the assumptions of constructivist teaching is that there is a transition from someone who teaches to someone who facilitates or mediates learning.[2] This argument assumes that those who teach in constructivist environments must not be mere transmitters of knowledge but must rather involve and engage students in the teaching and learning process to guide them into constructing their own knowledge.

According to a study by Mishra on the constructivist approach to learning, lecturers who promote constructivist learning environments strive to provide scaffolding that is characterized by problem-solving, critical thinking, and collaborative learning on the part of the student.[3] In addition, Almulla conducted a study about a paradigm for students' critical thinking, creativity, and problem-solving to foster academic achievement in education, and asserts that students' ability to think critically and creatively harnesses their problem-solving skills and enhances academic achievement.[4] This study focuses on the identification and exploration of AI tools that may potentially be integrated in the teaching and learning of the module ICR, which promote or foster constructivist teaching and learning. Guo, Yi, and Liu conducted a study that examined how constructivist learning may be enhanced with the aid of generative AI to create personalized learning experiences, and found that engagement, creativity and problem-solving can be fostered with AI-generated content.[5] This study hopes to identify and explore AI tools that will help lecturers employ more interactive teaching and learning activities that help students construct knowledge through meaningful learning experiences.

The integration of AI in education has become a buzzing phenomenon and topic among academics due to its capability to enhance teaching strategies for lecturers to improve learning outcomes.[6] Chen et.al., in their study on two decades of artificial intelligence in education, explain that AI has grown extremely important within the higher education fraternity due to its capability to support and enhance teaching and learning through, for example, intelligent tutors for content transmission, feedback development, and progress monitoring.[7] It is thus very important to explore and leverage some useful AI tools that lecturers can employ in their teaching of the module ICR. Additionally, Chen, Chen, and Lin, in their research on the

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[1] Kate O'Connor, "Constructivism, Curriculum and the Knowledge Question: Tensions and Challenges for Higher Education," *Studies in Higher Education* 47, no. 2 (February 1, 2022): 412–22, https://doi.org/10.1080/03075079.2020.1750585.

[2] George M. Bodner, "Constructivism: A Theory of Knowledge," *Journal of Chemical Education* 63, no. 10 (October 1, 1986): 873, https://doi.org/10.1021/ed063p873.

[3] Nirmal Raj Mishra, "Constructivist Approach to Learning: An Analysis of Pedagogical Models of Social Constructivist Learning Theory," *Journal of Research and Development* 6, no. 01 (June 6, 2023): 22–29, https://doi.org/10.3126/jrdn.v6i01.55227.

[4] Mohammed Abdullatif Almulla, "Constructivism Learning Theory: A Paradigm for Students' Critical Thinking, Creativity, and Problem Solving to Affect Academic Performance in Higher Education," *Cogent Education* 10, no. 1 (December 31, 2023), https://doi.org/10.1080/2331186X.2023.2172929.

[5] Hua Guo, Weiqian Yi, and Kecheng Liu, "Enhancing Constructivist Learning: The Role of Generative AI in Personalised Learning Experiences," in *Proceedings of the 26th International Conference on Enterprise Information Systems* (SCITEPRESS-Science and Technology Publications, 2024), 767–70.

[6] Francesc Pedro et al., "Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development," 2019.

[7] Xieling Chen et al., "Two Decades of Artificial Intelligence in Education," *Educational Technology & Society* 25, no. 1 (2022): 28–47.

integration of AI in education, opine that the introduction of AI and the strides it has made in the higher education sector have made it easier for educators to carry out their duties in more effective and efficient ways through its capabilities to perform human-like tasks.[8]

Research has been conducted on the integration of AI in higher education, as well as on teaching and learning that promotes and fosters constructivism. For example, Almulla conducted a study on the constructivist theory that explored how creativity and critical thinking enhanced academic performance in higher education.[9] In addition, Kurtz et.al. investigated strategies to integrate generative AI in higher education and explored how AI tools such as *ChatGPT* and *Bing Copilot* can enhance teaching and learning.[10] Moreover, Guo et al. explored the role of generative AI in enhancing constructivist learning and found that AI can be used to help students construct knowledge through active engagement and involvement, which characterize constructivist learning environments.[11]

Despite these interventions, ICR lecturers still do not leverage AI tools to enhance teaching and learning that fosters better academic performance for students. Much research has been conducted on constructivist teaching and learning, as well as on the integration of AI in higher education. However, limited research has been done on specific AI tools that can be integrated in the classroom in a manner that promotes constructivist learning. For this reason, this study seeks to identify and explore AI tools that can be integrated in higher education, and how these tools may be used to promote constructivist teaching and learning of the module ICR. Ultimately, this study aims to provide actionable insights and recommendations for Higher Education Institutions (HEIs) to support lecturers in leveraging AI to transform their teaching methodologies to enhance student learning in the module ICR.

This study seeks to identify and explore AI tools that HEIs lecturers may integrate to enhance constructivist teaching and learning of the module ICR. Emanating from the statement of the problem in this study are the following research questions:

I. What type of AI tools are currently being used by lecturers globally to harness and enhance teaching and learning, as well as assessment and feedback?
II. In what ways can AI tools be integrated to enhance student engagement, interaction, collaboration, personalized learning, assessment and feedback within ICR?

This study, therefore, seeks

I. To identify and explore AI tools that are used by lecturers globally to harness and enhance teaching and learning.
II. To investigate ways in which AI tools can be integrated to enhance student engagement, interaction, collaboration, and personalized learning within ICR.

