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Pedagogical Trends and Inclusive Practices in Indian STEMM Higher Education: An Exploratory Survey

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Short Report

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Additional Declarations:
The authors declare no competing interests.

The study involved a survey of faculty members in STEMM higher education institutions in India. Ethical approval was obtained from the Institutional Review Board (IRB)/Institutional Ethics Committee of Azim Premji University prior to commencement of data collection. Participation was voluntary, and informed consent was obtained from all participants. Responses were collected and analysed with informed consent, with no personally identifying information reported in the manuscript.

Title - Pedagogical Trends and Inclusive Practices in Indian STEMM Higher Education: An Exploratory Survey

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Abstract:

This study maps pedagogical practices among STEMM faculty in Indian higher education, identifying patterns of pedagogy adoption across traditional, active, experiential and research-oriented approaches. 93 faculty from diverse STEMM fields (Science, Technology, Engineering, Mathematics, Medicine) across India responded to the survey. A structured exploratory survey captured demographic data—including teaching experience (<1 to >10 years) and student age groups (primarily 18–25 years)—alongside self-reported instructional methods. Responders also skewed toward life sciences and engineering and many taught undergraduates in Indian Higher Education Institutes. 59% of faculty reported no prior experience teaching students with disabilities, highlighting limited faculty exposure to disability-inclusive teaching within the surveyed sample. While faculty spend dedicated break time developing new techniques, structural barriers like computational diversity and language differences persist.

10 variable teaching approaches were evaluated by faculty responders such as such as chalk-and-talk lectures, problem-based learning, group work, term projects, asynchronous methods, journal clubs etc. A 5-point Likert scale captured the frequency of teaching approaches, while additional items measured time allocated to learning new techniques during breaks. One of our main findings highlights the continued prevalence of traditional teaching practices alongside the gradual adoption of active learning approaches, suggesting that pedagogical change in Indian higher education may occur through gradual layering rather than replacement and offering implications for faculty development in resource-constrained contexts. Nonetheless, it is evident among our respondents that faculty members would be willing to embrace innovative teaching strategies, as long as institutional support is extended, especially in terms of time.

STEMM faculty are embracing teaching strategies that are continuous and student-focused and thus match NEP 2020 objectives. Nevertheless, moving from lecture-based instruction

to an inclusive form of education needs sufficient preparation time and faculty training in Universal Design for Learning (UDL) frameworks. We suggest that UDL training among STEMM faculty members should move beyond compliance measures and into a pathway to making classroom learning more engaging, inclusive and as a means of tackling structural barriers.

Introduction:

The need for active learning and inclusive classrooms has become increasingly urgent especially after COVID - 19 when we were forced to move online. We inadvertently created an overreliance on visual media to engage with concepts [1]. Unfortunately, conventional lecture-based teaching in Higher education institutes (HEI) remains deeply embedded in university education, particularly in contexts characterised by large class sizes, content-heavy curricula, limited faculty time, and uneven access to teaching resources [2]. Passive learning in lecture formats does not have the same reach as before as students spend considerable time on social media, engaging with content that limits attention in class to individual forms of pedagogy [3]. Perhaps this is why science, technology, engineering, mathematics, and medicine (STEMM) concepts elucidated by active learning strategies better student engagement and learning as compared to lecture formats of teaching [4].

Current STEM pedagogy has often benefited from active learning tools as depicted by two systematic reviews which showed a difference of an entire letter grade when active learning strategies were used in the classroom [5]. This might even help students in introductory courses where the rate of drop out tends to be higher than usual especially with students from marginalised backgrounds or those with learning disabilities [6];[7]. Students in active learning classrooms do not necessarily need to only rely on background knowledge from school which tends to skew the success rate for students from socially disadvantaged backgrounds. They can be supported in different ways such as attending, processing and analysing that information. In STEM especially, integrating abstract concepts, using one's quantitative reasoning, remembering specialised terminology and acronyms, as well as visual representations, and problem-solving skills are needed simultaneously. By creating multiple ways of learning in the classroom with peer review and feedback, interaction and application and several such active learning strategies one can accommodate students of differing needs.

Although the evidence supporting active learning is substantial, the implementation of these approaches is shaped by institutional and educational context. Indian STEMM classrooms may differ considerably in class size, student preparedness, language, access to educational technology, faculty workload, and opportunities for pedagogical development. Furthermore, pedagogical practice cannot be divorced from access and inclusion. Students do not enter higher education with uniform educational histories, learning preferences, physical abilities, sensory needs, or modes of attention and information processing [8]. The Rights of Persons with Disabilities (RPWD) Act, 2016 encourages "measures to promote, protect and ensure participation of persons with disabilities in adult education and continuing education programmes equally with others" [9]. Under the Rights of Persons with Disabilities Act, all government and government-aided higher educational institutions are required to have not less than 5% of seats for students with disabilities [9]. Since most higher education and research institutions in India fall in this group, it is important that the Act be implemented in practice as well as in spirit. However a survey by the National Centre for Promotion of Employment of Disabled People (NCPEDP) revealed that only 0.56% of such individuals attend HEIs in India [10]. This can be attributed almost solely to lack of access for both physically challenged and students with neurodevelopmental or learning differences. The problem gets more complicated as neurodivergence is often unrecognised or unassessed and hence unsupported in higher education.

