

Classroom environment and student-centered pedagogy as predictors of learning outcomes and 21st-century skills in Indian higher education

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Article Info

Article history:

Received Apr 11, 2026

Revised Aug 14, 2026

Accepted Aug 20, 2026

Keywords:

21st-century skills

Classroom environment

Higher education

Indian higher education

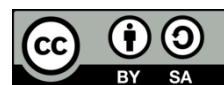
NEP 2020

Pedagogical practices

ABSTRACT

This study explores the association of classroom environments and students centered pedagogical practices on student learning outcomes (LO) and the 21st-century skills development in Indian higher education (IHE). Despite the National Education Policy (NEP) 2020 strongly advocating learner-centered pedagogy, a gap exists between policy vision and classroom practice. Using a cross-sectional survey, the data were collected from 320 students enrolled in higher education institutions (HEIs) in Delhi (India). The study employed the self-developed tools, including students' perception on classroom environment scale (SPCES), and students' centric pedagogical practices scale (SCPPS), along with measures of perceived LO and 21st-century skills. Statistical analyses, including factor analysis, Chi-square, analysis of variance (ANOVA), and multiple regression, were conducted. The findings reveal that classrooms having innovative environment (InnE) and interactive environment (IntE) are significantly associated with LO and 21st-century skills. Instructional and assessment quality (IAQ) emerged as the strongest predictor of LO, followed by technology-enhanced learning modes (TELM). The study concludes traditional teacher-led models still dominate in the classroom, despite NEP reform. This paper highlights the need for systematic pedagogical transformation, supported by faculty development, and alignment of classroom practices with NEP in India and comparable Global South contexts.

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1. INTRODUCTION

Transformation in higher education systems (HES) can be observed across the world, including India. Globalization, digitization, and skill-oriented employability are influencing the job market. Furthermore, students must be equipped with 21st-century skills in order to make them employable. This reorients the academic interest. This necessitates revolution in the classroom environment and pedagogical approach. So that students can learn better and develop essential skills. Further, the National Education

Policy (NEP) is committed to delivering a more learner-centric and holistic approach to existing education framework in India [1]. With a substantive focus on 21st-century skills, it promotes creativity, critical thinking, communication, and a collaborative approach. A bidirectional approach to innovative classroom practices and instructional strategies will facilitate in achieving these goals. A positive and interactive classroom environment significantly improves their student's engagement and their learning outcomes (LO) [2]. In contrast, traditional classrooms, often characterized by teacher-led instruction and limited student involvement, may hinder creativity and problem-solving skills [3]. Nevertheless, classroom environments, such as innovative environment (InnE) and interactive environment (IntE), support active learning, peer collaboration, and cognitive development of the students, particularly at higher level [4].

Pedagogical practices are equally critical in developing students' skills. Thus, these practices must be aligned with students' needs and educational objectives at each level. Flipped classrooms, problem-based learning along with integration of digital tools has a significant positive association with the LO of the students across the levels. The integration of assistive and associative digital tools can enhance engagement and LO [5]–[7]. The Indian higher education (IHE) continues to face several challenges, including unequal access, outdated instructional practices, and insufficient skill integration [8]–[10]. Addressing these challenges is essential for improving quality of higher education (HE) in India. Thus, it is important to understand classroom environment and pedagogical practices, particularly in India context. The major aim of the paper is to understand the effect of classroom environments and pedagogical practices on students' LO and the developmental of 21st-century skills. Further, it examines to provide empirical insights for NEP 2020 and practices gaps.

Conceptualizing classroom environment in HE: classroom environment encompasses the interaction behavior patterns of teacher-students and peers, which enable required learning space in the classroom. A positive classroom setting promotes healthy interaction, motivation, and participation [5]. Further, Fraser [2] describes “the classroom environment as the social, psychological, and physical climate in which learning occurs.” This includes ‘teacher-student relationships’, ‘peer collaboration’, ‘emotional safety’, and the ‘physical layout of the classroom’. These elements shape student learning, interactional and engagement experiences. In the IHE context, the classroom environment reflects the teaching approach, institutional culture, and degree of instructional innovation. Literature shows that student engagement increases in interactive and student-friendly settings [5]. Traditional classrooms often rely on rigid structures dominated by lectures, offering minimal opportunities for discussion or collaboration. This one-way model limits students' critical thinking, aptitude towards problem solving, and expression of creativity [3]. Interactive and innovative classrooms encourage freedom, discussion, and higher engagement of students. These environments often incorporate technology, group projects, and hands-on learning activities. These environments have positive relationship between ‘academic performance’ and ‘develop 21st-century skills development’ among students [4], [7]. Furthermore, recent studies further support the role of flexible and inclusive classroom environments in promoting social-emotional learning and student well-being of the students.

