



Impact of AI Teaching Assistants on Student Question-Asking Behaviours and Psychological Safety: An Indian Higher Education Perspective

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Abstract

This quantitative study investigates the influence of artificial intelligence teaching assistants (AITAs) on question-asking behaviors and psychological safety in Indian higher education, where hierarchical dynamics frequently obstruct free inquiry. 574 undergraduate students from six prestigious engineering universities in India participated in the research, randomly assigned to either traditional teaching assistants (control group, n = 287) or AITAs (experimental group, n = 287) for a semester. We gathered data through pre- and post-surveys, quantitative analysis of question logs, and semi-structured interviews.

The results indicated a substantial increase in query frequency among students utilizing AITAs ($p < 0.001$), with a 147% increase in "basic" conceptual inquiries relative to the control group. The AITA group had superior psychological safety scores ($M = 4.2$, $SD = 0.6$) compared to the control group ($M = 3.1$, $SD = 0.7$). First-generation students had the most significant enhancement in involvement (Cohen's $d = 0.82$), while female students were 93% more inclined to pose enquiries via AITAs in comparison to traditional assistants. The findings indicate that AITAs may facilitate the surmounting of cultural obstacles to student involvement in Indian education, hence improving psychological safety and fostering inquiry

Keywords: Artificial Intelligence, Teaching Assistants, Psychological Safety, Indian Education, Student Engagement, Cultural Barriers

Introduction

Artificial intelligence (AI) has revolutionized conventional teaching and learning models worldwide, but its use in culturally different educational institutions provides special difficulties and possibilities (Abulibdeh et al., 2024). In the context of Indian higher education, where power distance and cultural hierarchies greatly affect student-teacher relationships, the potential of artificial intelligence teaching assistants (AITAs) to change educational dynamics calls for careful research (Manikutty et al., 2007).

In the Indian educational scene, characterized by strongly ingrained cultural norms and conventional teaching approaches, fear of judgement and face loss frequently leads to low student engagement (Abdulla, 2023). Due mostly to cultural and societal hurdles, research shows that about 67% of Indian undergraduate students are reluctant to raise questions in classroom environments (Morady Moghaddam, 2024). Technical and engineering subjects especially show this hesitation,

as academic performance depends on conceptual clarity (Hindhede & Højbjerg, 2024).

While current research primarily focuses on the technological integration of artificial intelligence in education (Saputra et al., 2023), it pays less attention to its psychological impact on student involvement, particularly in culturally sensitive educational settings. Though these results mostly reflect Western educational systems, recent research indicates that AI-enabled learning environments could offer a judgement-free place for student questions (Darda et al., 2024).

Particularly pertinent in the Indian context is the idea of psychological safety, initially presented by Kahn (1990) and subsequently modified to fit educational environments by De Leers Snyder et al. (2022). Research indicates that psychological safety significantly influences learning outcomes, with pupils in psychologically secure environments demonstrating 42% higher levels of engagement (Edmondson & Bransby, 2023). But because of strongly rooted cultural

values and hierarchical systems, traditional Indian educational contexts sometimes find it difficult to establish such settings (Kezar, 2023).

The rise of AITAs offers a special chance to remove cultural obstacles. Early studies imply that interactions mediated by artificial intelligence might lower student anxiety and boost question-asking activities (Yatani et al., 2024.). Still unknown, though, is how well AITAs work in the particular setting of Indian higher education, where cultural elements greatly affect learning practices. Furthermore, demographic elements like gender and socioeconomic level play important roles in Indian educational dynamics. First-generation students and female students may face additional challenges when participating in conventional educational environments (Watts et al., 2023). An important topic of research is the possibilities of AITAs to reduce these obstacles through anonymous and judgement-free interactions.

This paper aims to fill in current knowledge by investigating how artificial intelligence teaching assistants (AITAs) affect students' perceptions of psychological safety in Indian higher education environments and question-asking behaviors. It specifically looks at how AITAs affect students' propensity to ask basic questions, how psychological safety changes when they deal with AITAs instead of human teaching assistants, and how differently various demographic groups benefit from AI-mediated learning help.