Although there have been increasing instances of international research that support active learning, relatively little is known about how STEMM faculty navigate access and inclusion in Indian HEIs, and how these practices intersect with faculty preparation for inclusive teaching [11]. In India variations exist not only in matters of access but also class size, knowledge systems, student preparedness, faculty workload, access to educational technologies, and opportunities for pedagogical training. It is thus not just a matter of individual preference. In order to know more about how and where STEMM faculty in HEIs in India may be facing roadblocks this study was formulated as a voluntary survey of pedagogical practices to examine patterns of similarity and convergence across disciplines.

Using a structured and detailed questionnaire, a survey was conducted among 93 faculty members belonging to various STEMM fields in Indian HEIs . The anonymous questionnaire included demographic and teaching-related information, frequency of usage of ten different kinds of pedagogies including chalk-and-talk method, problem-based learning, group learning, project method, asynchronous approach, and journal club, and the amount of time spent on acquiring the knowledge of any new pedagogy during breaks from academics. Additionally, the experiences of the faculty members with regards to teaching disabled students as well as the conditions necessary for using innovative pedagogies have been explored. With the help of this documentation this study seeks to inform context based faculty development across the country and start a conversation about institutional support strategies for Indian higher education.

Methods:

This exploratory study attempts to address four questions:

1. What pedagogical approaches are most frequently reported by STEMM faculty in Indian HEI?
2. How often are enquiry based, experiential, asynchronous and activity based approaches incorporated alongside traditional teaching methods in STEMM classrooms?
3. How much experience do STEMM faculty report in teaching students with disabilities?
4. What does faculty-reported time spent developing pedagogical practices suggest about the institutional conditions required for pedagogical innovation?

Study Design:

This study aimed to analyse the various teaching tools and pedagogical practices used by faculty members in STEMM universities in India. The study also aimed to capture the frequency with which instructors use active learning tools to reinforce lectures and preparation time required to implement these pedagogical practices. For a deeper understanding of the collected data demographic information, teaching experience and age groups taught was also collected.

Participant Recruitment:

A consolidated list of 1,074 universities in India by the University Grants Commission (UGC), last updated in 2023 was used as a reference list. The list consists of 460 state universities, 128 deemed-to-be universities, 56 central universities and 430 private universities across all states and union territories in India. Apart from the type of university, the list also mentions the name, location and notification date for universities according to the states they are located in. However, UGC now maintains separate lists for all central, state, deemed and private universities. Faculty members belonging to STEMM universities were identified and contacted to participate in the survey. A total of 3,316 faculty members were invited via email using their publicly available institutional contact information. It was also ensured that the instructors contacted had a diverse disciplinary background within STEMM (Science, Technology, Engineering, Mathematics, and Medicine) as well as other related fields. To ensure that every department was represented, one faculty member per department was contacted. Either the head of department (HOD) or the director was selected and invited to participate in the survey. In addition to university departments, colleges affiliated with the particular university were also identified and examined to identify a faculty member from the STEM department. With this sampling strategy medical colleges were also included in the study design and contacted through publically available information.

To prepare the survey questions a pilot study was first conducted among 18 science faculty members of Azim Premji University campuses across Bangalore and Bhopal. Based on the responses all questions were retained. Initial questions were planned after numerous participation in the study was voluntary, and responses were collected anonymously following institutional review board (IRB) approvals.

Survey Instrument:

The data was collected with the help of a structured questionnaire prepared by the authors, designed to answer demographic information of the respondents as well as their individual pedagogical practices. Questions were based on A total of 93 responses were recorded from the email invitations that were sent. The overall response rate was approximately 3.0%. Non-response or incomplete responses may have resulted from the voluntary recruitment approach and undeliverable institutional email addresses; however, the reasons for non-response cannot be established from the study data.
The survey was created in such a manner that the participants had the liberty of choosing from multiple options. Every question was optional. Thus not all respondents answered every question in the survey. As a result, the total number of responses will vary from question to question and analysis was conducted for the available responses for each question.