## THEORETICAL FRAMEWORK

This study was underpinned by Technological Pedagogical Content Knowledge (TPACK), which, according to Koehler and Mishra, comprises three knowledge domains for educators, namely Content, Pedagogy, and Technology, all of which competent teachers should possess and be able to integrate to enhance teaching and learning.[12] TPACK, in this study, helps to examine ways through which lecturers may integrate AI by

[8] Lijia Chen, Pingping Chen, and Zhijian Lin, "Artificial Intelligence in Education: A Review," *IEEE Access* 8 (2020): 75264–78.
[9] Almulla, "Constructivism Learning Theory: A Paradigm for Students' Critical Thinking, Creativity, and Problem Solving to Affect Academic Performance in Higher Education."
[10] Gila Kurtz et al., "Strategies for Integrating Generative AI into Higher Education: Navigating Challenges and Leveraging Opportunities," *Education Sciences* 14, no. 5 (May 7, 2024): 503, https://doi.org/10.3390/educsci14050503.
[11] Guo, Yi, and Liu, "Enhancing Constructivist Learning: The Role of Generative AI in Personalised Learning Experiences."
[12] Matthew J. Koehler and Punya Mishra, "What Happens When Teachers Design Educational Technology? The Development of Technological Pedagogical Content Knowledge," *Journal of Educational Computing Research* 32, no. 2 (March 1, 2005): 131–52, https://doi.org/10.2190/0EW7-01WB-BKHL-QDYV.

equilibrating technology, pedagogy and content knowledge. It provides an understanding of how AI tools can be synchronized with constructivist teaching and learning strategies. This theory best frames this study because it helps explore how ICR lecturers may align AI tools as a form of technology with their pedagogical approaches and module content to enhance students' understanding of the research process and concepts.

## METHODOLOGY

This study employed a systematic literature review (SLR) methodology to identify and explore effective integration of AI tools into the teaching methodologies of the module ICR. This research methodology entailed a thorough search, careful selection, and analysis of academic literature in the last decade. Cooper et al. reveal that a systematic literature search involves a rigorous search for articles and aims to provide a transparent description of how the relevant articles were identified, as well as how the findings of the review are located.[13] Snyder adds that a systematic literature review can be described as a research method or process used to pinpoint and evaluate relevant scholarly studies, and for collecting and analysing data from the research that meets specific inclusion criteria.[14] This assertion is corroborated by Mengist et.al., who are of the opinion that an SLR is a process through which relevant data which fits pre-determined criteria on a set topic is collected with the aim of answering the research questions.[15]

The systematic search was conducted with the use of keywords such as 'AI in education,' 'AI tools for teaching,' 'AI-supported teaching and learning,' and 'AI tools for constructivist teaching,' on academic databases such as Google Scholar, Web of Science, and Scopus. The criteria for the search focused on articles that examined the integration of AI tools to bolster teaching and learning in higher education, with much emphasis on tools that promote constructivist learning environments characterised by active student engagement, collaboration, and interaction. Cabrera and Cabrera recommend that the SLR researcher pay attention to the title of the article, read the abstract as well as the full text to determine if the article meets the selection criteria. According to Rouhani et.al., research articles must be studied rigorously, abstracts of all the papers must be read thoroughly, and those that closely relate to the research questions must be kept for further examination, while those that relate less must be eliminated.[16] The selected articles were meticulously analysed through understanding the title, reading the abstracts, and the full text, to recognize and extract key themes and best practices pertaining to the integration of AI tools in the constructivist teaching of ICR.

Inclusion and exclusion criteria were incorporated to ascertain rigor, transparency, and relevance of the selected studies. The inclusion criteria consisted of the following:

1. Publication period (Articles published between 2020 and 2025 to get the most recent advancements in the integration of AI within constructivist learning environments)
2. Contextual emphasis (Articles that focussed on the constructivist integration of AI in Higher Education pedagogy)
3. Relevance (Articles that explored pedagogical strategies in AI-enhanced constructivist environments)
4. Publication type (Peer-reviewed journal articles)

In contrast, exclusion criteria were established to eliminate articles that did not match the objectives of this study. These comprised:

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[13] Chris Cooper et al., "Defining the Process to Literature Searching in Systematic Reviews: A Literature Review of Guidance and Supporting Studies," *BMC Medical Research Methodology* 18, no. 1 (December 14, 2018): 85, https://doi.org/10.1186/s12874-018-0545-3.

[14] Hannah Snyder, "Literature Review as a Research Methodology: An Overview and Guidelines," *Journal of Business Research* 104 (2019): 333–39.

[15] Wondimagegn Mengist, Teshome Soromessa, and Gudina Legese, "Method for Conducting Systematic Literature Review and Meta-Analysis for Environmental Science Research," *MethodsX* 7 (2020): 100777, https://doi.org/10.1016/j.mex.2019.100777.

[16] Saeed Rouhani et al., "Text Analytics and New Service Development: A Hybrid Thematic Analysis with Systematic Literature Review Approach," *EuroMed Journal of Business*, September 17, 2024, https://doi.org/10.1108/EMJB-01-2024-0017.

1. Articles that generally addressed technology in education without special reference to AI.
2. Articles published before the year 2020.
3. Articles that emphasised algorithmic development of AI without application to teaching and learning.
4. Theses or dissertations that were not peer-reviewed.

According to Marshall et.al., clear and justified inclusion criteria must be outlined and based on concepts such as population characteristics and publication details.[17] From the initially identified 110 articles, 100 articles were screened, and 30 were excluded due to irrelevance. 70 articles published in 2020 and beyond were selected based on the aforementioned criteria, using the aforementioned keywords. These articles were reviewed and analysed with the intention of identifying those that focused on the integration of AI tools in a constructivist classroom. After conducting a thorough screening process of abstracts and full-text, 30 articles were deemed eligible for inclusion, and 40 did not meet the criteria. In the end, 26 articles were kept for analysis.