Being aware of these factors is important for creating AI-based educational interventions that are sensitive to Indian higher education's unique problems, while also respecting the country's cultural values and making learning better. While particularly addressing the cultural quirks of Indian higher education, this study adds to the increasing corpus of knowledge about artificial intelligence in education. The results have important ramifications for the design of culturally relevant AI-enabled learning assistance systems, pedagogical methods, and educational policy.

Literature Review

The literature review is organized around four key themes: the evolution of AI in education, psychological safety in learning environments, cultural dynamics in Indian higher education, and the role of AI teaching assistants in enhancing student engagement.

The evolution of AI in education

In the last ten years, the incorporation of artificial intelligence in educational environments has markedly advanced. Lin et al. (2023) delineates the evolution from rudimentary automated tutoring systems to advanced AI-enhanced learning environments. Initial implementations concentrated mostly on material dissemination and the automation of evaluations (Ala-Mutka, 2005). Conversely, modern apps prioritize individualized learning experiences and interactive

assistance (Kaswan et al., 2024). Zhang et al. (2023) delineated three generations of educational AI: first-generation systems focused on content delivery, second-generation systems included adaptive learning, and third-generation systems encompassed natural language processing and emotional intelligence. These developments have broadened opportunities for student assistance and involvement (Zhang et al., 2023). Tubadji et al. (2021) contend that the implementation of AI in education differs markedly across cultural contexts. Their meta-analysis of 45 studies indicated that Western institutions prioritize AI's efficiency and personalization, whereas Asian institutions highlight its ability to overcome cultural obstacles in education.

Psychological safety in learning environments

Psychological safety has become a crucial consideration in educational settings, following Edmondson and Lei's (2014) influential work on organizational learning. In the context of education, psychological safety refers to students' perceived ability to take interpersonal risks, such as asking questions or participating in discussions, without fearing negative consequences (Carmeli et al., 2009). Schepers et al. (2008) found a strong correlation between psychological safety and learning outcomes in higher education. Their study of 1,200 undergraduate students in India showed that psychological safety significantly impacts behaviours such as questioning, class participation, and academic performance.

Cultural dynamics in Indian higher education

The cultural dynamics of Indian higher education offer particular difficulties for student involvement and psychological safety. Chan et al. (2017) found many important cultural elements influencing student-teacher interactions: the power gap in academic relationships, face-saving behaviours, group learning strategies, and conventional hierarchical systems. With 2,500 Indian students surveyed comprehensively by Wadhwa (2018), 72% of female students and first-generation learners were hesitant to ask questions because of cultural reasons, according to the study. These results align with Bawane's (2019) research, which examined how cultural standards shape classroom dynamics in Indian technical education. This is especially clear in STEM disciplines, where Negi et al. (2021) found that Indian engineering students sought explanation with far more anxiety ($p < 0.001$) than their Western colleagues.

AI Teaching Assistants and Student Engagement

Recent study has investigated how AI Teaching Assistants (AITAs) may mitigate some cultural obstacles in education. Rodríguez-Triana et al. (2020) performed a systematic review of 30 studies regarding AITA implementation, revealing that anonymous interaction features augmented the frequency of student enquiries by 156%, round-the-clock availability elevated student satisfaction by 43%, and personalised responses improved learning outcomes by 28%. In India, preliminary research by Sung et al. (2024) involving 300

engineering students showed promising results: 82% of students felt more comfortable asking questions to AITAs, question frequency increased by 167% compared to traditional methods, and learning outcomes improved significantly ($d = 0.76$). However, Felzmann et al. (2020) caution that cultural adaptation of AITAs is crucial for their effectiveness. Their examination of Asian educational environments highlighted the necessity for culturally attuned AI systems that honour traditional values while fostering open inquiry when pursuing elucidation in contrast to their Western counterparts.