The questionnaire focused on data collection from two main sections:

a. **Demographic Information:**
   Years of teaching experience (<1 year, 2–4 years, 4–6 years, 7–8 years, >10 years)
   Age groups taught (Below 14, 14–17, 18–20, 21–25, 25–30, >30)

b. **Teaching Practices and Pedagogical Tools:**
   Faculty members were asked to indicate how frequently they used different teaching approaches in their classroom. These included:
   Chalk-and-talk lectures
   Student presentations

Group work or laboratory work
Problem-based learning
In-class activities (e.g., jigsaw model)
Asynchronous teaching methods
Out-of-class activities (e.g., field trips, nature walks)
Journal clubs
Term projects (research based written summary)
Other term projects (podcasts, video files, posters, exhibits)

The responses were recorded using the five-point Likert scale. This included Never, Rarely, Sometimes, Most of the time and All the time. Participants were also asked to report the amount of time they usually spend in semester breaks studying and integrating new pedagogical techniques using a similar 5-point scale where 0 meant no time and 5 meant all the time.

Data Collection:

The survey responses were collected with the help of google forms that were circulated electronically over the study period. The responses were then compiled into a single dataset.

Data Processing and Filtering:

Responses from both the nationwide survey as well as Azim Premji University were combined for processing. The final compiled dataset was further processed to remove any duplicate responses or filter out incomplete responses from the study. Only valid responses with sufficient information were kept for the final analysis.

Data Analysis:

Calculations for frequency distributions and their consequent visualizations using bar graphs were performed using R (version 4.5.1). Data visualization was carried out using the ggplot2, tidyr, janitor, patchwork, cowplot, patchwork, dplyr, stringr, viridis, polr(), and MASS packages in R.

Results:

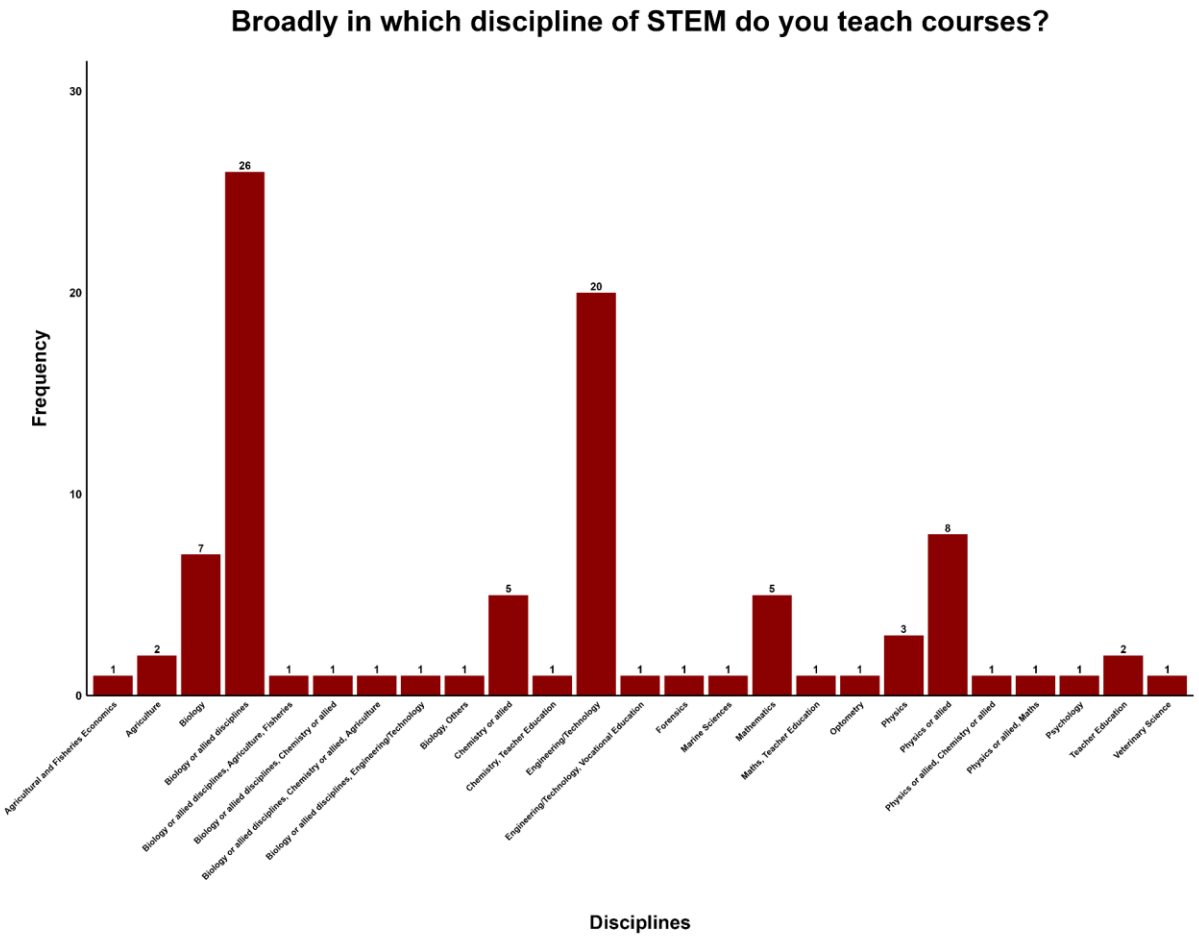


Fig. 1: Broad disciplines taught by the respondents (n = 93).