Below is a PRISMA flow diagram that illustrates the selection and screening steps, clearly demonstrating the number of articles identified, included, and excluded based on the criteria.

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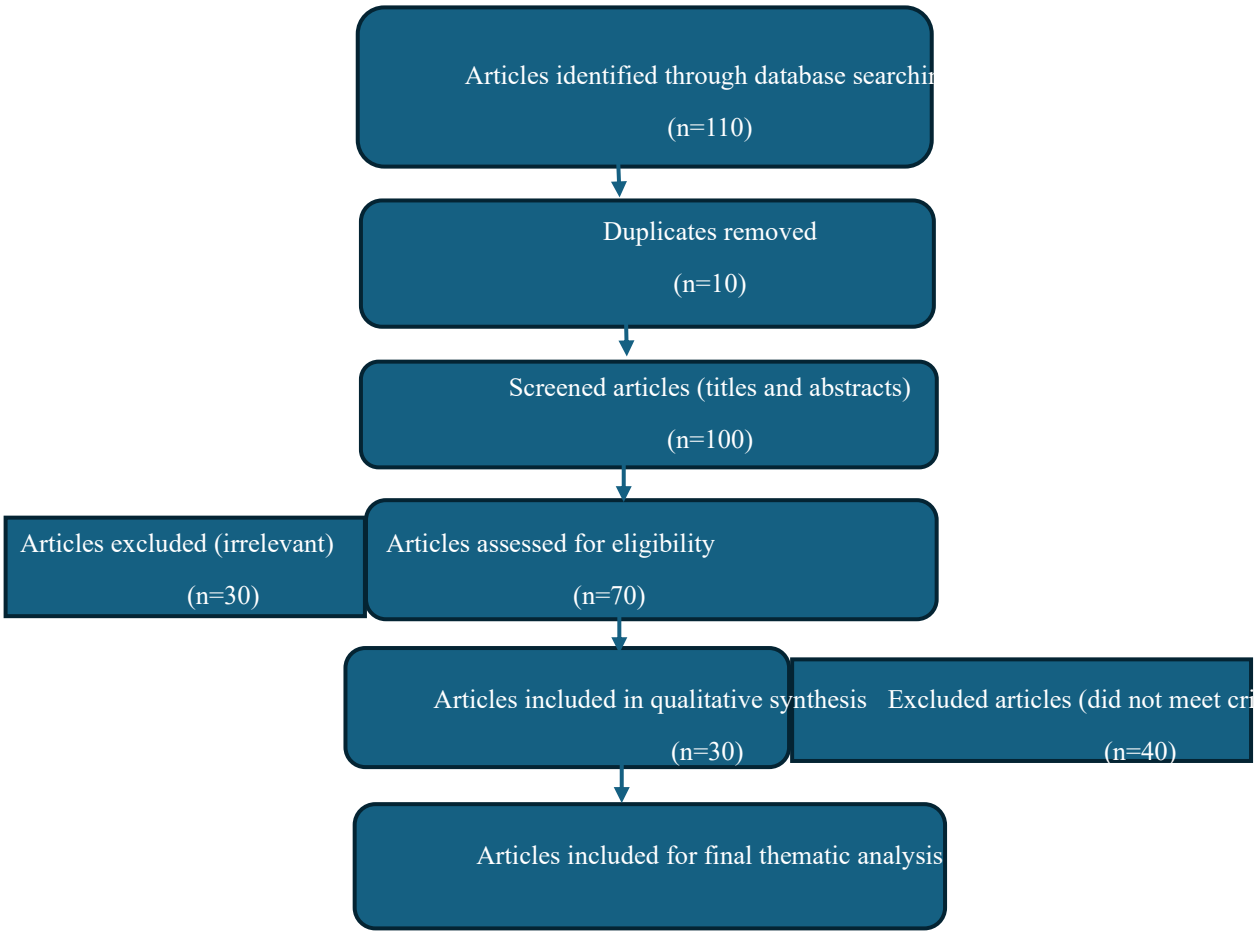


*Figure 1: PRISMA flow diagram depicting the selection procedure for articles on AI in Constructivist pedagogy*

[17] Iain J. Marshall et al., "Semi-Automated Evidence Synthesis in Health Psychology: Current Methods and Future Prospects," *Health Psychology Review* 14, no. 1 (January 2, 2020): 145–58, https://doi.org/10.1080/17437199.2020.1716198.

A thematic coding approach was adopted to classify AI tools according to their functionality, i.e., content delivery and personalized learning. According to Riazi et.al. a code is a descriptive feature that researchers allocate to a portion of the data to record the gist of the dataset, which involves labelling and establishing links between data and conceptual insights through repeated and refined analysis.[18] Rouhani et al. assert that thematic analysis in SLR entails combining portions of data to recognize, analyse and record recurring patterns through creating codes and gathering data for each code, finding themes, and reviewing the themes.[19] In this study, data were arranged into themes according to the type of AI tools being used globally, as well as the capabilities of the AI tools, which refers to the type of functions that each AI tool can perform. The coding framework for thematic analysis is outlined in Table 1 below.