The present study is considering three types of the classroom environments namely, traditional, interactive, and innovative. These three types of the classroom environments are supporting the examination the association of classroom environments on LO and 21st century skills development. Thus, within this framework, classroom environment reflects the social and physical learning context, pedagogical practices represent aligned instructional processes, LO and skill development constitute intended educational outcomes.

Pedagogical approach, bridging theory and practice: pedagogical approach is the core of the teaching-learning process. An approach determines how knowledge is presented, processed, and applied. Particular, at HE, pedagogy is not limited to content delivery. It also includes strategies that encourage students to think critically, create, and collaborate to develop 21st century skills among students. However, traditional lecture-based teaching remains widespread in many universities. These teacher-centered methods often promote passive learning and memorization. Such approaches may influence the progression of higher-order, out-of-box thinking and real-world solution-oriented skills [5], [6]. Furthermore, Saidapur [11] highlights: “*Modern pedagogies examples of modern pedagogies include: a combination of online and offline teaching-learning processes (blended learning), the use of flipped classrooms, virtual lecture halls and labs, webinars, seminars, use of online platforms, various apps, group learning, project-based learning, self-learning, quizzes, content creation, and sharing, solving solved and unsolved problems, creative and critical thinking, etc.*”

Student-centered pedagogies support active learning and its possible extensions. Progressions like flipped classrooms, project-based learning, cooperative learning, and blended instruction encourage participation, discussion, and collaboration. These strategies are associated with improved critical thinking, confidence, and academic achievement [5]–[7]. Recent research reinforces these benefits. Suprayogi *et al.* [12] reported that innovative pedagogical approaches enhanced learner motivation and engagement. Technology

enables visualization, online collaboration, and interaction inside and outside of the classroom. When integrated effectively, it supports inclusive and interactive learning environments [13]. However, low technology integration can lead to distractions and disengagement. Thus, educators need appropriate training to use digital tools purposefully.

Further, traditional assessment system often tests memory level learning rather than creativity or application. Innovative assessment strategies, including portfolios, peer-assessments, reflective journals, and formative feedback promote deeper understanding and continuous improvement [14]. Effective pedagogy adapts to the diverse needs of learners. It prepares them for the contemporary challenges in the day-to-day life. In the diverse context uniform pedagogy approaches often fall short in addressing this diversity [15].

Suitable pedagogical strategies facilitate development of 21st-century skills among students, particularly at higher level. Learning becomes a process of exploration, not just repetition or rote memorization. It enables students to develop knowledge and competencies that aligns with the in-demand workforce and civic life [16]. This study examines how students' centric pedagogical practices associated with students' LO and their 21st-century skills development in IHE.

The 21st-century skills (proposed currency of success): labor market is evolving rapidly. Globalization, automation, and artificial intelligence are transforming how people live and work. In this era of rapid transforming context, 21st century skills have emerged as essential tools for success not only professionally but also in personal life. These 21st century skills extend beyond cognitive development, it also includes creativity, critical thinking, digital literacy, adaptability, communication, and collaboration [17].

Nowadays, employers are increasingly seeking the graduates who can think independently and solve complex, real-world problems. Needless to mention that rote memorization is no longer sufficient in this complex labor market. The 21st-century skills enable learners to respond to technological shifts and social change [17], [18]. Skills are best developed in active, student-centered classrooms. Project-based learning, inquiry-driven tasks, and collaboration among peers are some of the approaches that have shown positive effects on skill development [17], [19]. Classrooms that encourage exploration and critical dialogue support deeper learning. Digital technologies, when integrated mindfully, can further enhance communication, creativity, and collaboration. Tools that promote engagement and real-time feedback are especially valuable. However, passive screen time or poorly planned technology use can be counterproductive. Balanced integration, guided by pedagogy, is essential [13].