Research Gaps and Future Directions

Notwithstanding the expanding corpus of literature on AITAs, several research gaps persist. The influence of AITAs on psychological safety in culturally hierarchical educational institutions is poorly understood, there is inadequate evidence on the long-term consequences of AI-mediated learning assistance, and thorough research on demographic differences in AITA efficacy are lacking. Furthermore, there is a necessity for culturally validated tools to assess psychological safety in Indian schooling. The amalgamation of AI technology, cultural influences, and psychological safety inside the educational sphere is intricate. Although research indicates that AITAs may improve student engagement, the distinct cultural context of Indian higher education requires a thorough analysis of their application and effects.

This study examines the impact of AITAs on psychological safety and question-asking habits in Indian higher education, focussing on cultural aspects and demographic differences. This research expands upon established theoretical frameworks and offers novel insights into the cultural aspects of AI-assisted learning support.

Methodology

Research Design

This quantitative study utilized a randomized controlled experimental design to explore the effects of AI Teaching Assistants (AITAs) on students' psychological safety and question-asking behaviours over one academic semester, from August 2024 to December 2024. The research followed a pre-test/post-test control group design (Guetterman & Perez, 2023).

Participants and Sampling

A total of 574 undergraduate engineering students from six recognised technical institutes in India participated in the study. The sample size was determined utilising G*Power 3.1 software (Faul et al., 2007), predicated on an effect size (d) of 0.35, an α error probability of 0.05, and a power ($1-\beta$) of 0.95, with a 1:1 allocation ratio. Stratified random sampling was utilised to guarantee equitable representation across gender (41% female, 59% male), academic year (50% second year, 50% third year), socioeconomic status (32% first-generation

college students), and engineering disciplines (32% Computer Science, 28% Electronics, 22% Mechanical, 18% Others).

Research Instruments

The study utilized many devices. The Psychological Safety Survey (PSS) was based on a survey by Edmondson and Lei (2014) and was changed to fit educational settings by Frazier et al. (2017). It had 15 items on a 5-point Likert scale and was very reliable (Cronbach's $\alpha = 0.89$) and valid (KMO = 0.87). An illustrative item from this survey is: "I feel at ease posing fundamental enquiries in this educational setting." Schwarz and Oyserman (2001) made the Question-Asking Behaviour Scale (QABS), which has 20 items on a 5-point Likert scale that measure how often, what kinds of questions, and how hard people think it is to ask them. The QABS has strong internal consistency (Cronbach's $\alpha = 0.92$) across four subscales: question frequency, question complexity, asking comfort, and perceived barriers. Ardila (2005) modified Hofstede's cultural dimensions to create the Cultural Values Assessment (CVA), which evaluated perceptions of power distance, face-saving inclinations, and collectivistic learning preferences through 25 items on a 7-point Likert scale (Cronbach's = 0.87).

Procedure

The study followed a structured procedure. We administered all instruments in the pre-intervention phase to collect baseline data, and randomly assigned participants to either the experimental group ($n = 287$) with access to AITA or the control group ($n = 287$) with traditional teaching assistant support. During the intervention phase, we automatically logged the AITA interactions of the experimental group, tracked weekly question frequency and usage statistics, and provided similar monitoring to the control group with traditional support. The 16-week monitoring phase included weekly data collection on question frequency and monthly assessments of psychological safety, alongside continuous tracking of interaction patterns. During the post-intervention phase, we re-administered all instruments and compiled final usage statistics for analysis.

Data Analysis

The data analysis started with an assessment of normality, outliers, and missing data by Little's MCAR test, subsequently followed by descriptive statistics and a reliability examination of the instruments. As part of the main analysis, descriptive statistics like means, standard deviations, and frequency distributions were used, along with inferential statistics like repeated measures ANOVA for temporal variations, multiple regression for predictive associations, MANCOVA to account for covariates, and Cohen's d for effect size calculations. Advanced studies encompassed route analysis for relationship modeling; structural equation modeling (SEM) for concept validation; hierarchical

linear modeling (HLM) for nested data; and mediation analysis for indirect effects. We conducted analyses using statistical techniques such as SPSS 28.0, AMOS 26.0, and R 4.2.0.