**Table 1: Coding framework for thematic analysis**

| Theme | Code | Description | Example from reviewed articles |
|---|---|---|---|
| Content Delivery | CD1 | AI tools that enhance interactive presenting of content | Use of ChatGPT generating relatable examples during lectures |
| Personalized Learning and Feedback | PLF2 | Tools that adjust to students' needs with real-time feedback | Use of NotebookLM for generating personalised audio feedback |
| Collaborative Learning | CL3 | Tools that foster peer engagement and co-construction of knowledge | Application of ChatGPT, NotebookLM, and Gemini for facilitation of group discussions |
| Assessment and Reflection | AR4 | Tools that enhance formative and summative assessment, with grading capabilities | Use of ChatGPT for student assessment |
| Instructor Support and Pedagogical Design | ISD5 | Tools that support lecturers design courses, develop teaching resources, and learning facilitation | Application of Gemini to generate graphs and charts from written text |

This coding table served as the analytical framework for summarizing patterns throughout the reviewed literature, making it possible to identify dominant trends, teaching and learning implications for the incorporation of AI into constructivist pedagogy of ICR.

## PRESENTATION OF FINDINGS

To respond to the first question concerning 'AI tools that are being used by lecturers globally to harness and enhance teaching and learning,' a thematic analysis of articles was conducted, which resulted in the identification of the following categories from the review of existing research:

### (1) AI tools for collaborative and active/engaged learning

To begin with, ChatGPT, according to Zhu et. al., is a generative AI tool that is used globally by lecturers and students in higher education to facilitate collaborative learning among students and enables them to share

[18] A Mahdi Riazi, Hessameddin Ghanbar, and Reza Rezvani, "Qualitative Data Coding and Analysis: A Systematic Review of the Papers Published in the Journal of Second Language Writing," *Iranian Journal of Language Teaching Research* 11, no. 1 (2023): 25–47.
[19] Rouhani et al., "Text Analytics and New Service Development: A Hybrid Thematic Analysis with Systematic Literature Review Approach."

ideas, co-reflect, and consolidate understanding.[20] In addition, Kim et.al. assert that ChatGPT may be used to foster peer-to-peer engagement through group discussions and the facilitation of dialogue.[21] Urban et.al. posit that the use of ChatGPT by students enhances their problem-solving skills and helps them come up with high-standard solutions that are more detailed and well-developed.[22] Furthermore, Dietis describes a "*triangular dialog*" between students, the lecturer, and ChatGPT, where students propose strategies to resolve problems, ChatGPT provides various interpretations, and the lecturer provides guidance to reach the most feasible solution.[23] This methodology fosters critical thinking and collaboration, which promotes enhanced understanding.

In addition, Google Gemini, in the view of Imran and Almusharaf, is another new generation AI tool that lecturers and students may integrate to construct new knowledge together through its capabilities to create simulations, personalised learning and image-based learning tools.[24] Gemini's multimodal capabilities can stimulate multiple senses in students through the generation and interpretation of visual and audio-visual teaching and learning aids.[25]

Lastly, NotebookLM is an AI tool which is capable of converting scholarly articles, PDF documents, diagrams, Power-Point slides, or any reading material into an audio discussion or podcast.[26] NotebookLM summarizes and generates explanations and descriptions of any text or content, and even videos with subtitles, in an audio talk-based, podcast-like style.[27]

### (2) AI tools for assessment and feedback

Educators around the world are integrating ChatGPT not only in their teaching and learning activities, but also in the assessment of learning as well as the provision of feedback.[28] According to Sain et.al., ChatGPT possesses the ability to provide accurate electronic grading systems, analysis of brief-answer responses, standardised assessments, as well as real-time, customized feedback to students' work, all of which help educators to better manage large class submissions and students to take control of their learning.[29] Oates and Johnson assert that, to foster critical thinking, students can analyse and assess AI-generated essays against predetermined standards or outcomes and provide feedback on their findings as a way of reflecting on their analytical skills.[30]

Furthermore, more Higher Education Institutions and educators globally are leveraging Google Gemini in their daily pedagogical endeavours. Google Gemini has capabilities to generate customized, multidimensional feedback to students not only for written work, but for visual (diagrams and images) and

[20] Gaoxia Zhu et al., "Embrace Opportunities and Face Challenges: Using ChatGPT in Undergraduate Students' Collaborative Interdisciplinary Learning," *ArXiv Preprint ArXiv:2305.18616*, 2023.
[21] Han Kyul Kim et al., "Exploring the Impact of ChatGPT on Student Interactions in Computer-Supported Collaborative Learning," *ArXiv Preprint ArXiv:2403.07082*, 2024.
[22] Marek Urban et al., "ChatGPT Improves Creative Problem-Solving Performance in University Students: An Experimental Study," *Computers & Education* 215 (July 2024): 105031, https://doi.org/10.1016/j.compedu.2024.105031.
[23] Nikolas Dietis, "Three Ways to Use ChatGPT to Enhance Students' Critical Thinking in the Classroom," Times Higher Education, 2024, https://www.timeshighereducation.com/campus/three-ways-use-chatgpt-enhance-students-critical-thinking-classroom.
[24] Muhammad Imran and Norah Almusharraf, "Google Gemini as a next Generation AI Educational Tool: A Review of Emerging Educational Technology," *Smart Learning Environments* 11, no. 1 (2024): 22.
[25] S Veerakannan, "Google Gemini as a Next Generation AI Educational Tool: A Review of Emerging Educational Technology," *Eduac Multidisciplinary Research Journal* 1, no. 01 (2025): 1–7.
[26] Biao Wang, "NotebookLM Now Lets You Listen to a Conversation about Your Sources," *Google Blog. September* 11 (2024).
[27] Jonah Schiestle and Andrew Imbrie, "AI System-to-Model Innovation," 2025.
[28] Jeromie Whalen and Chrystalla Mouza, "ChatGPT: Challenges, Opportunities, and Implications for Teacher Education," *Contemporary Issues in Technology and Teacher Education* 23, no. 1 (2023): 1–23.
[29] Zohaib Hassan Sain et al., "Harnessing ChatGPT for Effective Assessment and Feedback in Education," *Journal of Computer Science and Informatics Engineering*, April 30, 2024, 74–82, https://doi.org/10.55537/cosie.v3i2.856.
[30] Angela Oates and Donna Johnson, "ChatGPT in the Classroom: Evaluating Its Role in Fostering Critical Evaluation Skills," *International Journal of Artificial Intelligence in Education* 35, no. 4 (December 24, 2025): 1793–1824, https://doi.org/10.1007/s40593-024-00452-8.