The NEP 2020 highlights the importance of the 21st century skills. It advocates for holistic, experiential, and competency-based education [1]. In order to keep pace with the dynamic job market, Indian higher education institutions (HEIs) need to restructure their curriculum in the light of NEP 2020. Nevertheless, continuous professional development of faculty members is crucial. The faculty members must be empowered to facilitate creativity, reflection, and discussion in their classrooms.

India has a HES which is unparalleled globally in terms of its size and diversity. According to All India Survey on Higher Education (AISHE) [20], the India has over 1,100 universities and more than 43,000 colleges. This expansion reflects a strong commitment to improve access. However, increased enrolment has not always been accompanied by improvements in quality. Many institutions continue to rely on outdated teaching methods and rigid assessment practices [9]. Traditional classroom settings emphasize lectures and examinations. It offers a limited scope for interaction, creativity, or problem-solving ability. As a result, students often focus on scoring marks rather than developing relevant skills. This disconnects between classroom learning and workplace expectations remain a persistent issue [10].

NEP 2020 seeks to address these challenges. It advocates for holistic, flexible, and skills-oriented education [1]. It is emphasizing experiential learning, digital literacy, and critical thinking. The policy calls for substantial reforms in pedagogy, curriculum, and assessment. However, translating these goals into classroom practice presents significant challenges. Indian classrooms are highly diverse. Students differ in language, socio-economic background, and access to technology. These systemic barriers constrain the shift toward more inclusive and interactive teaching practices.

Despite these challenges, emerging opportunities are promising. Digital platforms including study webs of active-learning for young aspiring minds (SWAYAM), digital infrastructure for knowledge sharing (DIKSHA), and massive open online course (MOOC) are offering accessibility to flexible learning. Some institutions are beginning to implement blended learning, flipped classrooms, and interdisciplinary project work. Recent research points to these positive developments. Zhang and Ma [21] observed that project-based learning improved problem-solving skills among Indian undergraduates. Reform efforts must priorities faculty professional capacity-building, equitable digital access, and inclusive curricular design. Faculty members need professional development, institutional support, and the autonomy to innovate. Classrooms must become spaces for students where they are encouraged to think beyond conventions, question assumptions, and apply knowledge innovatively. Such transformation is vital for preparing a future-ready generation. This study responds to these national challenges of HEIs. It explores how classroom

environments and student's centric pedagogical practices associated with LO and skill development. The literature proposes the practical insights for repositioning HE approach with the objectives of NEP 2020 and broader global expectations [1].

In these dynamics' competitive world, HE faces growing demands driven by technological advances and shifting labor markets. Graduates are judged not only by grades but also by their ability to think critically, solve problems, and collaborate [22]. In this context, the quality of classroom environments and teaching practices is more important than ever. In India, the NEP 2020 sets transformative targets for reshaping teaching, learning, and assessment [1]. However, achieving these goals requires both classrooms and teachers to adopt new approaches [23]. This study addresses the urgent need of linking policy aspirations to real classroom conditions. Most research to date examines either pedagogy or learning spaces in isolation. Few studies investigate how both factors work together to foster 21st-century skills [24]. This gap is especially pronounced in India. By exploring the combined association of classroom type and instructional methods on student LO, this study fills a critical void.

The findings provide actionable guidance for institutions aiming to redesign physical spaces and teaching strategies. They also offer evidence to help policymakers shape curriculum standards and professional development priorities. In doing so, the research bridges the divide between NEP 2020's vision and ground-level practice. The study contributes to the global literature on educational equity and quality. As nations worldwide pivot toward skill-based learning, there is a pressing need for empirical evidence on what works [25]. Grounded in the Indian context but with lessons for all, this research advances our understanding about innovative practices that can prepare learners for the challenges of the 21st-century. This study addresses the research question: how do classroom environment types and student-centric pedagogical practices jointly influence students' LO and 21st-century skills development in Indian HE? In addition, the research objectives this study are:

- To examine the association between classroom environment types and students perceived LO in HE.
- To analyze the relationship between student-centric pedagogical practices and perceived LO.
- To explore difference in perceived 21st-century skills development across the classroom environment types.

Theoretical framework: constructivism and constructive alignment. This study is grounded in two main theoretical perspectives 'social constructivism' and 'constructive alignment' that provide a lens to understand how classroom environments and students' centric pedagogical practices are associated with student LO and skill development. Social constructivism as articulated by Vygotsky [26] emphasizes the locus-standee of social interaction, dialogue, and cultural context in learning. According to this view, knowledge which is constructed through interaction with 'others and the learning environment is a reflective entity. Classrooms that are interactive, inclusive, and collaborative are in better state to facilitate such social construction of knowledge. In the context of IHE, where diversity and resource disparities are prominent, the constructivist classrooms allow students to connect learning with their lived realities, promoting deeper engagement and critical thinking.