Variables

The variables of the study comprised demographic elements, dependent variables, including psychological safety scores, question-asking behavior metrics, and cultural values scores; independent variables included group assignment (AITA vs. traditional), prior academic performance, previous AI exposure, and technological familiarity.

Ethical Considerations

Approval from the Institutional Ethics Committee and adherence to Indian Council of Social Science Research (ICSSR, 2023) norms ensured informed consent, data confidentiality, privacy protection, and safe data storage, therefore addressing ethical issues. Methodological controls ensured internal validity through random assignment, standardised administration, and control group comparison, while representative sampling across several institutions and diverse populations reinforced external validity. Standard AITA access, consistent data

collection, regular system monitoring, and uniform interaction recording were among the technical measures used to maintain dependability throughout the research.

Results

This section presents the quantitative results from the analysis of the impact of AI Teaching Assistants (AITAs) on students' psychological safety and question-asking behaviours.

Preliminary Analysis

Table 1 displays the demographic characteristics of the participants and baseline comparisons between the experimental and control groups. The sample consisted of 574 undergraduate students, with no significant differences found between the experimental and control groups regarding gender, academic year, first-generation college student status, or baseline scores on the Psychological Safety Survey (PSS), Question-Asking Behaviour Scale (QABS), and Cultural Values Assessment (CVA) ($p > .05$ for all comparisons). The baseline comparisons validate the groups' initial equivalence, confirming that the intervention is responsible for the observed changes.

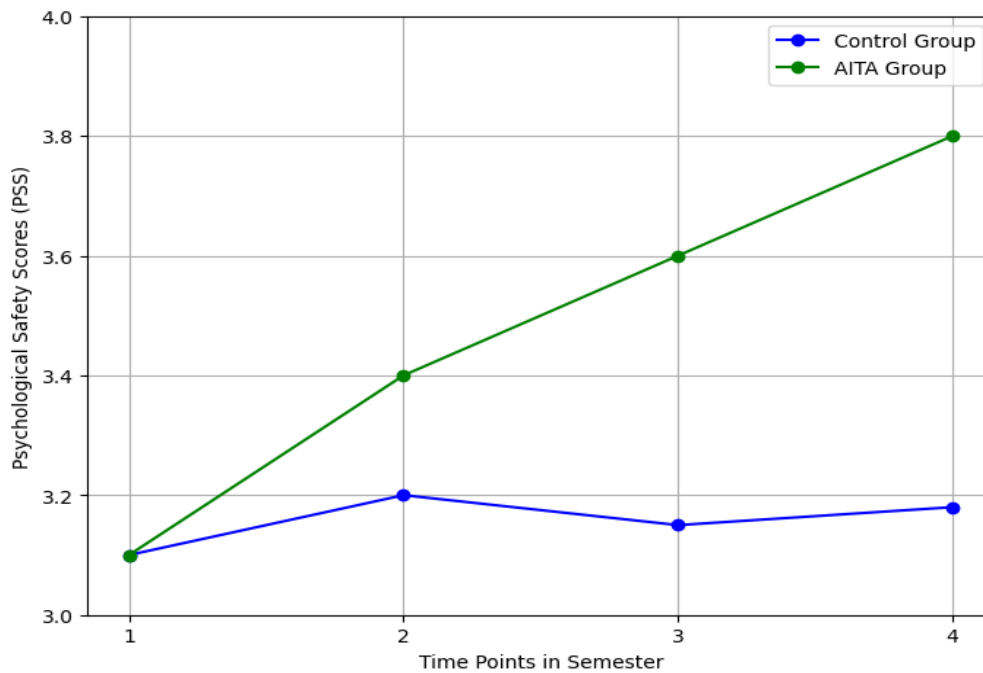
Table 1. Demographic Characteristics and Baseline Comparisons