audio-visual (videos/video recordings), as a comprehensive method of assessing student work.[31] Perera is of the view that Google Gemini, by virtue of its ability to analyse and assess a wide variety of students' submissions, such as text assignments, images/diagrams, voice recordings, and videos, caters to diverse learning styles in the classroom, for example, visual learners, auditory learners, and kinaesthetic learners.[32]

Additionally, Miranda emphasizes that educators and students can leverage NotebookLM's capabilities of tailoring assessment and feedback for each student's personal learning needs by generating audio podcasts of their written assignments.[33]

To respond to the second question regarding 'ways in which AI tools can be integrated to enhance student engagement, interaction, collaboration, personalized learning, assessment and feedback within ICR,' a thematic analysis of articles was also conducted. The following categories were identified from reviewing the existing literature:

(1) Practical integration of AI tools for collaborative and active/engaged learning within ICR.

Below are three ways in which ChatGPT can be integrated into a constructivist environment to enhance students' understanding of Introduction to Classroom Research:

I. To begin with, Kim et al. state that ChatGPT can be used by students as a brainstorming partner to help get their thinking off the ground and further refine its recommendations with their own ideas.[34]

*Constructivist approach*: For integration in ICR, the lecturer may divide students into groups and instruct them to incorporate ChatGPT to brainstorm possible action research topics that deal with real-world classroom problems. Each group may then prompt ChatGPT with their own topic suggestions and let it generate different approaches to reach the final topic, after which they may hold discussions to fine-tune ChatGPT's suggestions and create their own topic. This collaborative teamwork among students would characterize constructivist teaching and learning.[35]

II. In addition, ChatGPT can be used as a collaborative partner when planning projects and assignments, as it can be prompted to outline project headings and subheadings, as well as to propose schedules and timeframes.[36]

*Constructivist approach*: With the task of completing a classroom action research proposal, ICR students may write a full draft of their proposal in groups or pairs and request ChatGPT's feedback on it. Groups then deliberate on the effectiveness of AI and check whether its suggestions were feasible, and thereafter revise their initial research proposal, and finally provide justification for their decision. This approach fosters critical thinking among students.[37]

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[31] Imran and Almusharraf, "Google Gemini as a next Generation AI Educational Tool: A Review of Emerging Educational Technology."

[32] Pethigamage Perera and Madhushan Lankathilake, "Preparing to Revolutionize Education with the Multi-Model GenAI Tool Google Gemini? A Journey towards Effective Policy Making," *Journal of Advances in Education and Philosophy* 7, no. 08 (August 9, 2023): 246–53, https://doi.org/10.36348/jaep.2023.v07i08.001.

[33] Sergio Miranda, "Artificial Intelligence from Google Environment for Effective Learning Assessment," *Information* 16, no. 6 (May 30, 2025): 462, https://doi.org/10.3390/info16060462.

[34] Kim et al., "Exploring the Impact of ChatGPT on Student Interactions in Computer-Supported Collaborative Learning."

[35] O'Connor, "Constructivism, Curriculum and the Knowledge Question: Tensions and Challenges for Higher Education."

[36] Chalermsup Karanjakwut and Kamonwan Charunsri, "Transforming AI Chatbots for a Brainstorming Teaching Technique of Process Writing," *Malaysian Online Journal of Educational Technology* 13, no. 1 (January 6, 2025): 1–18, https://doi.org/10.52380/mojet.2025.13.1.559.

[37] Mishra, "Constructivist Approach to Learning: An Analysis of Pedagogical Models of Social Constructivist Learning Theory."

III. Finally, ChatGPT can be integrated as an actor in a simulation of classroom action research, where students can prompt the AI to act as different research participants, such as a teacher, learner, or head of department in preparation to justify their action research.[38]

*Constructivist approach*: ICR students may prompt ChatGPT to act as a participant and rotate roles to make presentations to the AI with the aim of receiving questions or any matters of interest, or even problematic areas, from it. This approach justifies the incorporation of ChatGPT to enhance students' problem-solving skills.[39]

Below are three ways in which Google Gemini can be integrated into a constructivist environment to enhance students' understanding of Introduction to Classroom Research:

I. According to Nikolic et.al., Google Gemini has the capability to translate text into educational images and diagrams. Students can therefore leverage this tool by generating research journals with image-based prompts.[40]

*Constructivist approach:* ICR students may request Google Gemini to generate a classroom action research cycle, which includes the planning phase, action, observation, and reflection, and then explore and interpret the cycle to enhance their understanding of the classroom action research step-by-step process. Image interpretation is essential for constructivist learning as it allows students to develop, visualize, and review their understanding of technical ideas or concepts.[41]

II. Google Gemini has the capability to simulate real-life scenarios with visual illustrations of real-life cases, and lecturers can prompt Google Gemini to create any real-world classroom problem that needs to be investigated through classroom action research.[42]
*Constructivist approach:* ICR students may explore and simulate the scenarios by applying and following action research guidelines, which fosters situated learning. According to Cho, Jeong, Yu, Lee, and Jung, situated learning, which is characterized by real-world contexts, is a critical element of constructivist learning.