Biggs and Tang [5] theory of 'constructive alignment' complements this view by emphasizing the alignment between pre-designed LO, teaching activities, and assessment tasks. Effective pedagogy, therefore, demands not only innovative instructional methods but also meaningful assessment practices that are directly aligned with the desired skills and competencies such as communication, critical thinking, creativity, and collaboration. This is particularly relevant for implementing the goals of the NEP 2020, which encourages competency-based learning and discourages rote memorization. Together, these two frameworks guide the inquiry into association of classroom environments (traditional, interactive, and innovative) and students' centric pedagogical practices on LO and development of 21st century skills. They also offer an interpretive lens to assess whether institutional practices are in harmony with the broader educational reforms envisioned for IHE landscape.

2. METHOD

The study employed quantitative, cross-sectional perception-survey design to examine the associations among the variables under investigation such as classroom environment types, student-centric pedagogical practices, LO and 21st-century skills. A structured questionnaire was administered to capture student perceptions of classroom environments, teaching methods, and skill development [27], [28].

2.1. Participants and sampling

Purposive sampling was used to select the students from HEIs in Delhi (India), enabling exploration of student perceptions within a specific urban HE context. A total of 320 students were part of the study. The study included a wide range of sample, as seen in Table 1. Moreover, the findings are not intended to be

statistically generalized beyond similar institutional contexts. Institutional permission was taken from head of the institution. Thereafter, the students were informed about the objectives of the survey, the participation in the survey was voluntary they can withdraw their participation at any time followed by informed consent, for ethical consideration [29].

Table 1. Sample of the study

Sl. No.	Background	Category (group)	Statistics	
			Number	Percent (%)
1	Age	18-21	238	74.4
		21-25	60	18.8
		More than 25	22	6.9
2	Gender	Male	166	51.9
		Female	154	48.1
3	Caste	General	193	60.3
		OBC	82	25.6
		ST	33	10.3
		SC	12	3.8
4	Course	UG	277	86.6
		PG	22	6.9
		PhD	21	6.6

2.2. Tools used

2.2.1. Classroom environment scale

The three items were identified using literature. The exploratory factor analysis (EFA) using principal component analysis (PCA) found these three items explained 84.5% of total variance which is acceptable in social sciences. The Kaiser-Meyer-Olkin (KMO) measure of sample adequacy is .753. It shows that the adequate sample size was used to conduct EFA. Bartlett's test of sphericity (BTS) (Chi square (χ^2)=653.77, $p=.000<.001$) was significant. The three items were correlated enough to identify an underlying factor. The communalities after extraction were ranges from .824 to .862. These were very high, showed items were explaining high variance. The reliability of the classroom environment scale (CES) is .906. The students had to rate each item on five-point rating scale, thus range of the score is 5-15.

2.2.2. Student-centric pedagogical practices scale

The EFA using PCA identified four-factor structure and 12 items out of total 22 items developed to capture the student-centric pedagogical practices. KMO is .886. It shows that the sampling is adequate to conduct EFA. BTS (χ^2 =6163.28, $p=.000<.001$) was significant. The items were correlated enough to identify underlying factors. The communalities after extraction were ranges from .633 to .841. These were high, showed items were explaining high variance. The identified four factors were collectively explaining 73.23% of total variances, which is acceptable in social sciences. Considering factor loading more than .40 and had no cross-loadings, 12 items were identified across the four factors. The reliability of the students' centric pedagogical practices scale (SCPPS) is discussed in Table 2. The students had to rate each statement on five-point rating scale, thus, the range of the score is 12-60.

Table 2. Cronbach's alpha of SCPPS

Sl. No.	Dimension	Cronbach's alpha	No. of items
1	Instructional and assessment quality (IAQ)	.869	4
2	Student engagement and learning readiness (SELR)	.904	4
3	Experiential learning methods (ELM)	.835	2
4	Technology-enhanced learning modes (TEML)	.830	2
5	Classroom environment scale (CES)	.903	3

2.2.3. The 21st-century skills

The nine 21st-century skills were identified using literature important for students of HEIs studying in India. These skills were critical thinking skill, problem solving skill, communication skill, creativity skill, constitutional value, intellectual curiosity, scientific temper, vocational skill, and technical skill. Students had to rate level of each skill development on a 5-point Likert scale, from 1 (highly developed) to 5 (not developed at all). Thus, the range of the score is 9-45.