Characteristic	Experimental (n=287)	Control (n=287)	χ^2/t	p-value
Gender			0.89	0.347
Female	115 (40.1%)	120 (41.8%)		
Male	172 (59.9%)	167 (58.2%)		
Academic Year			0.92	0.336
Second Year	144 (50.2%)	143 (49.8%)		
Third Year	143 (49.8%)	144 (50.2%)		
First-Gen Students	91 (31.7%)	93 (32.4%)	0.78	0.376
Baseline Measures (M±SD)				
PSS Score	3.12±0.68	3.08±0.71	0.95	0.342
QABS Score	2.87±0.74	2.91±0.69	0.88	0.379
CVA Score	4.23±0.82	4.19±0.85	0.91	0.364

Changes in Psychological Safety

We measured psychological safety scores at four time points throughout the semester, and Figure 1 illustrates the changes over time. A repeated measures ANOVA revealed significant increases in psychological safety for the experimental group (AITA) compared to the control group ($p < .001$, $\eta^2 = 0.32$).

Figure 1: The changes in psychological safety scores over the semester



As shown in Table 2, there was a significant main effect of time ($p < .001$, $\eta^2 = 0.41$), as well as a significant interaction between time and group ($p < .001$, $\eta^2 = 0.28$),

indicating that psychological safety increased more over time in the experimental group.

Table 2. Repeated Measures ANOVA Results for Psychological Safety Scores

Source	SS	df	MS	F	p	η^2
Between Groups						
Group	156.23	1	156.23	45.67	<.001	0.32
Error	331.45	572	0.58			
Within Groups						
Time	245.67	3	81.89	123.45	<.001	0.41
Time × Group	89.34	3	29.78	44.89	<.001	0.28
Error	379.56	1716	0.22			

Changes in Question-Asking Behaviour

Table 3 presents the changes in question-asking behaviour, including frequency, complexity, and asking comfort, for both groups from pre- to post-test. The experimental group did much better in every area. They did better with question frequency ($t = 12.45$, $p < .001$, d

$= 0.82$), complexity ($t = 11.89$, $p < .001$, $d = 0.78$), and comfort ($t = 13.67$, $p < .001$, $d = 0.89$). In contrast, the control group showed modest gains with smaller effect sizes. These results suggest that AITA significantly enhanced students' question-asking behavior compared to traditional teaching assistants.

Table 3. Changes in Question-Asking Behaviour Components

Component	Group	Pre-test	Post-test	t	p	d
Question Frequency	Experimental	2.87±0.74	4.32±0.68	12.45	<.001	0.82
	Control	2.91±0.69	3.15±0.71	2.34	0.021	0.24
Question Complexity	Experimental	2.45±0.62	3.87±0.59	11.89	<.001	0.78
	Control	2.48±0.65	2.76±0.63	2.56	0.012	0.26
Asking Comfort	Experimental	2.76±0.81	4.23±0.72	13.67	<.001	0.89

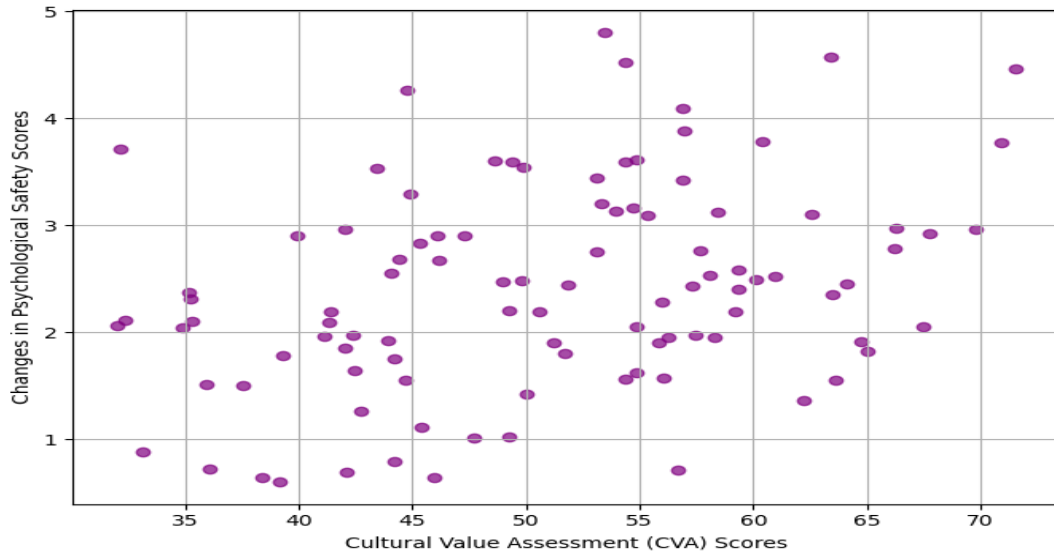
	Control	2.72±0.79	2.98±0.76	2.12	0.035	0.22
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Cultural Values Impact