The respondents represent a wide range of STEMM disciplines with a significant skewed towards Life Sciences and Engineering. The largest group of faculty responses are from biology or allied disciplines (*n* = 26), followed by engineering/technology (*n* = 20). Notable representations also include physics or allied disciplines (*n* = 8), biology (*n* = 7), chemistry or allied disciplines (*n* = 5) and mathematics (*n* = 5) as seen in fig. 1. Other disciplines namely agriculture, marine sciences, veterinary sciences, psychology and other interdisciplinary fields showed responses in low frequencies (*n* = 1-2 each).
Overall, our sample represents a heavy concentration of respondents in life sciences and engineering with limited representation from other STEMM fields.

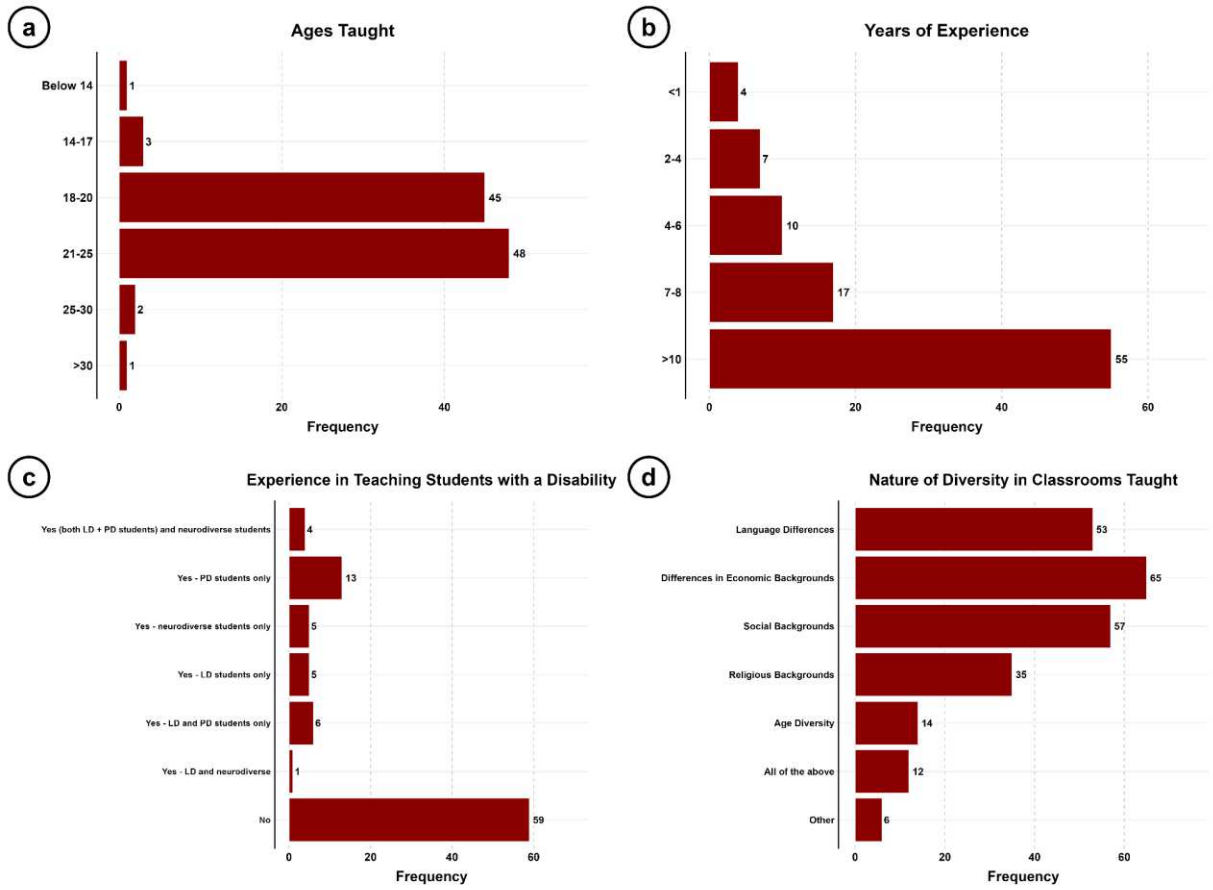


Fig. 2: Demographic characteristics of survey respondents (a - Age groups taught, b - Years of teaching experience, c - Experience in teaching students with a disability, d - Nature of Diversity in Classrooms).

