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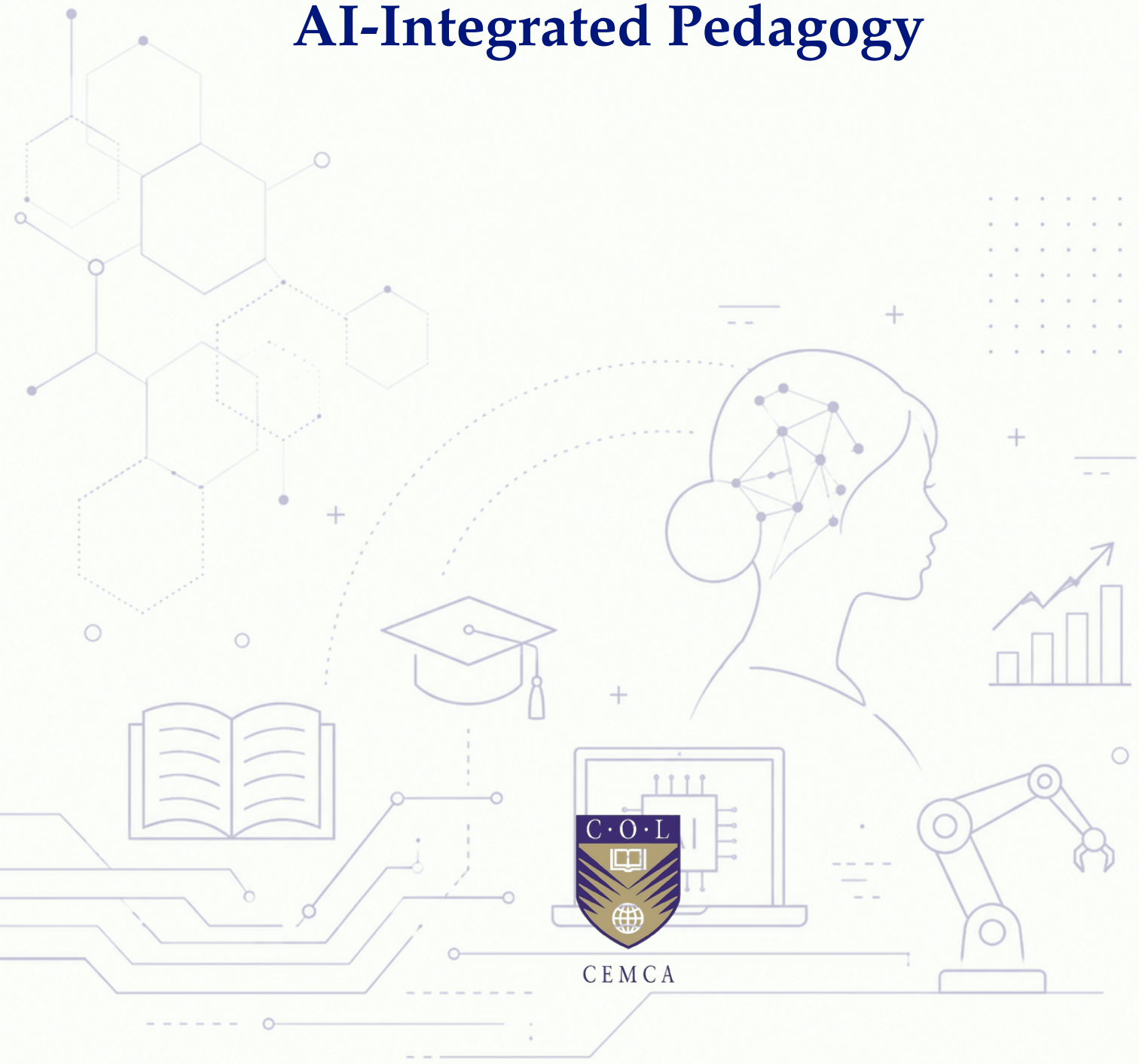
Empowering Women STEM Teachers through AI-Integrated Pedagogy

A Research Report Exploring the Pedagogical Integration of AI amongst the Higher Education Teachers of Rajasthan, India

May 2026

Empowering Women STEM Teachers through AI-Integrated Pedagogy



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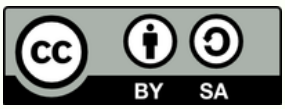

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Consultants:
Dr Sheriya Sareen, Dr Navchetan Awasthi & Dr Bhivraj Suthar
Indian Institute of Technology (IIT) Jodhpur, NH 62, Nagaur Road, Karwar, Jodhpur District, Rajasthan, 342030, India

Editorial Support:
Ms. Nabeela Ata, Consultant, COL-CEMCA
Published by Director, COL-CEMCA, 7/8 Sarv Priya Vihar, New Delhi - 110016, India

For further information, contact:
Commonwealth of Learning-Commonwealth Educational Media Centre for Asia (COL-CEMCA), or visit www.cemca.org

Acknowledgement

The Commonwealth Educational Media Centre for Asia (CEMCA), the regional centre of the Commonwealth of Learning (COL), gratefully acknowledges the contributions of all individuals and institutions whose expertise, commitment and collaborative spirit made the SHAPE-AI STEM project possible.

COL-CEMCA extends its appreciation to the Indian Institute of Technology Jodhpur (IIT Jodhpur) for serving as the institutional partner for this project. The School of Liberal Arts (SoLA) and the School of Artificial Intelligence and Data Science (SAIDE), under the leadership of Dr Alok Ranjan and Prof Anil Kumar Tiwari respectively, provided sustained institutional support, ensured the smooth coordination of administrative and logistical processes and lent institutional recognition to the initiative by gracing the valedictory session and prize distribution ceremony.

The project benefited immensely from the intellectual leadership of its Principal Investigators. Dr Sheriya Sareen brought expertise in education policy and participatory research methodologies, Dr Navchetan Awasthi contributed deep knowledge of AI technologies and their pedagogical applications and Dr Bhivraj Suthar provided insights from the frontiers of robotics and STEM innovation. Their interdisciplinary collaboration was central to shaping the project's research design and conceptual outcomes.

The contributions of the student research team at IIT Jodhpur, including Ms Parul Kumawat, Mr Kumar Gaurav, Mr Muhammed Sinan C, Ms Koyena Das, Ms Uma Mehta, Mr Mahipal Singh and Mr Akshat, strengthened the project across its operational phases, from workshop coordination and event documentation to data collection and management. The Office of SAIDE and the Next Generation BIRD Robotics Lab at IIT Jodhpur are also recognised for their administrative support and for hosting laboratory visits that enriched participants' exposure to emerging technologies.

The project would not have achieved its purpose without the women STEM teachers and students from colleges and universities across Rajasthan who generously contributed their time and professional experience. Their willingness to engage with unfamiliar tools, reflect openly on their teaching practices and share both their confidence and their uncertainties provided the empirical foundation for this study. The lesson plans, mind maps and reflections they produced enabled the development of the frameworks presented in this report. Their voices, perspectives and classroom realities are at the heart of everything this study offers. They are the true pioneers of this initiative.

This report was prepared under the guidance of Prof B. Shadrach, Director, COL-CEMCA. Ms Nabeela Ata, Consultant, COL-CEMCA, coordinated the project and provided editorial support throughout.

Foreword

"The future of intelligence is not merely artificial; it is collaborative, inclusive, and profoundly human. When we empower women educators to shape AI, we rewrite the very architecture of tomorrow's classrooms."

When we at COL-CEMCA first partnered with Dr Sheriya Sareen and her esteemed faculty colleagues at IIT Jodhpur to co-conceptualise what would ultimately mature into the SHAPE-AI STEM initiative, we were driven by a clear, urgent vision. We recognised that as Artificial Intelligence rapidly reshapes global landscapes, higher education stands at a critical crossroads. The intersection of STEM education, gender equity, and emerging technologies represents one of the most vital frontiers of our time. It was our firm conviction that women educators must not merely be passive consumers of these technological shifts, but active designers who steer them. This report stands as a brilliant, visionary realisation of the first step of that shared conviction.

The core paradigm of this initiative, *Empowering Women STEM Teachers through AI-Integrated Pedagogy*, is both an elegant response to a complex challenge and a bold reimagining of educational possibilities. In contemporary academic discourse, the role of AI is frequently contested, sometimes feared as a force that might destabilise the human agency in the form of the teacher who is increasing becoming the facilitator! The SHAPE-AI STEM project masterfully flips this narrative on its head. It positions AI not as a replacement for human intellect, but as a collaborative catalyst. By focusing specifically on women educators in higher education, this project builds a vital bridge where pedagogical authority meets technological innovation, ensuring that the classrooms of tomorrow are guided by diverse, empathetic, and highly skilled leaders.

A defining hallmark of this pioneering work is the introduction of the *Digital Mindset-Enabled HumanAI-Collaborative Lesson Planning Model*. Unravelling this framework reveals a sophisticated understanding of modern education: true innovation occurs when human agency and machine intelligence exist in a symbiotic relationship. This model ensures that teachers retain their essential role as the ethical and emotional anchor of the classroom, even as they harness the computational power of AI to design gamified, robotic, and deeply interactive learning experiences. It proves that a digital mindset is not about understanding code; it is about cultivating the confidence to co-create with technology.

This initiative also stands as a shining testament to the power of purposeful, synergistic partnerships. The collaboration between COL-CEMCA and IIT Jodhpur beautifully illustrates how an international intergovernmental organisation and a premier national technological institute can blend their unique institutional strengths. By weaving together policy-driven insights on digital inclusion with cutting-edge academic and technical expertise, we have created a cohesive, scalable pathway. This project demonstrates that when institutions align their storylines around a shared human cause, the impact resonates far beyond the walls of any single laboratory or lecture hall.

As this report beautifully chronicles the participatory explorations, methodologies, and breakthroughs achieved between April and June 2026, I must extend my deepest admiration to the Principal Investigators, Dr. Sheriya Sareen, Dr. Navchetan Awasthi, and Dr. Bhivraj Suthar, along with the entire project team at IIT Jodhpur and the team members of COL-CEMCA, Ms Nabeela Ata and colleagues, whose tireless commitment breathed life into this vision.

Most of all, I celebrate the remarkable women STEM teachers who participated in this journey fr-

om the land of Rajashtan or should I say 'Rani'sthan'. You are the true pioneers of this digital dawn. By embracing this collaborative model, you have not only elevated your own pedagogical practices but have also laid down a blueprint for educators across the region. You have proven that when women shape AI, technology becomes a truer reflection of our collective human potential.