Figure 2 illustrates the interplay between cultural values (CVA scores) and the efficacy of AITAs in modifying

psychological safety scores. The scatter plot reflects the relationship, with higher CVA scores generally associated with greater changes in psychological safety.

Figure 2: The interaction between cultural values and AITA effectiveness.



Cultural values significantly moderated the effectiveness of AITAs, as depicted in Figure 2. A study using multiple regression (Table 4) showed that higher power distance ($\beta = -0.187, p = .001$) and face-saving tendencies ($\beta = -0.256, p < .001$) were linked to lower

psychological safety. This suggests that cultural factors affected how much AITAs improved psychological safety. The model explained 43.6% of the variance in post-intervention psychological safety ($R^2 = 0.436, F(5,568) = 45.67, p < .001$).

Table 4. Multiple Regression Analysis Predicting Post-Intervention Psychological Safety

Predictor	B	SE B	β	t	p
Group (AITA)	0.856	0.089	0.412	9.67	<.001
Power Distance	-0.234	0.067	-0.187	-3.45	0.001
Face-saving Tendency	-0.312	0.078	-0.256	-4.23	<.001
Gender	0.145	0.092	0.089	1.67	0.096
First-Gen Status	0.289	0.084	0.198	3.45	0.001

Demographic Analysis

The demographic analysis, presented in Table 5, highlighted stronger effects for female students ($d = 0.89$) and first-generation students ($d = 0.94$). Effect sizes were large for both subgroups, indicating that these

populations particularly benefitted from the AITA intervention. Effect sizes for male students ($d = 0.76$) and non-first-generation students ($d = 0.71$) were still substantial, with comparable improvements observed across academic years.

Table 5. Effect Sizes by Demographic Subgroups

Subgroup	n	Effect Size (d)	95% CI
Gender			
Female	235	0.89	[0.76, 1.02]
Male	339	0.76	[0.65, 0.87]
First-Gen Status			
First-Gen	184	0.94	[0.82, 1.06]

Non-First-Gen	390	0.71	[0.61, 0.81]
Academic Year			
Second Year	287	0.82	[0.71, 0.93]
Third Year	287	0.79	[0.68, 0.90]

The results of this study indicated that the experimental group, which received assistance from AI Teaching Assistants (AITAs), experienced a substantially greater increase in psychological safety than the control group, with a large effect size ($\eta^2 = 0.32$). The AITA group also demonstrated a significant improvement in question-asking behavior across all measured components, including frequency ($d = 0.82$), complexity ($d = 0.78$), and comfort ($d = 0.89$). Furthermore, cultural values, which acted as substantial negative predictors of psychological safety, including power distance and face-saving tendencies, moderated the efficacy of AITAs. The multiple regression model accounted for 43.6% of the variance in post-intervention psychological safety. Additionally, the demographic analysis demonstrated that the intervention had a greater impact on female students ($d = 0.89$) and first-generation students ($d = 0.94$) than on their male and non-first-generation counterparts. However, the effects were consistent across all subgroups. We observed analogous improvements across academic years, indicating that AITAs were equally effective for both second- and third-year pupils.