Most of the faculty respondents reported in teaching undergraduate students, with the most common categories being the age groups 18 - 20 years (n = 45) and 21-25 years (n = 48). Very few respondents reported in teaching younger or older age groups, including age categories of 14 - 17 years (n = 3), 25 - 30 years (n = 2), and below 14 or above 30 (n = 1 each). Our findings primarily focus on pedagogical practices in the context of higher education, particularly undergraduate teaching as seen in fig. 2.

The majority of the respondents (n = 59) reported having no prior experience in teaching students with disabilities. Among the respondents who reported having experience, the distribution varied. Thirteen faculty respondents reported having taught students with physical disabilities only, five reporting learning disabilities only, and five with students reported by faculty as neurodiverse. Six respondents reported teaching students with both learning and physical disabilities.

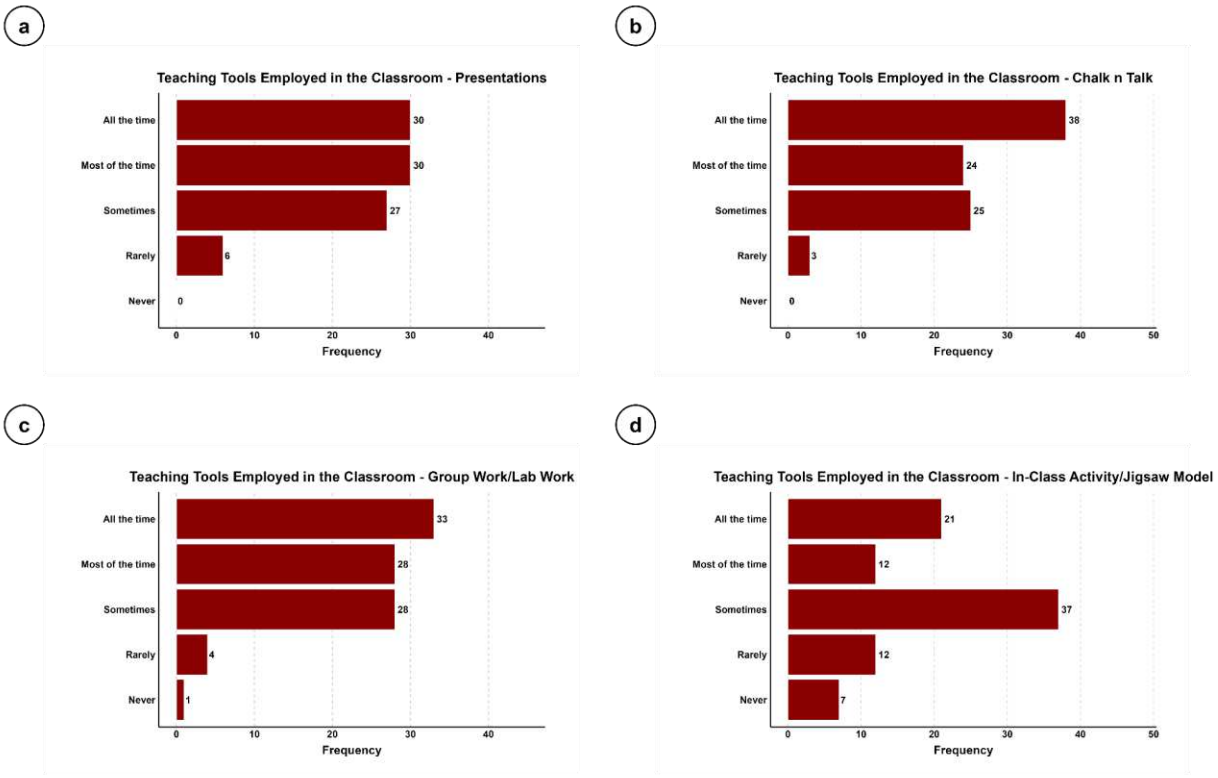


Fig. 3: Teaching tools employed in the classroom (a - Presentations, b - Chalk-n-Talk, c - Group Work/Laboratory Work, d - In Class Activity/ Jigsaw Model)

Fig. 3a and 3b show that classroom presentations are used "all the time" (n = 30) and "most of the time" (n = 30) along with a substantial number of respondents also responding "sometimes" (n = 27). Very few reported infrequent use and none to never using presentations as a tool. A similar pattern can be seen emerging from "chalk-n-talk", where maximum number of respondents reported to using it "all the time" (n = 38), followed by "most of the time" (n = 24) and "sometimes" (n = 25) indicating that traditional techniques remain a dominant strategy.

In contrast, Fig. 3c depicts that active learning approaches like group work/laboratory work and in class activities/jigsaw models display a varied pattern of use. Group work is observed to have relatively high engagement with respondents reporting an "all the time" usage (n = 33), "most of the time" (n = 28), "sometimes" (n = 28). This suggested that collaborative strategies are also well received in the classroom although not uniform across

all instructors. Only a small number reported infrequent use (n = 4) or no use (n = 1) of these methods.