Dr. B. Shadrach
Director, COL-CEMCA

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Abbreviations

AI	Artificial Intelligence
AVGC	Animation, Visual Effects, Gaming and Comics
BIRD	Next Generation BIRD Robotics Lab, IIT Jodhpur
CBPR	Community-Based Participatory Research
DM-HAICo	Digital Mindset-enabled Human-AI-Collaborative
HAICo	Human-AI-Collaborative
IIT/IITJ	Indian Institute of Technology, Jodhpur
LHB/LHC	Lecture Hall Building / Lecture Hall Complex
NSQF	National Skills Qualifications Framework
OECD	Organisation for Economic Co-operation and Development
SAIDE	School of Artificial Intelligence and Data Science
SoLA	School of Liberal Arts
STEM	Science, Technology, Engineering and Mathematics
TCK	Technological Content Knowledge
TK	Technological Knowledge
TPACK	Technology, Pedagogy and Content Knowledge
TPD	Teacher Professional Development
TPK	Technological Pedagogical Knowledge
XK	Contextual Knowledge
COL-CEMCA	Commonwealth of Learning – Commonwealth Educational Media Centre for Asia

Glossary

Terms	Definitions
Algorithmic bias	Systematic errors or unfair outcomes produced by AI systems as a result of biased training data, design assumptions or societal inequalities embedded in the technology.
CBPR (Community-Based Participatory Research	A research design that positions participants as co-creators of knowledge rather than passive subjects, emphasising equitable partnership and shared ownership of the research process..
Collaborative synthesis	The third stage of the HAICo model, in which teachers collectively evaluate, filter and contextualise AI-generated outputs through peer discussion and negotiation.
Digital literacy	Technical knowledge and skills required to operate digital tools. Distinguished in the report from "digital mindset".
Digital mindset	An individual's attitudes, beliefs and dispositions towards engaging with and adapting to digital technologies, encompassing openness to change, willingness to experiment, continuous learning orientation and critical capacity to leverage technologies. The report extends this to include reflexive criticality and inclusive digital consciousness.
Differentiated Instruction	A teaching approach that adapts content, methods, and assessment strategies to meet diverse learner needs and abilities.
DM-HAICo Model	The study's central conceptual contribution: a three-layer nested framework comprising a pedagogical layer (the HAICo iterative cycle), an epistemic layer (TPACK competencies) and a cultural layer (reflexive digital mindset).
Gamified learning	Instructional approaches that incorporate game-design elements (points, challenges, simulations) into educational activities to increase engagement.
HAICo Lesson Planning Model	A framework conceptualising AI-supported lesson planning as an iterative Human-AI-Human cycle across three stages: individual brainstorming, AI-assisted refinement and collaborative synthesis.
In-vivo codes	Codes derived directly from participants' own language and expressions, used in qualitative data analysis.

Glossary

Terms	Definitions
Inclusive digital consciousness	Awareness, foregrounded in the DM-HAICo model, that digital technologies are not neutral and that their design and deployment must incorporate gendered and marginalised perspectives.
Reflexive criticality	A disposition within the digital mindset that involves critically examining the sociotechnical dimensions of AI systems, including biases, ethical implications and power asymmetries, rather than engaging with technology uncritically.
STEM-integrated pedagogy	Teaching approaches that emphasise connections across scientific and technological domains rather than treating disciplines in isolation.
TPACK (Technology, Pedagogy and Content Knowledge)	A framework (Mishra and Koehler, 2006; revised by Mishra et al., 2023) describing the interplay between technological, pedagogical and content knowledge as fundamental to effective technology-integrated teaching. The report foregrounds four sub-components: TK, TCK, TPK and XK.
XK (Contextual Knowledge)	Within the revised TPACK framework, knowledge of the institutional, disciplinary and classroom realities that influence whether technology integration succeeds or fails.

Executive Summary

As Artificial Intelligence reshapes the landscape of higher education, understanding how women STEM teachers engage with AI-supported pedagogy is essential to ensuring that the digital transformation of classrooms is inclusive, context-sensitive and guided by those closest to the teaching-learning process.

This project examined AI integration among women STEM teachers in higher education institutions across Rajasthan. The study aimed to understand how women STEM educators integrate AI into teaching and learning, examine the factors influencing varying levels of AI integration and identify the forms of institutional and professional support required for meaningful, responsible and sustainable AI adoption in STEM classrooms.

The project adopted a community-based participatory research (CBPR) design combining empirical investigation with collaborative pedagogical experimentation. Through a one-day workshop at IIT Jodhpur in May 2026, 24 participants (18 women STEM teachers and 6 women STEM students aspiring to teach) engaged in iterative lesson planning, critical reflection, collaborative dialogue and AI-supported pedagogical design.

The findings indicate that participants perceive AI as a valuable cognitive resource capable of enriching lesson planning, supporting interdisciplinary thinking and enhancing instructional design when complemented by informed human judgement. At the same time, the study identified multiple contextual factors, including access to professional development, institutional support, technological confidence and existing pedagogical practices, that significantly influence the extent and nature of AI adoption. Notably, participants largely perceived AI adoption as gender-neutral and did not identify gender as a salient factor shaping their engagement with AI, a finding that stands in tension with the broader structural concerns documented in existing literature.

A major outcome was the development of the Human-AI-Collaborative (HAICo) Lesson Planning Model, an empirically grounded framework conceptualising AI-supported lesson planning as an iterative Human-AI-Human cycle comprising three stages: individual brainstorming, AI-assisted refinement and collaborative synthesis. A subsequent stage introduced participants to recent innovations in educational robotics, following which groups revisited their collaborative lesson plans and produced a fourth iteration incorporating robotics-related modifications. When asked to self-identify along a four-point adoption spectrum, no group positioned itself as sceptical or resistant; five of six groups identified as "curious but cautious" and one as an "enthusiastic adopter". Building on this, the project developed the Digital Mindset-enabled HAICo Model, which integrates pedagogical processes, TPACK knowledge competencies and cultural dispositions into a coherent framework for designing context-sensitive, inclusive and ethically grounded AI-supported STEM learning experiences.

These outcomes have the potential to inform teacher professional development programmes, institutional capacity-building initiatives and policy interventions across the Commonwealth and beyond. The Digital Mindset-enabled HAICo Model, in particular, offers a scalable and transferable framework that can support education systems in moving beyond skills-based approaches to AI training towards fostering the reflexive, collaborative and critically informed dispositions that sustainable human-AI collaboration in the classroom demands.

1. Context and Rationale

1.1 The Policy and Pedagogical Context

Policy frameworks across the Commonwealth and globally have increasingly prioritised the strengthening of Science, Technology, Engineering and Mathematics (STEM) higher education systems (Mathieson et al., 2023). STEM-integrated pedagogy, which emphasises connections across scientific and technological domains rather than teaching disciplines in isolation, is recognised as central to preparing students for interdisciplinary problem-solving and to addressing persistent skills gaps in industry (Klieger, 2024). This approach promotes inquiry-based learning and supports the development of critical thinking and innovation-oriented competencies among students (Winberg et al., 2019).

In India, national policy reforms have foregrounded the need to modernise teaching practices and make higher education more interdisciplinary and technology-enabled (Shadrach and Sareen, 2024). Colleges and universities are expected to integrate digital technologies, including Artificial Intelligence (AI), into their pedagogical approaches, promote collaborative learning and connect theoretical knowledge with real-world applications (Sareen and Mandal, 2024; Varghese, 2025). AI-supported tools and platforms, in particular, are increasingly viewed as integral to STEM pedagogy, offering possibilities for adaptive learning, data-driven instruction and enhanced student engagement. Implementation, however, remains uneven. Institutional contexts, resource availability and teachers' pedagogical preparedness continue to shape how effectively STEM and AI integration is realised in classrooms.

In states such as Rajasthan, higher education institutions serve a diverse student population with varied educational backgrounds. Teachers are the primary agents through whom curricular reforms reach the classroom, and their interpretation of STEM and AI integration directly influences teaching and learning outcomes. Within this landscape, women teachers constitute an important yet insufficiently examined group (Maji et al., 2023; Marmath, 2024). While women have made notable progress in accessing academic careers, they remain underrepresented in several STEM disciplines and in university leadership. Women teachers also navigate professional and social conditions that shape their engagement with innovative pedagogies, technology integration and interdisciplinary teaching in ways that differ from those of their male counterparts. At the same time, women teachers are well positioned to foster inclusive STEM learning environments and to support the participation of women students in science and technology fields (Norton, 2025). How women teachers conceptualise and practise STEM-integrated pedagogy, including the adoption of AI-enabled teaching tools, therefore offers a lens through which both the opportunities and the structural challenges of advancing innovative teaching in higher education can be examined (Freedman et al., 2023).

1.2 Research Gap and Objectives

Despite the growing policy emphasis on STEM education and AI integration in higher education, empirical research on how these are practised by teachers in Indian colleges and universities remains limited. The existing literature on STEM integration is concentrated at the school level, particularly at primary and secondary stages. How STEM-integrated and AI-supported pedagogies are conceptualised and implemented in higher education classrooms, where disciplinary boundaries tend to be more rigid and teaching practices are shaped by institutional and curricular constraints, is comparatively underexplored. Within this limited body of research, the experiences of women teachers have received particularly insufficient attention. Although women are increasingly present in higher education teaching, their perspectives on interdisciplinary and AI-supported pedagogies have not been systematically examined. Professional expectations, institutional support structures, access to training opportunities and so-

cio-cultural contexts all influence how women teachers engage with pedagogical innovation, yet these dimensions remain inadequately studied. Regional contexts compound this gap. Rajasthan presents distinct institutional and socio-cultural conditions, including differences in technological infrastructure, professional development provision and resource availability, that shape how pedagogical innovations are adopted in colleges and universities. Empirical studies examining these contextual influences from women teachers' perspectives are scarce.

Addressing this gap matters for three reasons. First, understanding how women teachers interpret and implement AI-integrated STEM pedagogy can reveal the practical realities of interdisciplinary teaching in higher education. Second, such evidence can inform the design of targeted professional development programmes that support teachers in adopting innovative and AI-enabled teaching practices. Third, findings from regional higher education contexts can contribute to more context-sensitive policy and institutional strategies for strengthening STEM teaching and learning.

The study was guided by the following objectives:

1. To understand how women STEM teachers in colleges and universities in Rajasthan integrate AI in their teaching and learning.
2. To analyse the factors that shape different levels and forms of AI integration among women higher education teachers in Rajasthan.
3. To evaluate the support requirements of women higher education teachers in Rajasthan for AI integration.

1.3 Focus of the Study

The study examined women teachers' AI integration practices within STEM teaching in the higher education context of Rajasthan, focusing on colleges and universities. It also engaged women higher education students with an expressed interest in teaching as a career. By analysing pedagogical approaches, professional experiences and contextual challenges, the study aimed to deepen understanding of how AI-integrated STEM teaching can be strengthened across the region.

2. Methodology and Workshop Design

2.1 The Community-Based Participatory Research Design

This study adopted a Community-Based Participatory Research (CBPR) design (Stewart et al., 2009), drawing on both qualitative and quantitative methods. CBPR is grounded in the principles of equitable partnership and shared ownership of the research process, positioning participants not merely as subjects of inquiry but as active contributors to knowledge production. While CBPR has a well-established presence in health sciences and community development research, its application in higher education settings remains comparatively limited (Hu, 2024). Its use in STEM higher education contexts is rarer still, despite the growing recognition that participatory and inquiry-driven approaches align closely with the epistemological orientation of STEM disciplines themselves (Guy, 2018).

The demand for workshop-based CBPR approaches has grown in recent years, driven by the need to work with research participants rather than merely study them, recognising them as sources of knowledge and agents of change within their own contexts (Öberg and Hernvall, 2016). This need is particularly pressing in STEM fields, where participants' engaged inquiry can orient them towards action-centred practices and generate insights that resonate with their disciplinary training.