2.2.4. Reliability statistics

Internal consistency for the SCPPS and CES were high, indicating high reliability [30]. Two factors were represented by two items each. Although three or more indicators per factor are generally recommended, two-item factors can be acceptable in exploratory research when items show strong loadings and clear conceptual coherence [31], [32].

2.3. Data collection and analysis

Data were collected through a Google Forms survey, a widely used online data-collection tool [33]–[35]. The survey link was active for two months, from November 3rd, 2023, to January 3rd, 2024. Participation was entirely voluntary and responses were submitted anonymously to ensure confidentiality and reduce social desirability bias [36]. Data were analyzed using SPSS. The statistical techniques were used such as EFA: to identify factor in the scales used, chi-square test to examine associations between classroom environment and LO, analysis of variance (ANOVA) to test differences in 21st-century skills levels across classroom types, and multiple linear regression to study the effect of pedagogical factors on LO.

3. RESULTS

3.1. Classroom environment and learning outcomes

A Chi-square test of independence was conducted to explore the relationship between classroom environment (traditional, interactive, and innovative) and students' LO (poor, average, good, excellent, and outstanding). Cross-tabulation results in Table 3 revealed notable differences in LO across the three classroom environments. In traditional classroom environment (TCE), the majority of students achieved "average" (42.1%) or "good" (31.6%) outcomes. A small proportion attained "outstanding" (5.3%), while none reached the "excellent" category. Additionally, 21.1% of students reported "poor" outcomes. Whereas in interactive classroom environment (ICE), most students showed higher achievement, with 33.6% scoring "good", 30.8% "excellent", and 14.5% "outstanding". Fewer students fell into the "average" (18.2%) and "poor" (2.8%) categories. Furthermore, in innovative classroom environment (InCE), LO were highest in this group, with 32.7% of students achieving "excellent" and 55.1% achieving "outstanding". No students reported "poor" or "average" outcomes. Thus, InCE leads to higher LO.

The Pearson Chi-square test, as seen in Table 4, revealed a significant association between classroom environment and LO, $\chi^2(8, N=320)=119.73, p<.001$. The likelihood ratio test also confirmed this association, $\chi^2(8, N=320)=126.18, p<.001$. A linear-by-linear association test showed a strong linear relationship, $\chi^2(1, N=320)=92.88, p<.001$. These results indicate that student LO are significantly associated with the type of classroom environment. Traditional environments were associated with lower outcomes, whereas innovative environments were linked with higher levels of achievement.

TCE are more likely to result in lower LO, with a higher proportion of students scoring in the "poor" and "average" categories. Whereas interactive classrooms foster improved outcomes, with a higher proportion of students achieving "good", "excellent", or "outstanding". However, innovative classrooms provide the most conducive learning environment for exceptional outcomes, as no students scored below "good", and the majority achieved "excellent" or "outstanding". These findings emphasize the significant role of classroom environments in shaping students' LO. Policies and practices aimed at creating innovative and ICE could greatly enhance educational outcomes in IHE.

Table 3. Cross tabulation of classroom environment and LO

Classroom environment	LO					Total
	Poor	Average	Good	Excellent	Outstanding	
Traditional environment (TraE)	12	24	18	0	3	57
Interactive environment (IntE)	6	39	72	66	31	214
Innovative environment (InnE)	0	0	6	16	27	49
Total	18	63	96	82	61	320

Table 4. Chi-square tests

Statistics	Value	Df	Asymptotic significance (2-sided)
Pearson chi-square	119.732 ^a	8	.000
Likelihood ratio	126.179	8	.000
Linear-by-linear association	92.875	1	.000
N of valid cases	320		

a. 2 cells (13.3%) have expected count less than 5. The minimum expected count is 2.76.