III. Due to Google Gemini's ability to convert text or numeric information to diagrams or graphs, students may collect qualitative or quantitative data and prompt Google Gemini to convert the data into pie charts or any form of bar graph.[43]

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[38] Rita Stampfl, Igor Ivkić, and Barbara Geyer, "Role-Playing Simulation Games Using ChatGPT," *ArXiv Preprint ArXiv:2402.09161*, 2024.
[39] Almulla, "Constructivism Learning Theory: A Paradigm for Students' Critical Thinking, Creativity, and Problem Solving to Affect Academic Performance in Higher Education."
[40] Sasha Nikolic et al., "ChatGPT, Copilot, Gemini, SciSpace and Wolfram versus Higher Education Assessments: An Updated Multi-Institutional Study of the Academic Integrity Impacts of Generative Artificial Intelligence (GenAI) on Assessment, Teaching and Learning in Engineering," *Australasian Journal of Engineering Education* 29, no. 2 (July 2, 2024): 126–53, https://doi.org/10.1080/22054952.2024.2372154.
[41] Siti Nur Aishah Mohd Noor and Mohd Khairul Amri Ramly, "Bridging Learning Styles and Student Preferences in Construction Technology Education: VARK Model Analysis," *International Journal of Academic Research in Progressive Education and Development* 12, no. 3 (September 27, 2023), https://doi.org/10.6007/IJARPED/v12-i3/19313.
[42] Buen Bajrami, Kostandina Veljanovska, and Zoran Kotevski, "QUALITATIVE ANALYSIS OF ARTIFICIAL INTELLIGENCE (AI) PLATFORMS IN EDUCATION," *UKLO Proceedings* 1, no. 2 (2025): 55–64.
[43] Nikolic et al., "ChatGPT, Copilot, Gemini, SciSpace and Wolfram versus Higher Education Assessments: An Updated Multi-Institutional Study of the Academic Integrity Impacts of Generative Artificial Intelligence (GenAI) on Assessment, Teaching and Learning in Engineering."

*Constructivist approach:* This approach encourages critical thinking as students analyse the generated graphs and charts to construct their own meaning of the data they collected. This activity promotes critical thinking which, according to Mishra, is essential to learning in a constructivist environment.[44]

Below are three ways in which NotebookLM can be integrated into a constructivist environment to enhance students' understanding of Introduction to Classroom Research:

I. NotebookLM has the capability to transform documents such as slides, PDF documents and articles into an audio that sounds like two people having a conversation about the contents of the documents, like a podcast.[45] Students, especially auditory learners, can leverage this feature by uploading documents on NotebookLM and prompting the tool to transform their notes into a podcast and instead of just reading the notes, they get to listen to a full discussion of the contents of the learning material. Below are three constructivist approaches or strategies that students and lecturers in ICR can apply to leverage NotebookLM:

(a) *Constructivist approach 1:* Lecturers may prompt the AI to transform an important reading or slides on classroom action research into podcasts and instruct students to listen prior to class and discuss the podcast in groups or pairs in preparation for the upcoming class. Taggart and Wheeler assert that students who collaboratively plan and discuss their work prior to engaging in general discussions in class display constructivist learning behaviour and usually surpass their peers who do not engage in this exercise.[46] Students come to class better prepared, having generated their own prior knowledge.

(b) *Constructivist approach 2:* The lecturer may assign a different action research process phase/stage to different groups within the class in podcast format and instruct the group to listen to the podcast, analyse it and note important points, then present their group summaries to the entire class in turns. According to Swargiary, students who engage in collaborative peer-to-peer learning make significant strides in academic achievement as their communication skills and self-efficacy, which are core elements of constructivist knowledge creation, improve.[47]

(c) *Constructivist approach 3:* Lecturers may encourage students to listen to NotebookLM podcasts enroute to campus, home, or during any of their free time, then write some reflective notes to be shared or exchanged amongst themselves. This approach fosters independent or self-directed learning, which Precellas and Napil opine characterizes constructivist learning as students take the learning initiative and reflect on their learning, constructing and sharing new knowledge in the process.

[44] Mishra, "Constructivist Approach to Learning: An Analysis of Pedagogical Models of Social Constructivist Learning Theory."
[45] Paul Huffman and James Hutson, "Enhancing History Education with Google NotebookLM: Case Study of Mary Easton Sibley's Diary for Multimedia Content and Podcast Creation," *ISRG Journal of Arts, Humanities and Social Sciences* 2, no. 5 (2024).
[46] Jessica Taggart and Lindsay B. Wheeler, "Collaborative Learning as Constructivist Practice: An Exploratory Qualitative Descriptive Study of Faculty Approaches to Student Group Work," *Active Learning in Higher Education* 26, no. 1 (March 31, 2025): 59–76, https://doi.org/10.1177/14697874231193938.
[47] khritish Swargiary, *Effectiveness of Peer Teaching in Enhancing Academic Performance, Engagement, and Social-Emotional Outcomes among High School Students: A Quasi-Experimental Study* (GOOGLE, 2024).

## DISCUSSION

This study aimed to identify an AI tool that university lecturers globally integrate for constructivist teaching and learning and explore how some of these tools may be incorporated within the Introduction to Classroom Research (ICR) module. Different constructivist approaches characterized by student collaboration and engagement were explored.

### *AI tools for collaborative and engaged learning*

The findings revealed that ChatGPT, Google Gemini, and NotebookLM are gradually becoming indispensable for fostering collaborative and engaged learning, both of which are essential elements of constructivist teaching and learning. Zhu et al. and Kim et al. acknowledged that ChatGPT, for instance, was broadly recognized as an AI tool that enables students to co-create meaningful insights, reflect together, and apply new knowledge to solve unfamiliar problems.[48] This is consistent with the principles of constructivist pedagogy that draw attention to mutual understanding through social interactions. In comparison, Msafiri, Kangwa, and Cai made an assertion that AI tools such as ChatGPT made remarkable improvements to collaborative learning when aligned with tasks that were supported by lecturers, but further found that very few studies explored the long-term impact thereof.[49] Therefore, even though the findings of this study coincide with the general findings regarding ChatGPT's impact, they highlight the need for long-term implementation to ensure sustained collaboration results.