Within this framework, a one-day participatory workshop was organised in the second week of May 2026 at the Indian Institute of Technology Jodhpur (IITJ), in collaboration with the Commonwealth Educational Media Centre for Asia (CEMCA). The workshop, titled "*Women Shaping AI in STEM Classrooms: A Participatory Exploration of Practice and Possibility in Higher Education*", served as the primary site for data collection. It was designed to capture the perspectives of women STEM teachers and women



Figure 1. *Community-Based Participatory Research Design implementation through a one-day workshop*

2.1.1 Situating CBPR within Global South research contexts

This study positions CBPR as a methodologically productive approach for researching STEM higher education in Global South contexts, particularly where gendered dimensions are central to the inquiry. This positioning rests on two propositions: first, that CBPR enables the generation of rich data within the time and resource constraints characteristic of STEM academic environments in developing nations; and second, that CBPR creates conditions for the empowerment of women participants through co-creation and collective reflection.

STEM higher education environments in countries such as India are characterised by high workloads, competitive pressures and constrained institutional resources (Varghese, 2025). These conditions limit the extent to which STEM academics can engage with conventional social science data collection methods, which often require sustained access over extended periods. For women STEM teachers and students, these constraints are compounded by gendered dimensions of access and participation in higher education (Maji et al., 2022; Amirtham and Kumar, 2021). A workshop-based CBPR approach addresses these constraints by concentrating data collection within a bounded timeframe while embedding it within activities - that participants experience as professionally meaningful rather than extractive.

Participant feedback collected through post-workshop forms (N=14) provided indicative support for both propositions, as outlined below:

Generating rich data within constrained environments

The workshop format enabled the collection of qualitative and quantitative data across multiple activities within a single day. Participants' reported comfort with the process suggests that the CBPR design facilitated candid engagement. This can be attributed in part to the alignment between the workshop's activity-based structure and the inquiry-driven epistemology familiar to STEM practitioners. Where conventional social science methods may require participants to operate within unfamiliar research modalities, the CBPR workshop created conditions in which data generation occurred through activities that participants recognised as continuous with their disciplinary practice (Figure 2). Participant responses reflected this alignment, with respondents highlighting the value of hands-on activities, group-based learning and the integration of real-world examples into the workshop design.



Figure 2. *Thick descriptions enabled through CBPR*

Creating conditions for empowerment through co-creation

The workshop also created observable conditions for participant empowerment (Figure 3), which manifested in two forms. First, participants co-created tangible outputs, including lesson plans and mind maps, through individual and collaborative activities. The process of producing these artefacts positioned participants as knowledge creators rather than research subjects, a distinction that is particularly significant in contexts where women STEM academics may have limited opportunities for collaborative professional engagement. Second, participants reported gains in confidence and openness as a result of the collaborative activities. In the context of Rajasthan, where caste-based patriarchy and gendered restrictions in domestic and institutional spaces shape women's professional lives (ES and Dixit, 2025), these reported experiences, while modest in scale, point to the potential of participatory research designs to create spaces that extend beyond data collection into professional development.

It should be noted that these observations are drawn from a small sample and a single workshop. They are presented not as generalisable claims about CBPR as a methodology but as indicative findings that warrant further investigation across larger and more diverse STEM higher education settings in the Global South.



Figure 3. *CBPR empowering women in STEM*

2.2 Workshop Design and Data Collection

The workshop was structured across five stages, each designed to generate specific forms of qualitative and quantitative data. Table 1 summarises the design, and the full workshop schedule is provided in Appendix I. Participants' prior consent was obtained for the use of all data and photographs for research purposes.

Stages	Activity	Data Source	Nature of Data	Focus	N
1.	Who is in the room?	Survey	Quantitative & Qualitative	Baseline idea of participants' tech orientation	24 participants
2.	My Last Class	Survey	Quantitative & Qualitative	Tools diversity, Teaching and learning practices	20 participants

Stages	Activity	Data Source	Nature of Data	Focus	N
3.	Confidence Group	Survey	Quantitative & Qualitative	Self-efficacy; Gendered expression	21 participants
4.	AI in Action: Co-building STEM Lessons	Lesson notes (Individual, human-computer interaction, and collaborative), Observation notes, and Participants' presentations	Qualitative	Development of lesson notes on a pre-chosen STEM topic	28 Teaching notes across three versions
5.	4 Corners' Dialogue: Mapping the Mindsets in Robotics, AI, and STEM	Mindmaps, Observation notes, and Participants' presentations	Qualitative	Refinement of Lesson Notes	10 mind maps
6.	Feedback Form	Survey	Qualitative	Aspects related to CBPR, and Future suggestions	14 participants

Table 1. *The five-stage design of CBPR*

2.2.1 Stage 1: Who is in the room?

The workshop opened with an ice-breaking activity titled "Who Is in the Room?", conducted through an interactive online survey (Figure 4).

The activity captured baseline information on participants' demographic profiles and their existing understanding of technological integration in teaching (detailed in Section 3.1). Table 2 summarises participants' demographics.

Aspect	N
Designation	
Female STEM Teacher	18
Female STEM student who is passionate about teaching	6
Broad Discipline	
Science	16
Technology	3
Engineering	3
Mathematics	2

Table 2. *The 'Who is in the room?': Demographics*

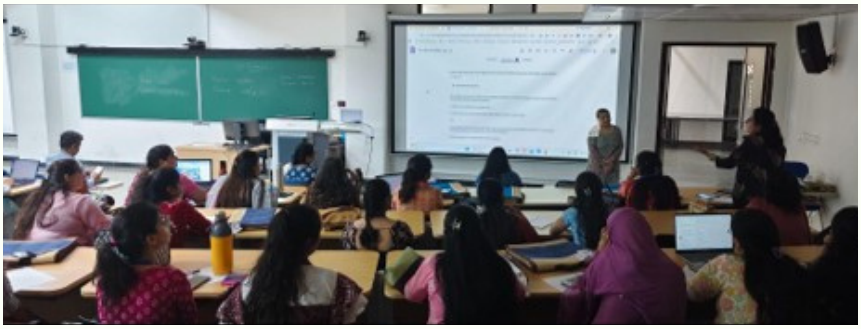

Figure 4. *Interactive online surveys*

2.2.2 Stage II: My Last Class

The second activity, "My Last Class", invited participants to identify which AI tools they had used in their teaching practice and for what purposes. Of 20 respondents, 19 confirmed that they had used AI-enabled tools to plan their teaching and learning. ChatGPT was the most frequently reported tool, followed by Gemini and YouTube (Figure 5). The two most commonly cited purposes for AI use were understanding concepts (N=17) and preparation of presentations (N=16) (Figure 6).

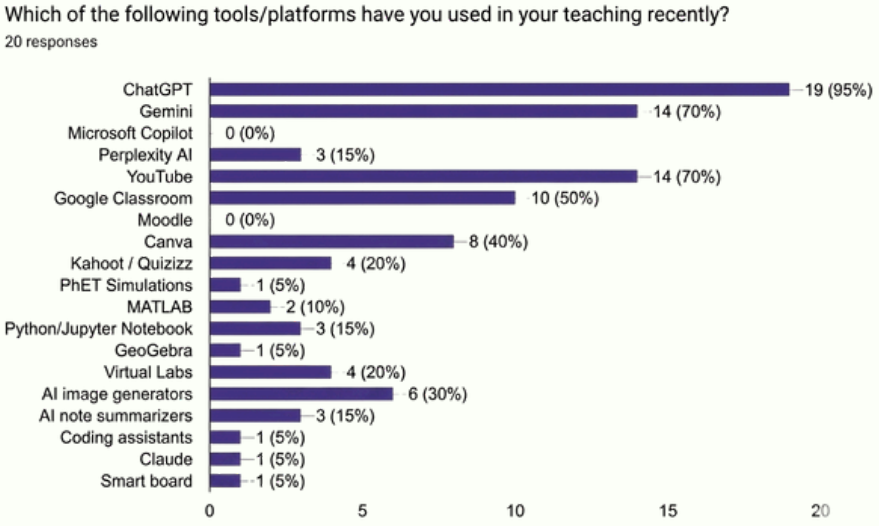

Figure 5. *AI tools and platforms used by STEM teachers*

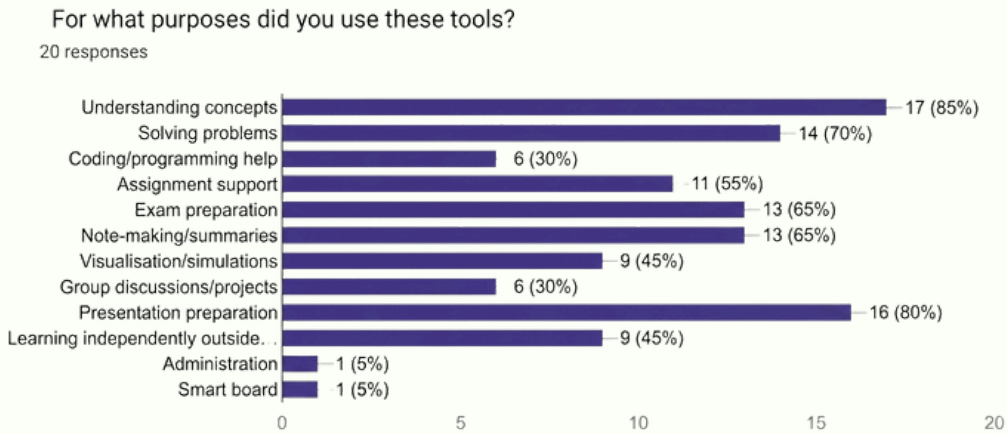

Figure 6. *Purpose of using AI tools and platforms by STEM Teachers*

2.2.3 Stage III: Confidence Group

The third ice-breaking activity, "Confidence Group", asked participants to reflect on their confidence in using AI in STEM classrooms and to indicate their response on a three-point scale, where 1 indicated "not confident", 2 "somewhat confident" and 3 "very confident". Using response sheets provided to them, participants selected the level that best represented their perceived confidence in integrating AI into their teaching practices. In addition to the numerical rating, participants were invited to provide their names and briefly explain the reasons for their chosen level. They were also encouraged to indicate whether any of these reasons were related to gendered experiences or perceptions. The activity generated both quantitative and qualitative data. As Table 3 indicates, no respondent selected the lowest confidence level, suggesting a broadly optimistic orientation towards AI use among the participant group.

Level	Number of Respondents
1 (Not Confident)	0
2 (Somewhat Confident)	17
3 (Very Confident)	3

Table 3. *Participants' confidence level for using AI in their teaching*



Figure 7. *Participants are being briefed about the Confidence Group activity*

2.2.4 Stage IV: AI in Action- Co-building STEM Lessons

The fourth stage followed an expert session titled "Understanding the Role of AI in STEM Teaching", delivered by Dr Navchetan Awasthi. The session introduced participants to examples of AI technologies and tools relevant to STEM classrooms and demonstrated, through a common STEM topic, how AI could support content delivery, interactivity, collaboration and pedagogical decision-making. Particular emphasis was placed on effective human-AI interaction, including the formulation of prompts for engaging with AI tools (Figure 8).