However, Fig. 3d depicts a more structured approach to active learning through in-class activities using jigsaw models as an example. The most common response reported was "sometimes" (n = 37), with fewer responses tilted towards frequent use, "all the time" (n = 21), "most of the time" (n = 12). A noticeable portion of responses were also to limited (n = 12) or no use (n = 7) of such methods. Taken together, traditional teaching practices remain dominant with high frequency of use while active learning is inconsistent in classroom settings.

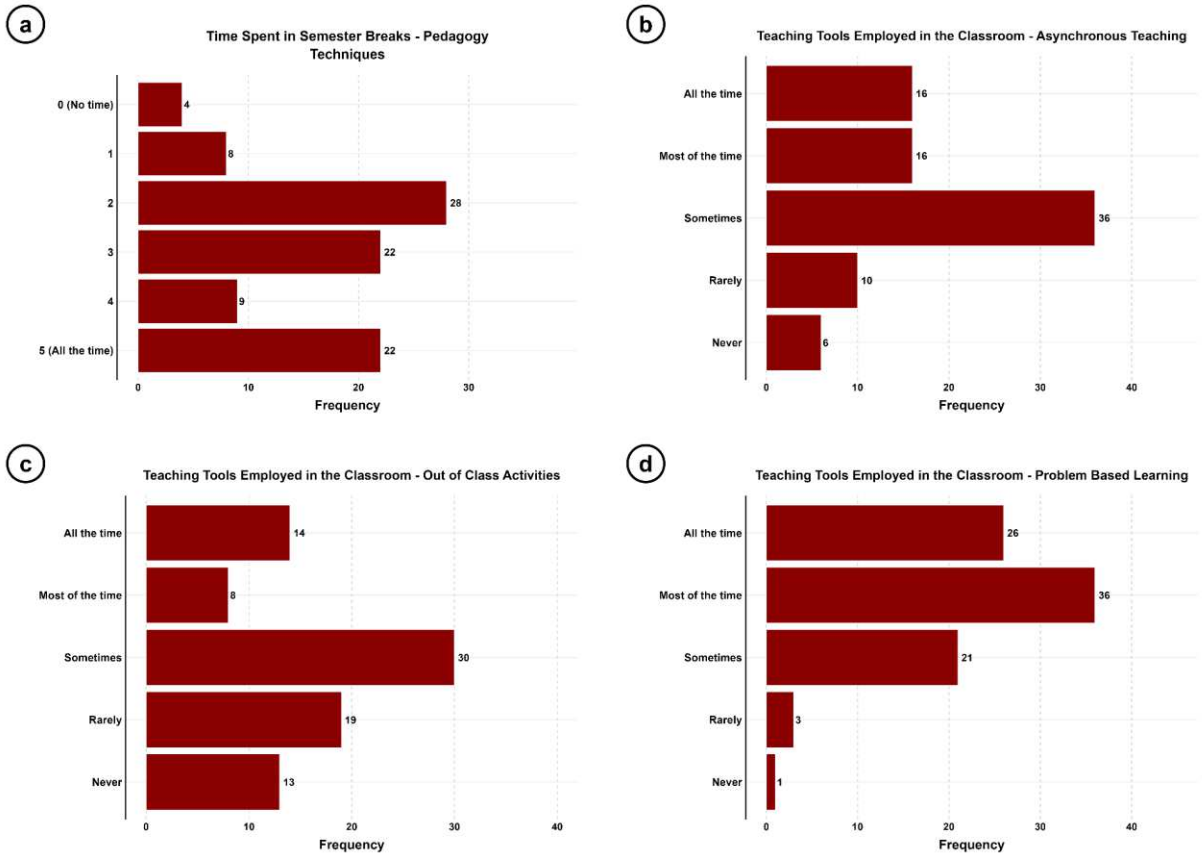


Fig. 4: Teaching Tools employed in the classroom (a - Time spent in semester breaks to integrate pedagogy techniques, b - Asynchronous teaching, c- Out of class activities, d - Problem based learning)

Fig. 4a represents time spent by faculty members in integrating different pedagogical techniques during semester breaks. Responses were recorded on a scale ranging from 0

(no time spent) to 5 (all the time). The distribution can be seen ranging from moderate to high, where the most common response is seen to be “2” (*n* = 28), followed by “3” (*n* = 22) and “5” (*n* = 22). Lower levels of engagement were reported less frequently, with infrequent responses with “0” (*n* = 4) and “1” (*n* = 8). Overall nine respondents also selected for “4” (*n* = 9). Overall, it is seen that most respondents dedicate time in semester breaks to integrating new practices and teaching tools for the next semester.