Dietis's concept of three-way interaction between AI, lecturer, and students was especially noteworthy.[50] This is an approach through which learning takes place through facilitated interactions. In a similar vein, Google Gemini's capabilities of converting text into visual and audiovisual content showcase it as a tool that leverages sensory interaction through multimedia features, fostering students' ability to create new insights from multidimensional sources.[51] Nonetheless, the systematic review by Ruiz-Rojas et.al. revealed that even though generative AI tools enhance critical thinking and collaboration, practical integration usually calls for intensified training and support for lecturers.[52] Thus, ICR lecturers need intensive support and training to incorporate Google Gemini in their teaching practices.

NotebookLM's capabilities of converting written text into podcasts also make a significant impact towards constructivist pedagogy. This is particularly beneficial to auditory learners as they interact with learning material through thoughtful and collaborative methods, emphasizing key principles of constructivist pedagogy.[53] However, Ruiz-Rojas et al. noted that students were concerned that their critical thinking was negatively affected by overreliance on AI, which is a hint that the incorporation of tools like Notebook LM must be carefully mediated by lecturers.[54]

### *AI tools for assessment and feedback*

Another significant theme, namely, AI tools for assessment and feedback, mirrors the increasing global incorporation of AI, which, apart from summative and formative assessments, also includes students' self-

[48] Zhu et al., "Embrace Opportunities and Face Challenges: Using ChatGPT in Undergraduate Students' Collaborative Interdisciplinary Learning"; Kim et al., "Exploring the Impact of ChatGPT on Student Interactions in Computer-Supported Collaborative Learning."

[49] Mgambi Msambwa Msafiri, Daniel Kangwa, and Lianyu Cai, "A Systematic Literature Review of ICT Integration in Secondary Education: What Works, What Does Not, and What Next?," *Discover Education* 2, no. 1 (November 16, 2023): 44, https://doi.org/10.1007/s44217-023-00070-x.

[50] Dietis, "Three Ways to Use ChatGPT to Enhance Students' Critical Thinking in the Classroom."

[51] Veerakannan, "Google Gemini as a Next Generation AI Educational Tool: A Review of Emerging Educational Technology."

[52] Lena Ivannova Ruiz-Rojas, Luis Salvador-Ullauri, and Patricia Acosta-Vargas, "Collaborative Working and Critical Thinking: Adoption of Generative Artificial Intelligence Tools in Higher Education," *Sustainability* 16, no. 13 (June 24, 2024): 5367, https://doi.org/10.3390/su16135367.

[53] Schiestle and Imbrie, "AI System-to-Model Innovation"; Wang, "NotebookLM Now Lets You Listen to a Conversation about Your Sources."

[54] Ruiz-Rojas, Salvador-Ullauri, and Acosta-Vargas, "Collaborative Working and Critical Thinking: Adoption of Generative Artificial Intelligence Tools in Higher Education."

directed learning. Whalen et al. posit that speedy grading and customized feedback that is tailored for individual students' needs are achievable with the assistance of ChatGPT, hence fostering self-directed learning, which is an essential tenet of constructivist pedagogy.[55] Furthermore, constructivist pedagogy is substantiated by the ability of students to critically examine AI-generated feedback, which renders them critical thinkers and reflectors.[56] A recent review study by Zhao revealed that "*assessment, evaluation, and feedback are among the most prevalent roles for AI in education research,"* which corroborates the findings of this study that these are common themes.[57] However, concerns about the obscurity of AI feedback algorithms and their reliability were raised, which further suggests the need for ethical use of AI.

Google Gemini's capability to assess diverse submission formats highlights its potential to foster inclusive, student-focused assessment practices.[58] Due to this tool's versatility, students are able to demonstrate understanding in a range of formats, thus accommodating diverse learning styles and validating the constructivist viewpoint regarding tailored, situational assessment.

Furthermore, NotebookLM adds significant value by delivering customized audio feedback that promotes ongoing reflection and independent learning.[59] The tool accomplishes this by enabling students to get feedback through audio podcasts, adding an uncharted territory to automated formative feedback. Individual students can prompt this tool to personalize their feedback in line with their learning tempo and preferred style.

### *Integration of AI tools in constructivist pedagogy within ICR*

To answer the second research question, the study investigated different ways in which these AI tools may be strategically integrated into the teaching and learning of ICR, while maintaining constructivist learning environments. The findings from the literature revealed that AI, when integrated correctly, can be a catalyst for self-directed learning, critical thinking, and collaborative learning. Specifically, students can use ChatGPT as an idea generation and simulation partner to enhance their skills in solving unfamiliar real-world problems, as well as using it as a feedback generator to constructively review their ICR proposals, which cultivates critical reflective thinking regarding their own work.[60] On the contrary, Chen, Chen, and Lai found that while AI tools foster higher-order thinking and reflection, this benefit depends heavily upon insightful scaffolding by lecturers.[61] This assertion underscores a possible drawback for AI integration into ICR.

Additionally, Google Gemini's ability to transform written text into diagrams/graphs and pictures and create different types of visuals from students' work caters for a plethora of learning styles and fosters hands-on, authentic learning opportunities, which translates into constructivist learning.[62]

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[55] Whalen and Mouza, "ChatGPT: Challenges, Opportunities, and Implications for Teacher Education."