Building on the ideas introduced in this session, participants were organised into groups of three to five members, comprising either teachers or students. Each group selected a broad STEM theme (for example, Data in Science and Engineering, Patterns in Nature and Technology, Measurements and Observations, Graphs and Vis-

Visualisations, or Variables and Relationships) and collaboratively developed lesson plans using a shared blended workspace. A group leader was designated to present each group's final output.

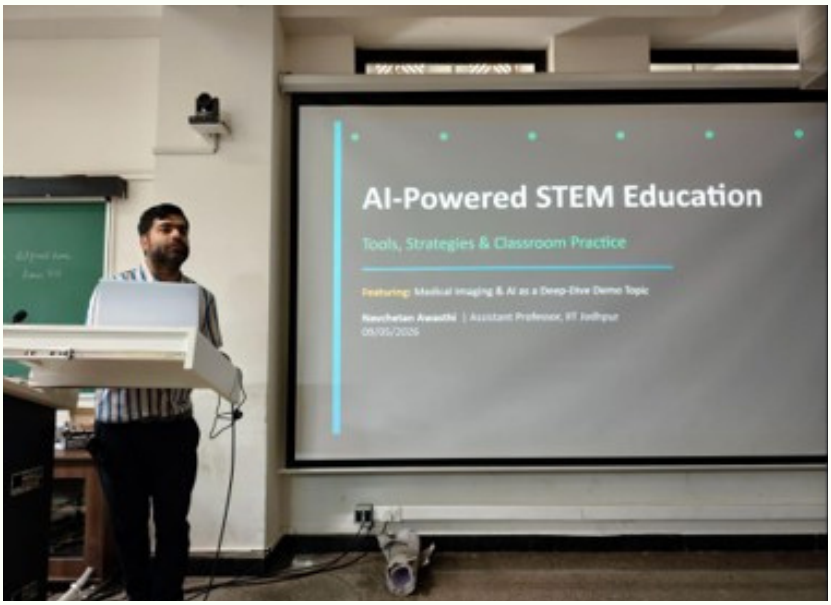

Figure 8. *Expert Talk 1: Understanding the role of AI in STEM teaching*

The activity involved three iterations of lesson development, designed to trace the evolution of pedagogical thinking as AI tools were progressively introduced:

In the first iteration, participants individually prepared lesson notes using a common template, drawing solely on their existing knowledge and pedagogical experience. In the second iteration, participants revised their initial lesson plans with the support of AI tools, exploring how AI-generated suggestions, examples and resources could enhance their original designs. In the third iteration, group members discussed their AI-assisted lesson plans and collaboratively synthesised the most effective elements into a shared lesson plan. Participants were encouraged to use both digital and physical resources to support discussion and the co-construction of ideas. The activity structure is summarised in Figure 9, and the implementation timeframe is presented in Figure 10.

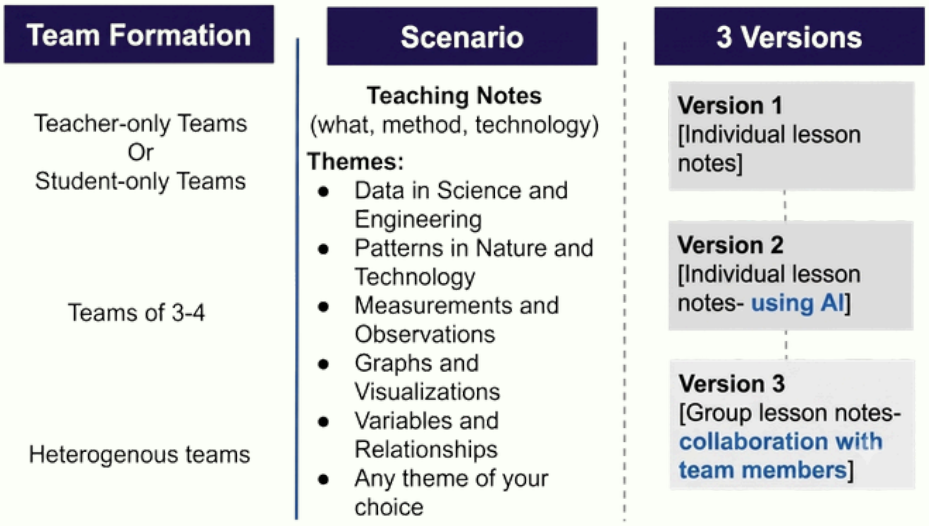

Figure 9. *The three iterations of AI in Action: Co-building STEM Lessons*

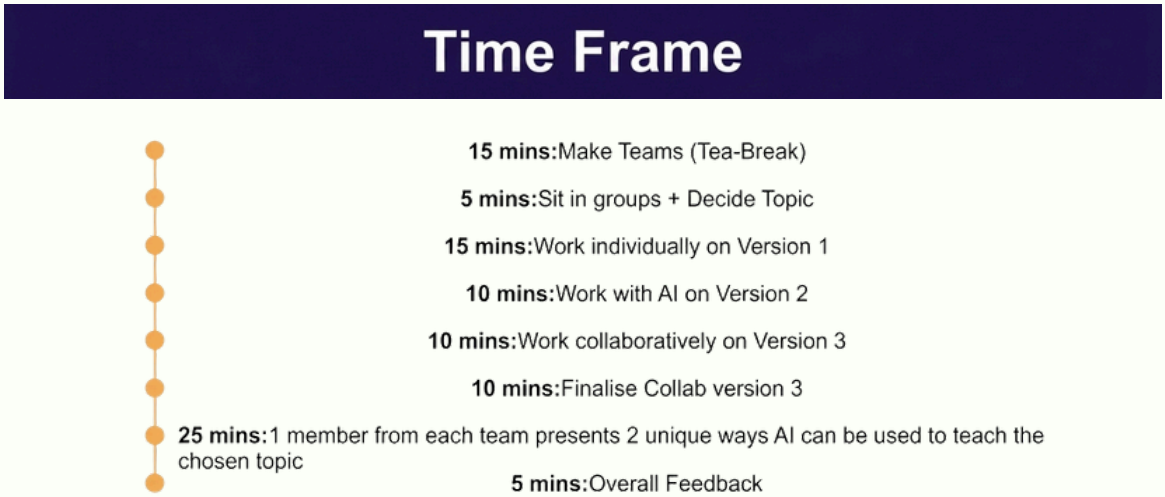

Figure 10. *Time frame of AI in Action: Co-building STEM Lessons*

Through this activity, the following data were collected: Version 1 lesson plans (without AI support), Version 2 lesson plans (AI-assisted revisions), Version 3 collaborative lesson plans and observation notes from participants' presentations, as summarised in Table 4. Figure 11 (a, b, c, d) provides visual documentation of these activities.

To guide the development of lesson notes across all three versions, participants were provided with the following prompts: What are some ways this topic can be taught or explored in class? What kinds of examples, activities or representations could be used? Where can AI be meaningfully used in this topic? What role would AI play (for example, explaining, generating, analysing or simulating)? What added value does AI bring for this topic?

Group	Nature of Participants	Theme of lesson notes	Whether submitted all 3 versions
1.	Women STEM teachers	Data in Science and Engineering	Yes
2.	Women STEM teachers	Patterns in nature and technology	No, 3rd version is not submitted
3.	Female STEM students who are passionate about teaching	Patterns in nature and technology	Yes
4.	Female STEM students who are passionate about teaching	Patterns in nature and technology	Yes
5.	Female STEM students who are passionate about teaching	Patterns in nature and technology	No, 3rd version is not submitted
6.	Female STEM students who are passionate about teaching	Patterns in nature and technology	Yes

Table 4. *Group Formation details for AI in Action: Co-building STEM Lessons*







Table 11. *Participants interacting with AI and collaboratively working*



Figure 11b. *Participants presenting their ideas*

2.2.5 Stage V: 4 Corners Dialogue: Mapping Mindsets in Robotics, AI and STEM

The final stage of the workshop was anchored around a second expert session, "Robotics and AI in STEM Classrooms: Recent Innovations", delivered by Dr Bhivraj Suthar (Figure 12). The session explored recent developments in educational robotics and examined how these innovations could be integrated into STEM teaching and learning. Through videos, demonstrations and interactive discussion, participants were introduced to emerging possibilities for incorporating robotics and AI into classroom practice. The session aimed to stimulate participants' curiosity and encourage critical examination of the pedagogical implications of these developments.

Following the session, participants revisited the collaborative lesson plans developed in Stage IV and reflected on whether the newly introduced ideas warranted further modification. Through group discussions, participants produced a fourth iteration (Version 4) of their lesson plans, incorporating insights from the expert session.

Groups then self-identified their position along a four-point adoption spectrum (Table 5): Enthusiastic Adopter, Curious but Cautious, Sceptical, or Resistant (Figure 13). Each group joined the position that best represented its current stance, based on the degree of change introduced during the preparation of Version 4. The activity timeframe is presented in Figure 14.

Corner Number	Group Numbers	No. of Groups
1 (Enthusiastic adopter)	Group 4	1
2 (Curious but Cautious)	Group 2, Group 3, Group 5, Group 1, Group 6	5
3 (Sceptical)	NA	0
4 (Resistant)	NA	0

Table 5. *Positions chosen by the groups*

Participants then engaged in structured group discussions and recorded their collective responses on chart papers in the form of mind maps (Figures 15a, 15b). Separate chart papers were used for each discussion prompt. The prompts addressed: the reasons underlying participants' chosen positions and the factors that could influence movement to another position; the forms of institutional support required to facilitate greater adoption, including structural, cultural and personal dimensions; aspe-

cts of AI and robotics that participants considered untrustworthy and the conditions necessary for building trust; and the future support mechanisms required for the effective integration of AI and robotics in STEM classrooms. Data collected at this stage included groups' self-positioning across the four adoption orientations and chart papers documenting collective reflections on motivations, barriers, trust and institutional enablers. Discussion outputs addressed structural factors (infrastructure and policies), cultural factors (leadership and gender) and personal factors (time, skills and confidence) shaping AI and robotics integration. Figures 16a and 16b provide visual documentation of this activity.