3.2. Students' centric pedagogical practices and learning outcome

The mean scores, as in Table 5, indicate moderate to high perceptions across instructional and assessment quality (IAQ), student engagement and learning readiness (SELR), experiential learning methods (ELM), and technology-enhanced learning modes (TELM). Furthermore, students perceive their LO is at moderate average level with acceptable variability, suggesting sufficient dispersion for regression analysis. A multiple linear regression was conducted to examine whether IAQ, SELR, ELM, and TELM significantly predicted LO of the students. LO was significantly and positively correlated with all predictor variables such as IAQ, SELR, ELM, and TELM with the strongest relationship observed for IAQ, as shown in Table 6. Moreover, the correlations among predictors were moderate and below critical thresholds, indicating no serious multicollinearity concerns.

Table 5. Descriptive statistics

Category	Variable	Mean	SD
LO	LO	3.41	1.07
Student-centric pedagogical practices	IAQ	13.73	4.28
	SELR	13.67	4.46
	ELM	5.95	2.44
	TELM	6.04	2.45

Table 6. Pearson correlation matrix

Variable	1	2	3	4	5
1. LO	—				
2. IAQ	.495***	—			
3. SELR	.174**	.387***	—		
4. ELM	.255***	.448***	.238***	—	
5. TELM	.310***	.360***	.128*	.689***	—

* $p < .05$, ** $p < .01$, *** $p < .001$ (1-tailed)

A multiple regression analysis was conducted to examine the extent to which IAQ, SELR, ELM, and TELM predicted LO, as seen in Tables 7 and 8. The overall model was statistically significant, $F(4, 315) = 29.05$, $p < .001$, explaining 27% of the variance in LO. Moreover, the Durbin-Watson was 1.94. IAQ emerged as the strongest predictor of LO ($\beta = .47$, $p < .001$), indicating that well-aligned teaching practices, assessment fairness, and meaningful feedback substantially enhance student learning. TELM also significantly predicted LO ($\beta = .21$, $p = .002$), suggesting that blended and online learning approaches contribute positively to students' achievement. In contrast, SELR ($\beta = -.01$, $p = .843$) and ELM ($\beta = -.10$, $p = .172$) did not significantly predict LO when other variables were controlled. This suggests that although these variables are positively correlated with LO, their unique contribution diminishes when instructional quality and technology-enabled learning are considered simultaneously.

Table 7. Multiple regression analysis predicting LO

Predictor	B	SE	β	t	P
Constant	1.541	.214	—	7.201	.000
IAQ	.117	.014	.467	8.159	.000
SELR	-.003	.013	-.010	-.199	.843
ELM	-.042	.031	-.096	-1.368	.172
TELM	.091	.029	.209	3.126	.002

Table 8. Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.519	.270	.260	.920

3.3. Classroom environment and 21st-century skills

An ANOVA was conducted to evaluate the association of classroom environment (TCE, ICE, and InCE) on students' 21st-century skills. The results indicated a statistically significant difference in mean scores across the three types of classroom environments (TCE, ICE and InCE), $F(2,317) = 72.52$, $p < .001$, as shown in Table 9. Thus, there exists a significant association between classroom environment and 21st-century skills development.

Table 9. ANOVA results for classroom environment on 21st-century skills

Source of variance	Sum of squares	Df	Mean square	F	Sig.
Between groups	10217.189	2	5108.594	72.521	.000
Within groups	22330.283	317	70.443		
Total	32547.472	319			

Calculate η^2 (eta squared) to measure the strength of the effect:

$$\eta^2 = \text{SSBetween} / \text{SSTotal} = 10217.189 / 32547.472 \approx 0.314$$

This indicates that approximately 31.4% of the total variance in 21st-century skills is explained by the classroom environment. This is a large effect size. Thus, the classroom environment is a major factor in students' 21st-century skills development like critical thinking, collaboration, and digital literacy.

Thus, the type of classroom environment significantly affects the development of 21st-century skills among students. Specifically, students in InCE demonstrated the highest skill levels, followed by those in interactive environments, with traditional environments being the least conducive, as seen in Table 10. These results highlight the importance of fostering innovative and interactive teaching-learning spaces in HE to promote the development of critical thinking, problem-solving, and other essential skills.