[56] Oates and Johnson, "ChatGPT in the Classroom: Evaluating Its Role in Fostering Critical Evaluation Skills."

[57] Chunyi Zhao, "AI-Assisted Assessment in Higher Education: A Systematic Review," *Journal of Educational Technology and Innovation* 6, no. 4 (2024).

[58] Imran and Almusharraf, "Google Gemini as a next Generation AI Educational Tool: A Review of Emerging Educational Technology"; Perera and Lankathilake, "Preparing to Revolutionize Education with the Multi-Model GenAI Tool Google Gemini? A Journey towards Effective Policy Making."

[59] Miranda, "Artificial Intelligence from Google Environment for Effective Learning Assessment."

[60] Kim et al., "Exploring the Impact of ChatGPT on Student Interactions in Computer-Supported Collaborative Learning"; Stampfl, Ivkić, and Geyer, "Role-Playing Simulation Games Using ChatGPT"; Mishra, "Constructivist Approach to Learning: An Analysis of Pedagogical Models of Social Constructivist Learning Theory."

[61] Shih-Yeh Chen, Wei-Cheng Chen, and Chin-Feng Lai, "Generative AI as a Reflective Scaffold in a UAV-Based STEM Project: A Mixed-Methods Study on Students' Higher-Order Thinking and Cognitive Transformation," *Education and Information Technologies* 30, no. 17 (November 4, 2025): 24787–814, https://doi.org/10.1007/s10639-025-13758-4.

[62] Min Soo Cho et al., "Edoxaban Antithrombotic Therapy for Atrial Fibrillation and Stable Coronary Artery Disease," *New England Journal of Medicine* 391, no. 22 (2024): 2075–86; Mohd Noor and Amri Ramly, "Bridging Learning Styles and Student Preferences in Construction Technology Education: VARK Model Analysis."

Using NotebookLM collaboratively to generate podcasts to prepare for classes/lectures allows students to independently interact with learning content and co-create understanding, sustaining a constructivist learning environment.[63]

In conclusion, findings from the literature affirm that ChatGPT, Google Gemini, and NotebookLM can effectively support self-directed, active, and collaborative learning within ICR, while also supporting assessment and feedback strategies that foster student-centred learning, authentic problem solving, and group dynamics. To fully leverage AI in constructivist spaces, continuous critical evaluation, ethical awareness, and informed teaching practices are of the utmost importance.

## RECOMMENDATIONS

This study recommends that further studies be conducted to explore the incorporation of AI tools in the pedagogy of ICR in real time, gathering perspectives and experiences of students and lecturers. The study further recommends that ICR lecturers and students be afforded opportunities for intensive mentoring on constructivist strategies to integrate ChatGPT, Google Gemini, and NotebookLM in ICR.

Additionally, the study recommends that students and lecturers be provided with opportunities for continuous professional development that focuses on the integration of AI in constructivist teaching and learning strategies. Lecturers and students should be afforded AI literacy training through structured workshops. Peer mentoring programs where lecturers who have adopted AI integration are paired with those who are new to AI should be implemented.

Furthermore, HEIs should establish policies that guide responsible and effective use of AI, ensuring the enhancement of constructivist learning in ICR. Ethical standards should be formulated by HEIs to foster fairness and honesty, and to curb overreliance on AI, further providing funding for institutional access to AI tools that are not freely open for public use.

Finally, HEIs should orient students on the responsible use of AI that promotes reflective and critical thinking, which are skills needed to succeed in ICR.

It is through these actionable measures that the integration of AI tools into ICR can become a transformative intervention to promote constructivist pedagogy within HEIs.

## CONCLUSION

This study identified three AI tools that can be integrated into the teaching and learning of the module Introduction to Classroom Research (ICR) in constructivist environments. After reviewing the literature, the findings revealed that the three identified AI tools, namely, ChatGPT, Google Gemini, and NotebookLM, can be integrated in the pedagogy of ICR in strategic ways that promote critical thinking, collaborative and personalized learning, as well as real-world assessment methods, all of which are key elements of constructivism. NotebookLM accommodates auditory learners through its capability to transform text into podcasts and audio feedback, ChatGPT facilitates brainstorming and fosters reflective thinking, and Google Gemini creates images and diagrams, which enhances multidimensional engagement. All three tools help deepen students' comprehension of intricate concepts in ICR, as well as foster inclusivity through accommodating varied learning styles. Incorporating these tools, however, calls for lecturers to possess rigorous Technological Pedagogical and Content Knowledge (TPACK), which requires continuous professional development of ICR lecturers.

[63] Taggart and Wheeler, "Collaborative Learning as Constructivist Practice: An Exploratory Qualitative Descriptive Study of Faculty Approaches to Student Group Work"; Lee Brenda C. Precellas and Melissa C. Napil, "Constructivist Learning Environment, Critical Thinking Motivation, Self-Directed Learning Readiness, a Structural Equation Model on Students' Engagement," *Asian Journal of Advanced Research and Reports* 18, no. 11 (October 22, 2024): 124–41, https://doi.org/10.9734/ajarr/2024/v18i11781.

## LIMITATIONS

This study, just as any research, has its limitations. To begin with, the inclusion criteria only incorporated journal articles from Google Scholar, while books and conference proceedings were not included. Additionally, this was a theoretical study that relied on data collected from existing studies and lacked authentic validation that could be obtained from real-time integration of AI tools in ICR classrooms, thus rendering the generalization of the findings impractical. Moreover, the fast-paced development of AI tools can render the recommended tools obsolete or swiftly replaced.

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## ACKNOWLEDGEMENTS

Sincere appreciation goes to Dr Patric Paseka Mollo, a colleague who introduced the author to this journal and helped him meet the specification requirements of the journal.

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