Figure 12. *Expert Talk II on Robotics and AI in STEM Classrooms: Recent Innovations*

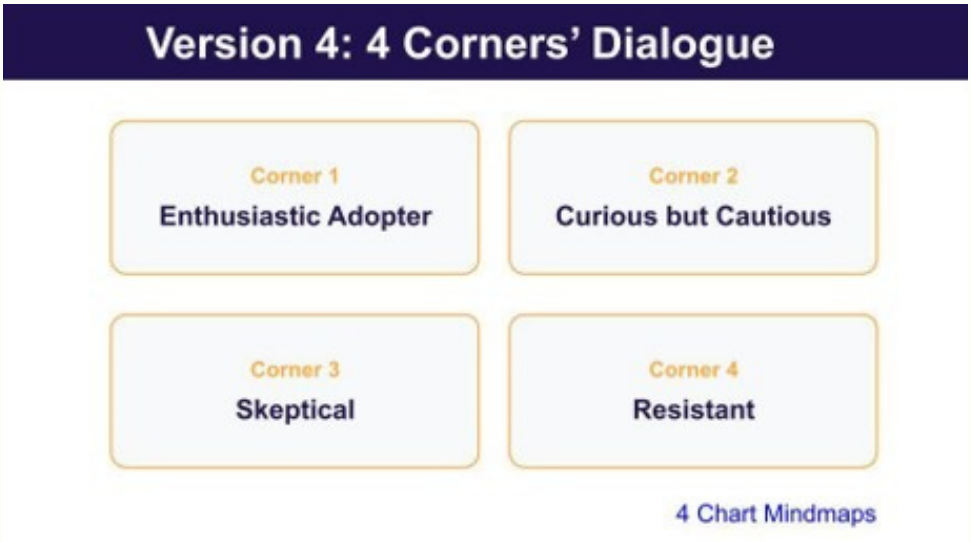

Figure 13. *The 4 corners*

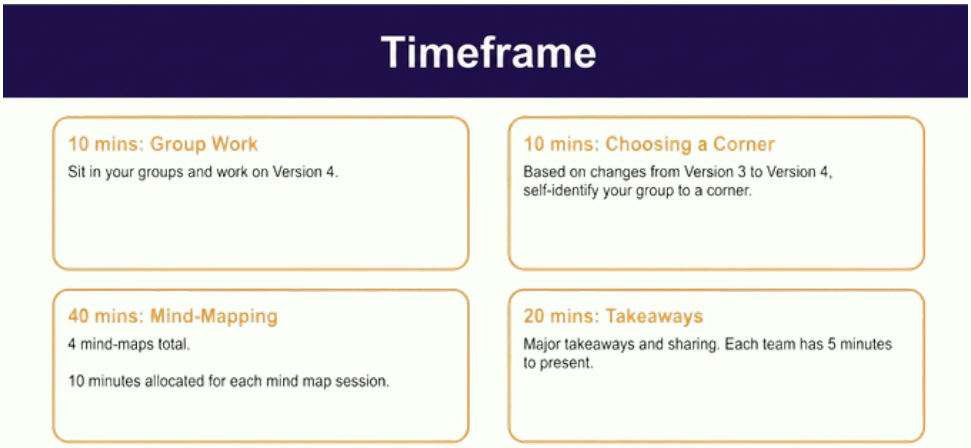

Figure 14. *Timeframe of the 4 corners' dialogue activity*

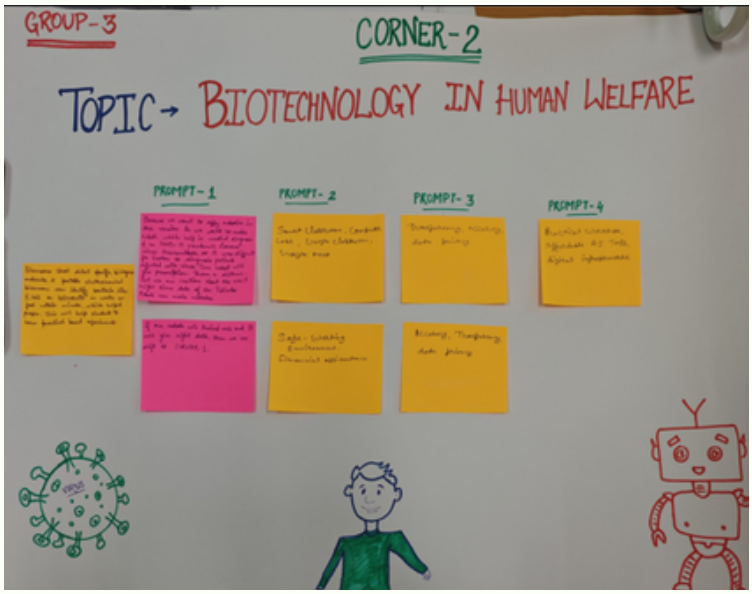

Figure 15a. *Sample mind map 1 developed by the participants*



Figure 15b. *Sample mind map 1 developed by the participants*



Figure 16a. *Participants working on Mindmaps*



Figure 16b. *Participants presenting the mindmaps in a discussion mode*

3. Participants' Orientations, Lesson Planning Model and Digital Mindset Framework

A recurring tension in STEM education research is the gap between teachers' expressed enthusiasm for technology and the unevenness of its integration into actual classroom practice. The findings presented in this chapter surface this tension directly. Women STEM teachers and students in Rajasthan reported strong optimism about AI and high aspirations for its pedagogical potential, yet their engagement with AI-supported lesson design revealed that translating these dispositions into practice required structured iteration, peer collaboration and a critical orientation towards technology that participants did not initially articulate. From this process, two conceptual outputs emerged: the Human-AI-Collaborative (HAICo) Lesson Planning Model and the Digital Mindset-enabled HAICo framework, which together propose a pedagogical, epistemic and cultural architecture for AI integration in STEM teaching.

This chapter presents the study's findings across two areas: participants' attitudes, aspirations and gendered expressions regarding AI in STEM (drawing on data from Stages I, II and III); and the development of the Human-AI-Collaborative (HAICo) Lesson Planning Model and its extension into the Digital Mindset-enabled HAICo Model (drawing on data from Stages IV and V).

3.1 Attitudes, Aspirations and Gendered Expressions of Women in STEM

The first set of findings draws on data collected during Stages I, II and III of the workshop, which captured participants' baseline orientations towards technology, their experiences with AI tools in teaching and their self-assessed confidence in AI integration. Together, these activities generated a composite picture of how women STEM teachers and students in Rajasthan perceive and relate to AI in their professional practice.

3.1.1 Participants' orientations towards technology and AI

Without exception, all participants reported an optimistic orientation towards technology in their STEM teaching and learning. Their perceptions of the current and anticipated role of technology in their teaching careers were organised into three inductively derived themes, each supported by participants' in vivo codes (Table 6).

Theme	Scope	In-Vivo Code
Interactive and Innovative	Technology as an innovative and interactive enabler of teaching, learning, research, and student participation.	Data in Science and Engineering
Tool for Efficiency and Management	Technology as an essential tool for analysis, concluding tasks, learning management systems, smart classes, utilizing smartboards, educational apps, and presentation-making (PowerPoint)	Technology in teaching and learning is the reason students now say “send PDF” instead of “write notes.” From smart boards to AI tools, education officially entered its digital era.
Continuous Learning	Technology as a space for lifelong learning, with every update representing a new beginning; source of unfiltered suggestions and empowerment.	[Technology is] a friend which interacts when required and gives unfiltered suggestions when I am stuck! :)

Table 6. *Technology as perceived by participants in their teaching*

3.1.2 Aspirations for AI in STEM teaching and learning

Thematic analysis of participants' responses in stage II indicated that women participants held relatively high expectations regarding the potential of AI in STEM education. Four inductively derived themes captured these aspirations (Table 7).

Theme	Scope	In-Vivo Code
Increased Accessibility and Understanding	Technology as an innovative and interactive enabler of teaching, learning, research, and student participation.	By providing a holistic view in concept bullets for students, along with the use of simulators, concepts become easier to understand.
Enhanced Engagement and Personalisation	The tools make STEM learning more interactive, personalised, and engaging. AI systems adapt problems and explanations to each student's level, providing differentiated scaffolding for struggling learners and deeper challenges for advanced students.	One of the biggest gains is personalised learning. AI systems can adapt to each student's level, tailoring problems, hints, and explanations. Instead of everyone moving at the same pace, students who struggle get step-by-step scaffolding, while advanced learners can explore deeper challenges. This reduces frustration and keeps more students engaged.
Instant Feedback and Critical Thinking	Immediate feedback is a major advantage, as AI tools instantly highlight mistakes in solutions or code, helping students correct misconceptions quickly. This also supports inquiry and creativity by allowing students to use AI as a thinking partner to test hypotheses and focus more on design and reasoning.	Another powerful use is supporting inquiry and creativity. Students can use AI as a thinking partner—asking "what if" questions, testing hypotheses, or exploring alternative solutions. In coding or engineering tasks, AI can help debug or suggest improvements, allowing students to focus more on design and reasoning rather than getting stuck.
Teacher Support and Efficiency	AI helps teachers by reducing routine workloads, such as generating practice problems and quizzes, and analysing class performance data to strategically adjust instruction.	In teaching, AI can support you by reducing routine workload. It can help generate practice problems, quizzes, or differentiated lesson plans quickly. It can also analyse class performance data to show where students are struggling, helping you adjust instruction more strategically rather than guessing.

Table 7. *Participants' aspirations for AI in STEM*

3.1.3 The Absence of Gendered Articulations

Analysis of the Stage III confidence activity revealed several reasons for participants' self-identification at confidence levels 2 and 3 on the three-point scale. Although there was considerable overlap in responses, a notable distinction emerged between the two groups.

Participants who rated their confidence at level 2 acknowledged the usefulness of AI for supporting their studies and teaching, particularly for understanding concepts, preparing presentations and locating learning resources. Their confidence was, however, tempered by concerns about the limitations and risks associated with AI, including data privacy and the possibility of inaccurate or unreliable outputs. Their responses reflected a cautious optimism in which the benefits of AI were recognised alongside reservations about its trustworthiness.

Participants who rated their confidence at level 3 expressed a stronger sense of assurance in into both teaching and learning. Their responses emphasised the potential of AI to facilitate their own professional work and to enhance students' learning experiences. Concerns regarding privacy or reliability were less pronounced in their accounts compared to those of participants at level 2.

When prompted about gender-specific experiences or considerations, participants largely reported not perceiving any particular advantages, disadvantages or concerns associated with being women in relation to AI use in STEM. They tended to view AI adoption as gender-neutral. This absence of explicit gendered expressions was further triangulated through observation notes, which indicated that several participants questioned the relevance of discussing women in STEM as a distinct category. Such responses suggest that participants did not perceive gender as a salient factor shaping their experiences with AI in STEM, despite the structural concerns documented in the wider literature.

It is important to note, however, that a single workshop day with structured activities may not have created sufficient conditions for surfacing deeply embedded gendered experiences. The absence of gendered articulations should therefore be read as a finding about participants' expressed perceptions within this specific research context rather than as evidence that gender does not shape women's engagement with AI in STEM. This interpretive caution is revisited in the discussion of the digital mindset framework in Section 3.3.

3.2 Towards a Human-AI-Collaborative Lesson Planning Model

The second set of findings draws on data collected during Stages IV and V of the workshop, in which participants moved from reflecting on AI to actively using it. Through a structured lesson design activity comprising three iterations, individual brainstorming, AI-assisted refinement and collaborative synthesis, participants produced multiple versions of lesson plans on pre-selected STEM topics. The progressive shifts observed across these iterations provided the empirical basis for the study's principal conceptual output.

The Human-AI-Collaborative (HAICo) Lesson Planning Model (Figure 17) conceptualises lesson planning as a Human-AI-Human iterative cycle comprising three interconnected stages. In the first stage, individual brainstorming enables teachers to draw upon their existing disciplinary and pedagogical expertise to articulate learning objectives and develop an initial lesson structure. This stage serves as the human foundation of the lesson planning process, grounded in teachers' prior experiences and contextual understanding of their classrooms and disciplines.