Table 10. Means comparison using Tukey a, b post-hoc test

Classroom environment	N	Subset for alpha=0.05		
		1	2	3
Traditional environment	57	19.58		
Interactive environment	214		28.06	
Innovative environment	49			39.24

Means for groups in homogeneous subsets are displayed.

a. Uses harmonic mean sample size=70.381.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

3.4. Recommendations for redefining classroom and pedagogical practices

On the basis of the findings, the recommendations proposed to enhance classroom practices and pedagogy in IHE are as: i) foster innovative and interactive classrooms: institutions should prioritize creating a classroom with innovation and active interaction. These environments support higher LO and skill development. Collaborative seating, project work, and digital tools may contribute in enhancing learning activities and student engagement; ii) integrate student-centered pedagogical approaches: teaching methods should focus on interaction, exploration, and real-life application. Pedagogies such as flipped classrooms, problem-based learning, and blended strategies should be promoted through curriculum design and teacher training; iii) embed skill-based learning: learning experiences must foster 21st-century skills, such as critical thinking, creativity, communication, and collaboration. Activities like group tasks, experiential learning, and innovation challenges should be part of regular classroom practice; and iv) ensure continuous assessment and feedback: assessment methods must align with learning goals and focus on skill application. Regular formative assessments with timely feedback can support both student growth and instructional improvement.

4. DISCUSSION

In the Indian HE context, it found that the classroom environments and pedagogical strategies have critical roles improving LO and 21st-century skills among HE students. Traditional classroom is characterized by lectures and passive student roles. This type of classroom environment still exists in the Indian HE context. This environment negatively influences LO and skill development among students. This finding is supported by [4], [5], [10], [37], [38].

ICE and InCE are based on constructivism. LO and skill development in these environments are significantly higher than the traditional classroom. This finding is supported by [5], [39]. Further, the finding is relevant for India's NEP 2020, which envisions flexible, experiential, and learner-driven education.

IAQ and technology integrated learning emerged as significant predictors of LO. The multiple regression model was statistically significant and explained 27% of the variance in LO. It highlights the central role of IAQ in shaping student academic achievement particularly in the IHE context. Technology integrated learning also contributes to LO of the students. It highlights the value of blended and digital pedagogical approaches in contemporary educational systems [6], [7]. Students in innovative classrooms

have the strongest critical thinking, creativity, collaboration, and communication skills, followed by those in ICE. Traditional classrooms had the least benefit for skill development [16].

The analysis identifies a policy-practice gap. While NEP 2020 advocates for constructivist and technology integrated pedagogy, their implementation is uneven across the Indian HEIs. Moreover, while technology integrated learning environments have potential to revolutionize learning of the students. However, without advanced pedagogical approach and professional support, digital tools may result in disengagement rather than inclusion. This aligns with recent findings by [13], who argue that effective digital integration requires both technical infrastructure and pedagogical vision.

5. CONCLUSION

This study examined classroom environments and student's-centric pedagogical practices are associated with students LO and development of 21st-century skills in IHE. The findings reveal that ICE and InCE are significantly related with higher academic performance and skill development. On the contrary, traditional teacher-lead classroom is associated with lower academic performance and skills development. Further, the student-centered pedagogies, instructional, and assessment quality emerged as the strongest predictor of LO.

These findings highlight a gap between policy aspirations, particularly NEP 2020 and classroom practices. NEP 2020 envisions competency-based learning and learner-centered pedagogies. However, institutional response in its implementation seems uneven across HEIs. The study suggests immediate need for systematic pedagogical transformation, including continuous professional development of faculty members, alignment of policy and practices and integration of technology.

By grounding its analysis in theory and providing empirical evidence from the Indian context, the study contributes to both national reform efforts and the broader discourse on learning innovation in the Global South. Further, researches can explore the association of constructive alignment and culturally responsive pedagogy on diverse institutional settings. In this process, a better understanding can be developed about how theory-informed classroom practices translate into meaningful educational transformation. The novelty of the study lies in its integrated assessment of classroom environment (traditional, interactive, and innovative) and student-centric pedagogical practices within NEP 2020 framework particularly in IHE. The study contributes empirical evidence regarding the relationship between InCE, pedagogical reform, LO, and 21st-century skills development.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research involving human participants was conducted in compliance with all national regulations and institutional policies, and institutional policies, and in accordance with Helsinki Declaration. Formal permissions were taken from head of the institutions.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [SKJ], upon reasonable request.

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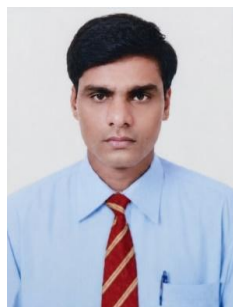
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