The use of asynchronous teaching methods is illustrated in fig. 4b. Responses are more concentrated towards "sometimes" (*n* = 36) indicating a moderate adoption of asynchronous teaching techniques. An equal number of participants reported “all the time” (*n* = 16) and “most of the time” (*n* = 16), while a smaller proportion of participants reported “ rarely” (*n* = 10) and “never” (*n* = 6) indicating limited usage of asynchronous tools. These findings indicate that asynchronous teachings have been implemented into classroom practice by a substantial proportion of participants, however their implementation remains inconsistent across instructors.

Fig. 4c shows faculty responses regarding use of out-of-class activities. The majority of respondents indicated using “sometimes” (*n* = 30), while smaller proportions indicated “rarely” (*n* = 19) or “never” (n = 13). More frequent implementation was less common with only fourteen respondents selecting “all the time”(*n* = 14) and eight selecting “most of the time” (*n* = 8). Responses indicate that out-of-class activities are used occasionally by most faculty with fewer responses reporting consistent implementation.

Fig. 4d demonstrates the use of problem based learning. Compared to other active learning approaches, problem-based learning accounts for a relatively high level of implementation. The highest response frequency was observed in the “most of the time” category (n = 36), followed by “all the time” (*n* = 26) and “sometimes” (*n* = 21). Very few respondents indicated limited use in “rarely” (*n* = 3) and “never” (*n* = 1). Problem-based learning is seen to be more consistently adopted as an active learning strategy within the survey respondents.

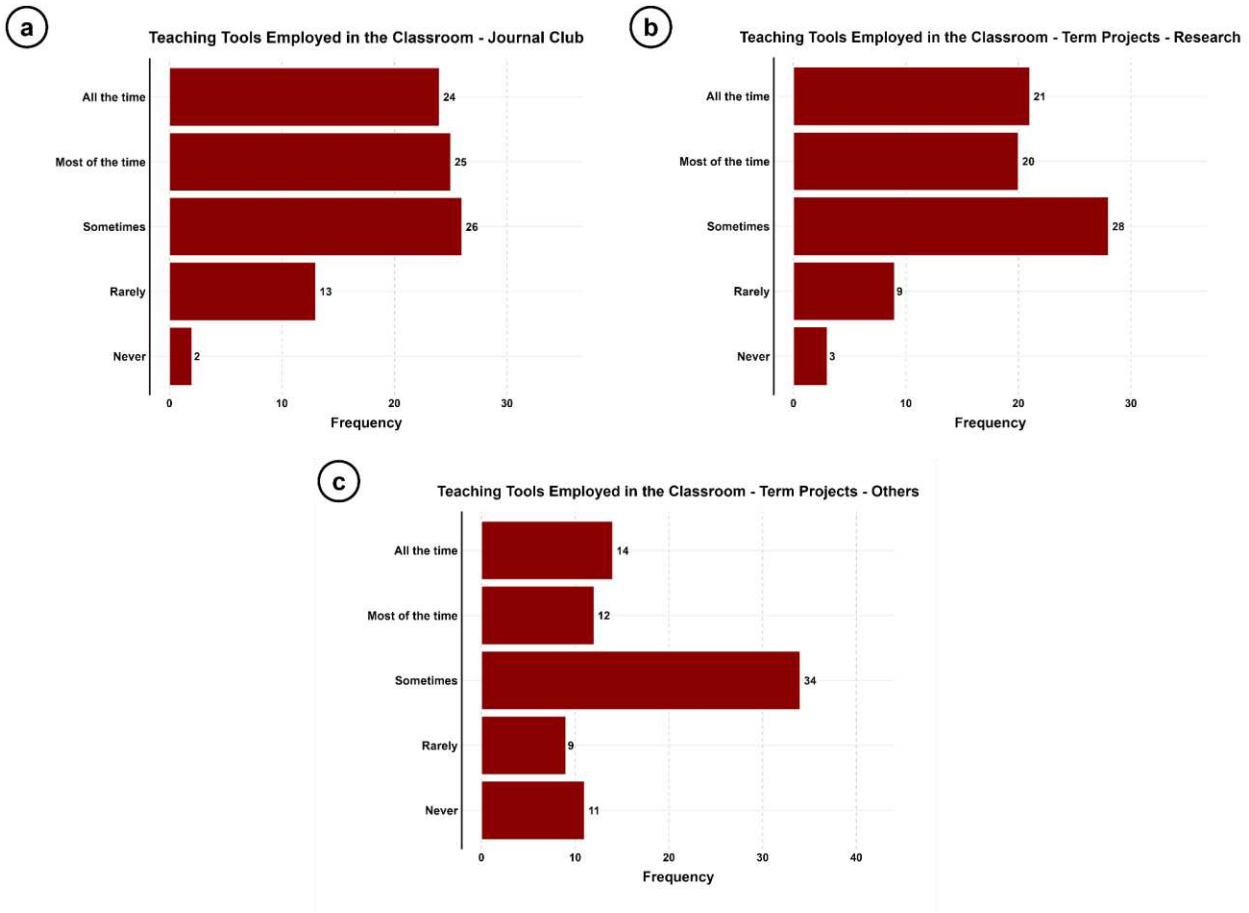


Fig. 5: Frequency of various teaching tools employed in classrooms (a - Journal club, c - Research projects, c - Engaging in other term projects)

Fig. 5a-c highlights patterns representing the use of research-oriented and project-based teaching tools in classrooms. Compared to traditional teaching tools, these approaches demonstrated moderate to less usage.