In the second stage, AI-assisted refinement expands the range of instructional possibilities by surfacing alternative explanations, examples, activities and representations. Through prompting and experimentation with AI tools, teachers are exposed to pedagogical possibilities beyond their immediate repertoire and develop a more informed understanding of both the affordances and the limitations of AI technologies.

In the third stage, collaborative synthesis centres on human interaction. Through peer discussion and collective reflection, teachers critically evaluate AI-generated outputs, negotiate meanings and adapt ideas to the realities of their specific classrooms and disciplinary contexts. This stage functions as a human-centred validation mechanism, transforming AI-generated possibilities into pedagogically grounded and contextually appropriate lesson plans.

Taken together, these findings indicate that AI-supported lesson planning is not a linear process of technological substitution but an iterative cycle in which human expertise, AI augmentation and collaborative reflection mutually reinforce one another. The HAICo model accordingly positions AI as a cognitive partner embedded within collaborative, context-sensitive lesson planning rather than as an autonomous instructional agent.

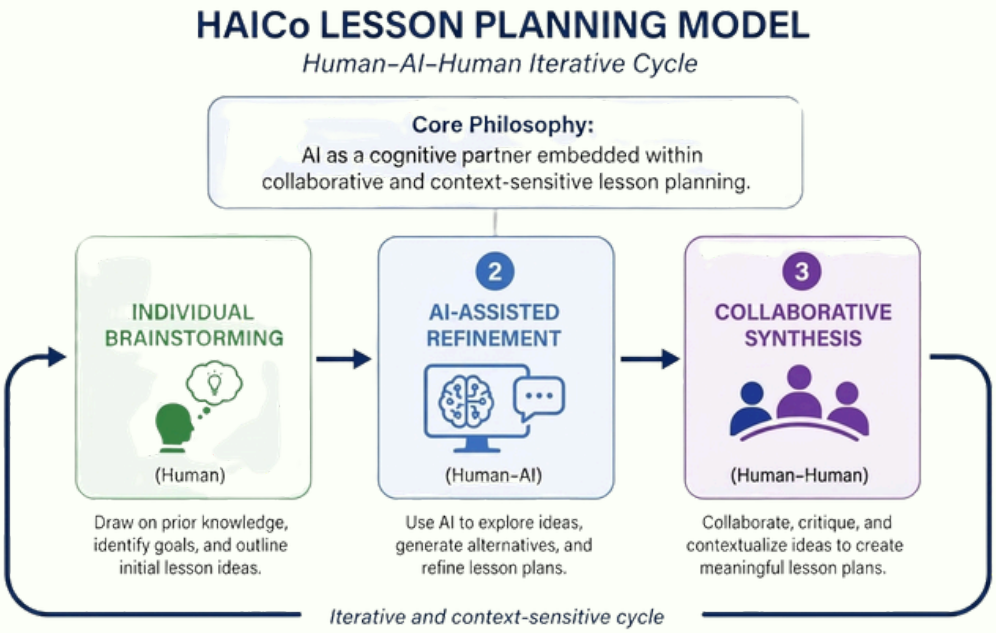

Figure 17. *The Process Framework for the HAICo Lesson Planning Model*

3.2.1 Conceptual underpinning: the TPACK framework

The HAICo Lesson Planning Model is conceptually underpinned by the Technology, Pedagogy and Content Knowledge (TPACK) framework. Originating from the work of Mishra and Koehler (2006), the TPACK framework highlights the interplay between technology, pedagogy and content knowledge as fundamental to effective technology-integrated teaching. More recently, Mishra et al. (2023) proposed a revised TPACK framework to account for the implications of emerging technologies, foregrounding five competencies particularly affected by technological advancements: Technological Knowledge (TK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), Technological Pedagogical Content Knowledge (TPACK) and Contextual Knowledge (XK).

Drawing on Mishra et al. (2023) and furthered by Mandal et al. (2025), the present study focused on four competencies of particular relevance to AI-supported lesson planning: TK, TCK, TPK and XK, and thus on TPACK as a composite construct. Technological Knowledge (TK) refers to teachers' understanding of AI technologies, including their affordances and limitations. Technological Pedagogical Knowledge (TPK) concerns how AI tools can shape teaching and learning practices, such as using generative AI to support student annotation and feedback. Technological Content Knowledge (TCK) captures how AI can be leveraged to represent and communicate disciplinary content. Contextual Knowledge (XK) foregrounds the institutional, disciplinary and classroom realities that influence the successful adoption of technology and encompasses the factors that may prevent teachers from "being as successful as they could be" (Mishra et al., 2023, p. 10).

The three versions of lesson notes generated during Stage IV were analysed through the lens of these four TPACK components. The analysis sought to address two questions: which TPACK elements were evident across the three versions of lesson plans; and how these elements evolved from Version 1 (individual brainstorming) through Version 2 (human-AI interaction) to Version 3 (collaborative synthesis). Lesson notes produced by all six groups were analysed and further corroborated through participants' group presentations and observation notes recorded during the activity.

Table 8 summarises the evolution of TPACK components across the three lesson iterations and highlights the shifts that occurred through individual ideation, AI-assisted refinement and collaborative synthesis. Collectively, these shifts provided the empirical basis for the development of the HAICo Lesson Planning Model, which conceptualises lesson planning as an iterative, context-sensitive process involving human expertise, AI augmentation and peer collaboration, as illustrated in Figure 18.

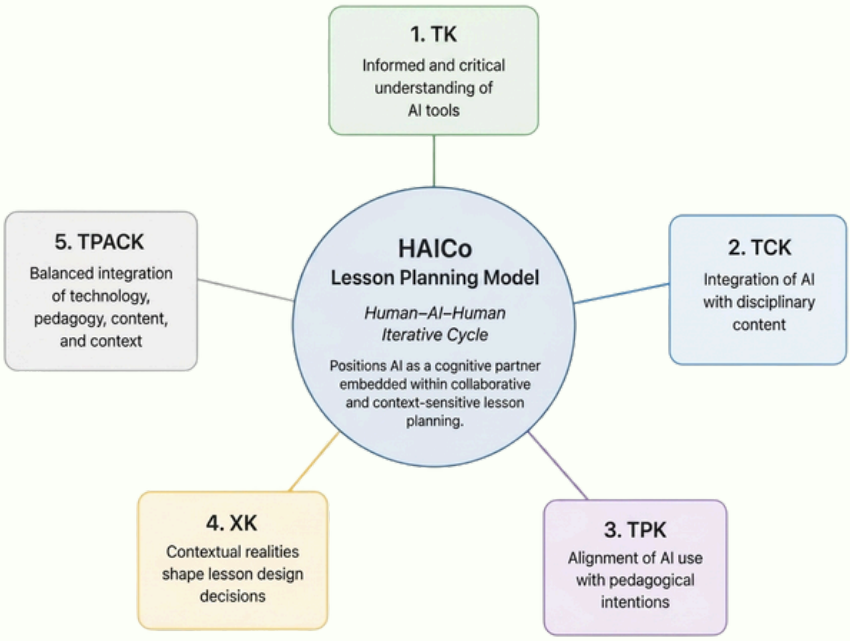

Figure 18. *Conceptualisation of the HAICo Model through TPACK*

Lesson Notes Version	Dominant Process	TK	TCK	TPK	XK	Major shift observed	Contribution to HAICo Model
Version 1 (Individual brainstorming)	Individual ideation and lesson planning	Limited evidence of AI-related knowledge [e.g., the notes depicted that AI 'can be used to teach this topic', with no further elaboration]	Content was presented through conventional approaches based on teachers' prior knowledge	Predominantly traditional teaching strategies	Implicit consideration of classroom realities [e.g., designing experiments based on local resources]	Baseline stage characterised by reliance on existing expertise, mainly related to TCK and XK	Provides the human foundation for lesson design by activating teachers' disciplinary and contextual knowledge
Version 2 (Teacher-AI interaction)	AI-assisted refinement	Limited evidence of AI-related knowledge [e.g., the notes depicted that AI 'can be used to teach this topic', with no further elaboration]	Increased awareness of AI capabilities and limitations through prompting and experimentation [e.g., the notes at this stage refereed to specific AI tools that teachers may use]	TCK factors received limited attention	Contextual factors received limited attention [the focus remained concentrated on TK and TPK aspects]	Expansion of technological and pedagogical possibilities	Strengthens technological knowledge and broadens pedagogical possibilities
Version 3 (Teachers' Collaboration)	Collaborative synthesis and peer	Participants critically evaluated AI outputs and negotiated their use	AI-generated content was adapted and	Pedagogical strategies were refined through	Explicit consideration of learner	Greater contextualisatio n and peer	Human collaboration acts as a

Lesson Notes Version	Dominant Process	TK	TCK	TPK	XK	Major shift observed	Contribution to HAICo Model
	discussion	[e.g., From version 2 to version 3, only a few most appropriate AI tools were retained]	contextualised for disciplinary and career-stage needs	peer interaction and collective decision-making	characteristics, feasibility, and classroom realities	validation of AI-supported ideas	filtering and contextualising mechanism, transforming AI-supported possibilities into meaningful lesson notes
HAICo Lesson Planning Model	Human–AI–Human iterative cycle	Informed and critical understanding of AI tools	Integration of AI with disciplinary content	Alignment of AI use with pedagogical intentions	Contextual realities shape lesson design decisions	Balanced integration of technology, pedagogy, content, and context	Positions AI as a cognitive partner embedded within collaborative and context-sensitive lesson planning

Table 8. *From TPACK to HAICo Lesson Planning Model*

3.3 The Digital Mindset as Cultural Environment for the HAICo Model

The second major conceptual output of the study proposes that the digital mindset constitutes a cultural dimension of the learning environment that creates the conditions necessary for sustainable implementation of the HAICo Lesson Planning Model, particularly for women in STEM. Within this framing, the HAICo cycle represents the mechanism of AI-supported lesson planning, while the reflexive digital mindset represents the condition that sustains and ethically orients that mechanism.

Digital mindset refers to an individual's attitudes, beliefs and dispositions towards engaging with and adapting to digital technologies. Unlike digital literacy, which primarily concerns the technical knowledge and skills required to operate digital tools, a digital mindset encompasses openness to technological change, willingness to experiment, orientation towards continuous learning and the capacity to critically and creatively leverage technologies for problem-solving and innovation (Dweck, 2006; Westerman et al., 2014). Where digital literacy addresses the question of how to use technologies, digital mindset addresses the question of how to think about and continuously adapt to technologies in evolving contexts.

The significance of a digital mindset has become particularly pronounced with the emergence of AI and other rapidly evolving technologies. Possessing digital skills alone may not be sufficient for meaningful technology integration; STEM teachers are also required to demonstrate adaptability, critical judgement and a readiness to learn alongside and collaborate with intelligent systems. Fostering a digital mindset is accordingly viewed as essential for navigating uncertainty and enabling sustained participation in technology-rich educational environments (OECD, 2021).

From the perspective of the HAICo Lesson Planning Model, the digital mindset represents a cultural dimension of the learning environment that provides the cognitive and social conditions necessary for sustaining human-AI collaboration. Since the model conceptualises AI as a cognitive partner rather than an autonomous agent, its successful implementation depends not merely on teachers' digital competencies but on their willingness to engage in iterative experimentation, critically evaluate AI outputs and collaboratively contextualise those outputs within their teaching realities. Such a mindset promotes continuous learning, adaptability and responsible human oversight, ensuring that AI-supported lesson planning remains context-sensitive and pedagogically meaningful.