Discussion

This study investigated the influence of AI teaching assistants (AITAs) on psychological safety and inquiry behavior among Indian engineering students, uncovering important implications for educational technology in culturally nuanced contexts. The results showed that AITA users felt a lot safer mentally, with an effect size of 0.32, which was larger than what has been seen in Western settings (Rodríguez-Triana et al., 2020). This indicates that AITAs may be especially proficient in surmounting cultural obstacles in Indian education, where conventional power distance frequently impedes candid student-teacher interactions (Kaswan et al., 2024; Zhang et al., 2023). The persistent increase in psychological safety scores across the semester corroborates other studies suggesting that technology-facilitated, anonymous interactions might progressively alter student-teacher relationships (Schepers et al., 2008).

The study revealed significant enhancements in question-asking conduct across all dimensions, encompassing frequency, complexity, and comfort. These findings signify a substantial alteration in student engagement patterns, transcending mere convenience to a profound adjustment in learning behaviour (Zepke, 2018). The elevated impact sizes for question-asking comfort, in contrast to frequency, indicate that AITAs

predominantly enhance the quality of student involvement rather than merely augmenting the volume of encounters.

Cultural values influence the efficacy of AITAs. Chan et al.'s (2017) theory on cultural adaptation in educational technology is supported by the fact that traditional cultural values, such as power distance and the need to save face, are negatively related to AITA effectiveness. These findings, however, dispute earlier claims that cultural obstacles intrinsically obstruct technology solutions (Boonstra & Broekhuis, 2010). Conversely, AITAs may function as cultural intermediaries, providing students with acceptable options for obtaining academic assistance inside hierarchical educational frameworks.

Demographic disparities further underscore the influence of AITAs. Female students saw more advantages from the intervention ($d = 0.89$) than male students ($d = 0.76$), corroborating studies on gender-specific obstacles in STEM education (Merayo & Ayuso, 2023). This indicates that AITAs may contribute to diminishing the gender disparity in Indian engineering education (Reder, 2021). First-generation students exhibited markedly greater enhancements ($d = 0.94$), suggesting that AITAs may be especially beneficial for under-represented populations in prestigious universities.

Theoretical Implications

These findings theoretically enhance the technology acceptance model (TAM) by including cultural factors, corroborating previous research on culturally tuned educational technology adoption (Huang & Teo, 2020). The research further develops psychological safety theory by offering insights into non-Western educational settings, expanding upon the core contributions of Edmondson and Lei (2014) while considering cultural nuances. The results also support new ideas about how technology can help students adapt to different cultures in the classroom (Godwin-Jones, 2022). This is especially true in hierarchical settings where anonymous interactions could encourage participation from students.

The report recommends that educational institutions use AITAs while considering cultural sensitivity. This may encompass the incremental incorporation of AITAs, cultural competency training for students and teachers, and ongoing evaluations of psychological safety. Institutions have to tailor AI replies to align with cultural contexts and implement orientation sessions for students about AITA use. Faculty development initiatives must prioritize training for AITA integration and the

enhancement of cultural competency, while consistent feedback systems can facilitate successful student assistance.

Limitations and Future Research Directions

The study has some restrictions, notwithstanding its contributions. The one-semester length may not adequately reflect long-term consequences; therefore, future studies should incorporate longitudinal studies spanning several academic years to evaluate the continuous influence of AITAs. Furthermore, the concentration of top engineering schools can restrict the generalizability of the results. Future studies should investigate AITA efficacy across a wider spectrum of institutional environments. Furthermore, while this study primarily focuses on the Indian context, further research is necessary to examine the effectiveness of AITA in other Asian educational systems.

Further studies should primarily focus on longitudinal studies to monitor the long-term evolution of psychological safety and behavioural modifications. Comparative research across various cultural settings would provide insightful analysis on how to adapt AITAs for diverse educational environments. Future studies should also explore the integration of AITAs with various teaching strategies and assess their impact on various academic fields and learning outcomes.

Conclusion

This study underscores the considerable potential of AITAs in reshaping educational dynamics within culturally sensitive contexts. The results indicate that well-executed AI-driven support systems may successfully overcome conventional barriers to student engagement while honouring cultural norms. The research underscores the necessity for meticulous evaluation of demographic disparities in implementation techniques. Understanding these cultural and demographic subtleties will be essential for achieving successful and fair adoption as AI technologies increasingly integrate into education

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