Indicative evidence of such a mindset was visible

across multiple stages of the workshop. During Stage I, participants displayed optimistic orientations towards AI and expressed willingness to engage with digital technologies. Stage II revealed participants' aspirations regarding the transformative potential of AI in STEM education. During Stage V, after being introduced to recent innovations in robotics and AI, participants revisited their lesson plans and produced a fourth iteration incorporating substantive modifications. Furthermore, no participants positioned themselves within the "Sceptical" or "Resistant" categories, an observation consistent with an orientation characterised by openness and curiosity, though it should be noted that participants who voluntarily attended a workshop on AI in STEM may not be representative of the broader teaching population.

The findings also reveal, however, a more complex picture. While participants demonstrated several characteristics associated with a digital mindset, their responses simultaneously exposed the limitations of an orientation that remains insufficiently critical. As discussed in Section 3.1.3, women participants frequently questioned the need to discuss women in STEM as a distinct category and largely perceived AI adoption as gender-neutral. This absence of gendered articulations, coupled with limited awareness of algorithmic and societal biases embedded within AI systems, suggests that participants' digital mindset was oriented more towards technological opportunity than towards critical engagement with the broader sociotechnical environment in which AI operates.

This finding points to an important extension of the concept of digital mindset. Beyond openness and adaptability, a mature digital mindset requires awareness of and critical engagement with the AI ecosystem of which users themselves are a part. Such reflexivity entails recognising that technologies are not neutral artefacts but are shaped by social structures, values and inequalities. While the HAICo model is enabled by the cultural factor of a digital mindset, the present study argues that this mindset must intentionally incorporate gendered perspectives and the voices of other marginalised groups. Only through such critical incorporation can human-AI collaboration move beyond technological competence towards more inclusive, ethical and socially responsive forms of lesson planning.

3.4 The Digital Mindset enabled HAICo Model

The study's central conceptual contribution is the Digital Mindset-enabled HAICo Model: a three-layer nested framework in which the digital mindset serves as the enabling cultural environment within which the HAICo lesson planning cycle operates, powered by the TPACK knowledge domain (Table 9). This provides a coherent pedagogical-epistemic-cultural architecture that extends substantially beyond a lesson planning model alone (Figure 19).

The Digital Mindset-enabled HAICo Model conceptualises AI-supported lesson planning as an iterative Human-AI-Human cycle comprising three interconnected stages: individual brainstorming, AI-assisted refinement and collaborative synthesis. At its core, the model positions AI as a cognitive partner embedded within collaborative, context-sensitive lesson planning rather than as an autonomous instructional agent. The HAICo cycle is sustained by a reflexive digital mindset, conceived as a cultural dimension of the learning environment and characterised by digital optimism and openness, continuous learning and adaptability, human agency and collaborative judgement, contextual awareness, reflexive criticality and inclusive digital consciousness. While the model fosters experimentation and innovation, it simultaneously emphasises critical engagement with the sociotechnical environment, including awareness of AI biases and the incorporation of gendered and marginalised perspectives. The Digital Mindset-enabled HAICo Model accordingly offers a holistic framework for developing context-sensitive, pedagogically meaningful, inclusive and ethically grounded AI-supported STEM lesson plans.

System Level	Key Institutions
Process (Pedagogical)	Human → AI → Human (collaborative) iterative lesson planning cycle

System Level	Key Institutions
Knowledge (Epistemic)	TPACK competencies (TK, TCK, TPK, XK)
Environment (Cultural)	Digital mindset characterised by openness, adaptability, human agency, contextual awareness, criticality, and inclusion

Table 9. *The pedagogical, epistemic and cultural layers of the Digital Mindset-enabled HAICo Lesson Planning Model (DM-HAICo Model)*

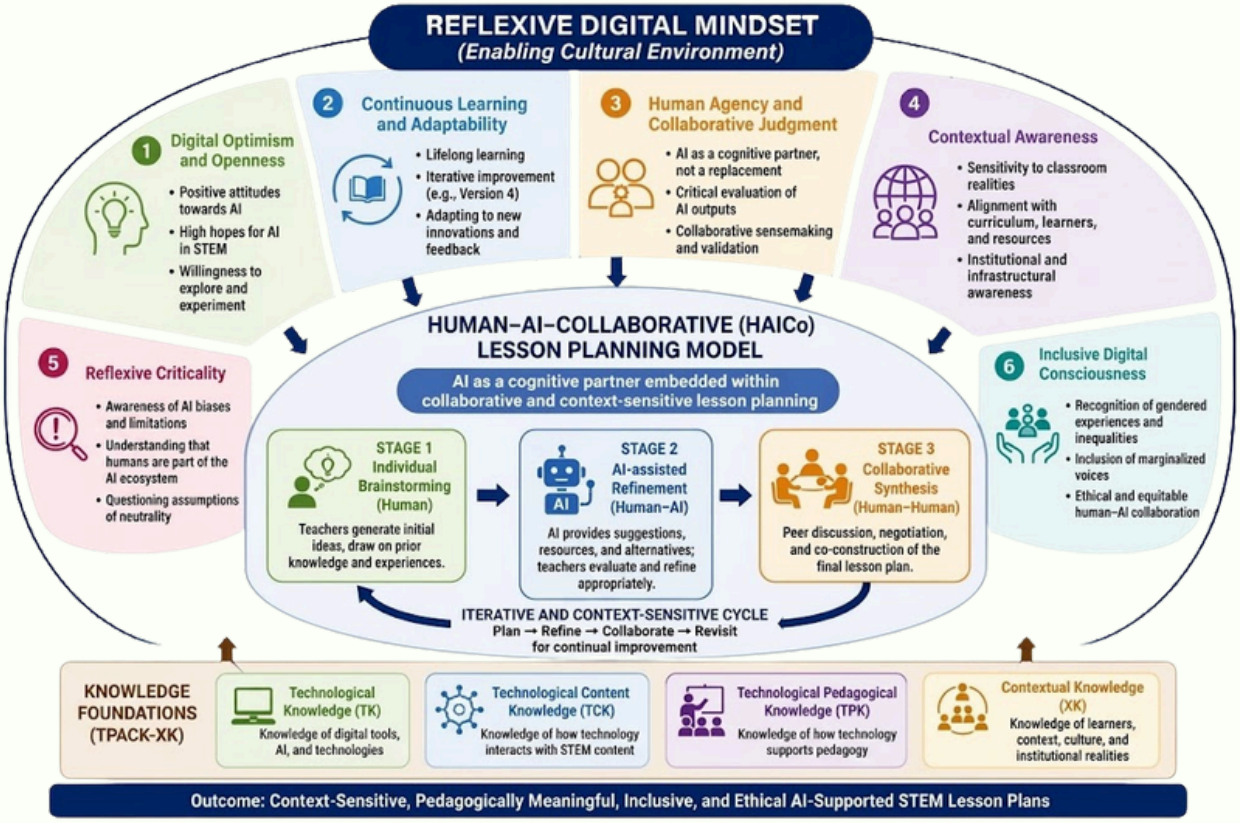

Figure 19. *The Digital Mindset enabled HAICo Model for STEM Classrooms*

4. Recommendations and Way Forward

The findings of this study point to several priorities for future research, professional development and institutional action. The HAICo model and its Digital Mindset-enabled extension offer an empirically grounded starting point, but translating these frameworks into sustained practice requires deliberate effort across multiple levels of the education system. The recommendations that follow are directed at teacher educators, institutional leaders, policymakers and researchers seeking to promote responsible and inclusive AI integration in STEM higher education. They are organised around four interconnected areas: strengthening teacher professional development, embedding supportive institutional practices, validating and scaling the proposed frameworks and pursuing the research questions that this study has opened but could not, within its scope, fully resolve.

4.1 Teacher Professional Development

The study found that while participants demonstrated optimism and willingness to engage with AI, their understanding of AI's sociotechnical dimensions remained limited. Participants largely perceived AI adoption as gender-neutral, showed limited awareness of algorithmic bias and did not identify concerns related to the gendered implications of AI systems. At the same time, their confidence in using AI was largely self-reported at the "somewhat confident" level, suggesting that familiarity with tools such as ChatGPT and Gemini has not yet translated into deep pedagogical confidence. The Digital Mindset-enabled HAICo model that emerged from these findings conceptualises effective AI integration as requiring not only technical skill but a reflexive orientation characterised by openness, adaptability, critical engagement and inclusivity.

These findings suggest that future teacher professional development (TPD) initiatives for women STEM teachers should move beyond a purely skills-based approach to AI integration. Technological competence alone is insufficient for meaningful AI adoption. TPD programmes should deliberately cultivate a reflexive digital mindset, integrating the ethical and sociotechnical dimensions of AI into training design with explicit attention to issues such as algorithmic bias, responsible AI use, gender equity and the inclusion of marginalised voices. Rather than treating these as supplementary or optional modules, future programmes should position critical AI literacy as an integral component of any AI-focused professional learning initiative. The enthusiasm and openness that participants demonstrated throughout the workshop suggest that women STEM teachers are ready for this deeper engagement, provided that training environments are designed to be participatory, collaborative and grounded in their disciplinary contexts.

4.2 Institutional Practice

The iterative lesson planning process at the heart of the HAICo model emerged directly from what was observed during the workshop's Stage IV activities. When participants moved from individual brainstorming (Version 1) through AI-assisted refinement (Version 2) to collaborative synthesis (Version 3), each iteration produced qualitatively different outputs. Version 1 drew on existing disciplinary and contextual knowledge but showed limited engagement with AI. Version 2 expanded technological and pedagogical possibilities but lost contextual grounding. It was only in Version 3, through peer discussion and collective reflection, that participants filtered, adapted and contextualised AI-generated outputs into lesson plans that were both pedagogically meaningful and feasible within their classroom realities. This pattern was consistent across all six groups and confirmed through observation notes and group presentations.

These findings indicate that institutions should encourage collaborative, iterative lesson planning processes that position AI as a cognitive partner

rather than a replacement for human expertise and pedagogical judgement. The three-stage structure of the HAICo model offers a practical scaffold that institutions can embed within existing faculty development and curriculum design processes. The collaborative synthesis stage, in particular, proved essential for contextualising AI-generated content and should not be treated as optional. Institutions might consider establishing peer lesson planning circles or collaborative design workshops as regular features of faculty development, using the HAICo cycle as a structuring framework. Future work may also explore how institutional structures, leadership cultures and policy environments influence the development of reflexive digital mindsets and the successful implementation of AI-supported pedagogical practices. The role of institutional leadership in legitimising experimentation with AI, creating safe spaces for pedagogical risk-taking and allocating time for collaborative planning deserves particular attention.

4.3 Validation and Scaling

The HAICo model and its Digital Mindset-enabled extension were developed through a single participatory workshop with 24 participants drawn from colleges and universities across one state in India. While the model is empirically grounded in the iterative lesson planning data and conceptually underpinned by the revised TPACK framework, its development within a specific regional, institutional and disciplinary context necessarily raises questions about transferability. The participant group was drawn predominantly from the sciences (16 out of 24), with comparatively limited representation from technology (3), engineering (3) and mathematics (2). Five of the six groups worked on the same broad theme (Patterns in Nature and Technology), meaning the model's applicability across a wider range of STEM topics and disciplinary traditions remains untested. Furthermore, the workshop took place at a premier national institution (IIT Jodhpur), and the dynamics of collaboration, access to AI tools and institutional culture at state universities, affiliated colleges and polytechnics may differ significantly.

The Digital Mindset-enabled HAICo model should therefore be further validated across different educational contexts, disciplines, institutional settings and learner populations to examine its transferability and adaptability. Opportunities exist to extend the model beyond STEM education and investigate its applicability in interdisciplinary and non-STEM contexts, particularly in the humanities and social sciences where the relationship between AI and disciplinary epistemology may be differently configured. Future studies may develop structured interventions and training modules around the three stages of the HAICo framework to support systematic and replicable AI integration in classrooms. COL-CEMCA's network across Commonwealth Asia, spanning diverse institutional types and national education systems, provides a natural platform for this cross-contextual validation work.

4.4 Future Research

Several findings from this study open avenues for further investigation. The absence of gendered articulations among participants, despite the broader structural concerns regarding women in STEM documented extensively in the literature (Maji et al., 2023; Marmath, 2024; Amirtham and Kumar, 2021), is perhaps the most striking. Participants not only did not identify gender-specific concerns related to AI adoption but actively questioned the relevance of discussing women in STEM separately. This finding can be read in at least two ways. It may reflect a genuine perception among these participants that AI adoption in their professional lives is not shaped by gender. Alternatively, it may indicate that the methodological conditions of a single-day structured workshop, with its emphasis on activities and group tasks, were insufficient to surface deeper gendered dimensions of technology engagement that might emerge through longitudinal ethnographic or interview-based approaches. Future research should investigate this tension directly, examining whether and how gendered experiences of AI integration manifest differently across research designs, institutional types and regional contexts.

Longitudinal and cross-contextual studies are also recommended to examine the sustainability, effect-

and evolving nature of the Digital Mindset-enabled HAICo model in response to rapidly changing AI technologies. The model was developed at a particular moment in the evolution of generative AI, when tools such as ChatGPT and Gemini were the dominant reference points for participants. As AI technologies continue to develop in capability and accessibility, the knowledge demands, ethical considerations and pedagogical possibilities associated with AI-supported teaching will shift accordingly. Whether the HAICo model's three-stage cycle and its underpinning digital mindset dispositions remain robust under these conditions is an empirical question that only sustained, longitudinal inquiry can answer. Comparative studies across different regional and institutional contexts within the Commonwealth would further strengthen understanding of how sociocultural factors shape women STEM teachers' relationships with AI and how the model can be adapted to serve diverse educational realities.

5. Conclusion

This participatory study, jointly conducted by IIT Jodhpur and COL-CEMCA, examined the integration of AI in STEM higher education across Rajasthan, with a particular focus on women teachers. The study sought to understand how women STEM educators engage with AI in their teaching, what factors shape varying levels of adoption and what forms of support are needed to make that adoption meaningful, responsible and sustainable.

The findings reveal that the attitudinal preconditions for meaningful AI adoption are already present among women STEM teachers in the region. Participants demonstrated a largely optimistic orientation towards AI, viewing it as a means of fostering interactive teaching, enhancing efficiency and supporting continuous professional learning. They reported using AI tools primarily for understanding concepts and preparing presentations and expressed high expectations regarding AI's potential to personalise learning, provide instant feedback and reduce routine workloads, even where technological confidence remained at the "somewhat confident" level for the majority.

However, the study also found that optimism and tool familiarity alone do not translate into meaningful integration. What proved decisive was the process through which teachers engaged with AI. The three-stage lesson planning activity revealed that AI expanded pedagogical possibilities but that human collaboration was essential for filtering, contextualising and grounding AI-generated outputs within classroom realities. Individual brainstorming activated disciplinary and contextual knowledge. AI-assisted refinement broadened the repertoire of pedagogical strategies. But it was only through collaborative synthesis, where teachers discussed, debated and adapted one another's AI-assisted plans, that lesson designs became both pedagogically sound and feasible within the constraints of real classrooms. This iterative dynamic formed the empirical basis for the HAICo model, which positions AI as a cognitive partner embedded within collaborative and context-sensitive pedagogical practice rather than as an autonomous instructional agent.

At the same time, the study surfaced important limitations in participants' engagement with AI. While they demonstrated openness and adaptability, their awareness of the sociotechnical dimensions of AI, including algorithmic bias, data ethics and the gendered implications of AI systems, remained limited. Participants largely perceived AI adoption as gender-neutral and actively questioned the relevance of discussing women in STEM separately, a finding that stands in tension with the broader structural concerns documented in the literature. These observations pointed to the need for a deeper enabling condition beyond technical skill or positive attitude. The resulting Digital Mindset-enabled HAICo model addresses this by integrating pedagogical processes, TPACK knowledge competencies and cultural dispositions, including reflexive criticality and inclusive digital consciousness, into a coherent framework for AI-supported lesson planning that is context-sensitive, inclusive and ethically grounded.

It is important to note that this study was exploratory in nature, drawing on a participatory workshop with 24 participants from a single regional context. The findings are indicative rather than generalisable and should be interpreted within the scope of this small-scale, context-specific investigation.

Notwithstanding these limitations, the study contributes both empirical evidence and conceptual innovation to the emerging field of AI-supported STEM education. By integrating participatory research with pedagogical model development, it advances a human-centred vision of AI in education that preserves teacher agency, values collaboration and recognises the importance of contextual realities in shaping technological innovation. The Digital Mindset-ena-

bled HAICo model, with its three interconnected layers of process, knowledge and environment, offers a framework that can inform not only individual teaching practice but also the design of professional development programmes, institutional capacity-building strategies and policy interventions aimed at embedding responsible AI use within higher education systems. As AI continues to reshape higher education across the Commonwealth, frameworks such as these can help ensure that this transformation remains grounded in the voices, expertise and lived realities of the women who teach.

Declaration on the Use of Artificial Intelligence

The authors acknowledge the use of generative artificial intelligence (AI) tools solely for language editing, stylistic improvement, and assistance in organising the presentation of the manuscript. No AI tools were used for data generation, data analysis, result interpretation, or the formulation of conclusions. All intellectual contributions, including the conceptualisation, methodology, analysis, and interpretation of findings, are attributable to the authors, who have reviewed and validated all content and accept full responsibility for the manuscript.

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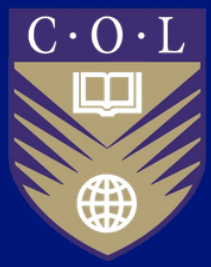
Annexure 1

Women Shaping AI in STEM Classrooms (SHAPE-AI STEM): A Participatory Exploration of Practice and Possibility in Higher Education

9 May 2026 | 8:00 am - 5:45 pm | Venue: LHB 106, LHC-I, IIT Jodhpur

Time	Session	Resource Person(s)
Registration | 8:00 am - 8:45 am		
8:00 am - 8:45 am	Registration and Breakfast	Kumar Gaurav and Parul Kumawat (IITJ)
8:45 am - 9:00 am	Assembly and Networking at the venue	
Inaugural Session | 9:00 am - 9:45 am **Session Moderator: Parul Kumawat (IITJ)**		
9:00 am - 9:10 am	Welcome address	Dr. Sheriya Sareen (IITJ)
9:10 am - 9:20 am	Special Remarks	Dr. Bhivraj Suthar (Associate Dean, International Connect, IITJ) | Women Scientists at IIT Jodhpur: Advancing AI for National Development
9:20 am - 9:40 am	Keynote Address	Prof. B. Shadrach (Director, CoL-CEMCA) | Women Shaping AI in STEM classrooms in Indian higher education
9:40 am - 9:45 am	Vote of Thanks	Dr. Navchetan Awasthi (IITJ)
Opening Circle: STEM Women Shaping Technology | 9:45 am - 10:15 am		
9:45 am - 10:15 am	Interactive ice-breaker session on Women in AI and STEM	Dr. Sheriya Sareen (IITJ)
Expert Session I | 10:15 am - 1:00 pm **Session Moderator: Kumar Gaurav (IITJ)**		
10:15 am - 11:00 am	Expert Talk I	Dr. Navchetan Awasthi (IITJ) | Understanding the role of AI in STEM teaching
11:00 am - 11:05 am	Quiz I	Dr. Navchetan Awasthi (IITJ)
11:05 am - 11:15 am	Discussion	Dr. Navchetan Awasthi (IITJ)

Time	Session	Resource Person(s)
11:15 am - 11:25 pm	Introducing Group Activity	Dr. Sheriya Sareen | AI in action: Co-building STEM lessons
11:25 am - 11:40 am	Tea Break	
11:40 am - 12:30 pm	Group activity	Dr. Navchetan Awasthi & Dr. Sheriya Sareen (IITJ)
12:30 pm - 1:00 pm	Group presentations	Participants
1:00 pm - 2:00 pm	Lunch & Community Building	
Expert Session II | 2:00 pm - 4:30 pm Session Moderator: Parul Kumawat (IITJ)		
2:00 pm - 2:45 pm	Expert Talk II	Dr. Bhivraj Suthar (IITJ) | Robotics and AI in STEM Classrooms: Recent Innovations
2:45 pm - 2:50 pm	Quiz II	Dr. Bhivraj Suthar (IITJ)
2:50 pm - 3:00 pm	Discussion	Dr. Bhivraj Suthar (IITJ)
3:00 pm - 3:10 pm	Introducing Group Activity	Dr. Sheriya Sareen | 4 Corners' Dialogue: Mapping Mindsets in Robotics, AI & STEM
3:10 pm - 4:10 pm	Group activity	Dr. Bhivraj Suthar & Dr. Sheriya Sareen (IITJ)
4:10 pm - 4:30 pm	Group presentations	Participants
Closing Session | 4:30 pm - 4:45 pm Session Moderator: Kumar Gaurav (IITJ)		
4:30 pm - 4:40 pm	Felicitation Ceremony	Dr. Alok Ranjan (Head, School of Liberal Arts) and Prof. Anil Kumar Tiwari (Head, School of Artificial Intelligence and Data Science)
4:40 pm - 4:45 pm	Valedictory address	Dr. Navchetan Awasthi (IITJ)
4:45 pm - 5:05 pm	Networking Tea	
5:05 pm - 5:15 pm	Assemble at the Bus pick up point for Lab visit	Muhammed Sinan (IITJ)
5:15 pm - 5:40 pm	**Lab visit**	
5:05 pm - 5:15 pm	Lab visit	Dr. Bhivraj Suthar (IITJ) | Visit to Next Generation BIRD Robotics Lab and Cognitive Lab
5:40 pm - 5:45 pm	Assemble at the Bus pick up point for Return Journey	Muhammed Sinan (IITJ)



CEMCA

Commonwealth of Learning-Commonwealth Educational Media Centre for Asia
7/8, Sarva Priya Vihar, New Delhi 110016, India
Tel: +91-11-26537146/47
Web: www.cemca.org