The use of journal clubs in Fig. 5a shows a relatively balanced distribution amongst the frequency of usage categories. The highest number of responses reported to "sometimes" (n = 26) using journal clubs, followed by "most of the time" (n = 25) and "all the time" (n = 24). A notable proportion of people also reported using it "rarely" (n = 13) and even "never" (n = 2). This distribution demonstrates that journal clubs are recognized and implemented as a teaching practice in classrooms.

A similar pattern can be observed in the case of Fig. 5b term projects related to research. Similar to Fig. 5a, the most common response was "sometimes" (n = 28), followed by "all

the time" (*n* = 21) and "most of the time" (*n* = 20). Comparatively fewer respondents reported limited use with "rarely" (*n* = 9) and "never" (*n* = 3) using terms projects related to research as a teaching tool. These findings indicate that research oriented teaching methods are integrated by a substantial number of faculty members in STEMM disciplines. In contrast, it is seen that term projects are not directly related to research as shown in Fig. 5c shows a different trend. There is a stronger concentration towards "sometimes" (*n* = 34). Fewer respondents reported frequent use with "all the time" (*n* = 14) and "most of the time" (*n* = 12), while a proportion of respondents also reported infrequent use with rarely (*n* = 9) and "never" (*n* = 11). This suggests that term projects that are central to research may not be an important component while designing a teaching tool for many instructors.

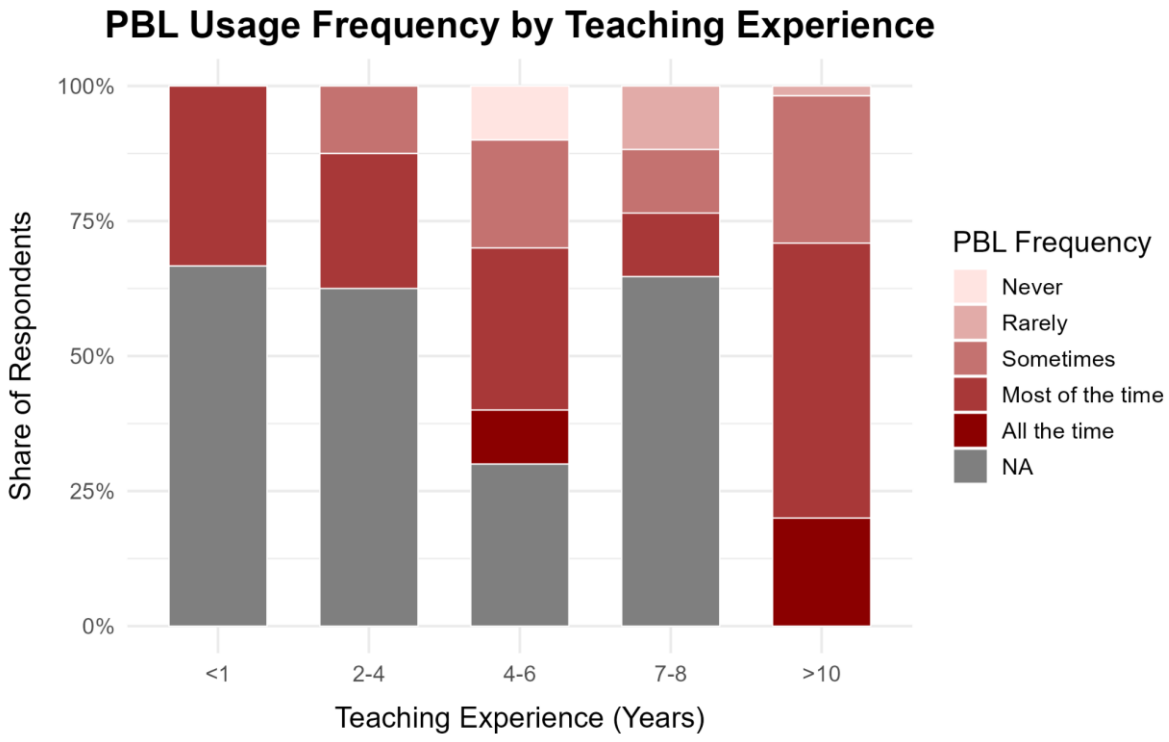


Fig. 6: Frequency of usage of problem-based learning (PBL) with accordance to teaching experience.

The above stacked bar chart shows the distribution of responses attributed to problem-based learning (PBL) within each teaching group based on experience made using proportional-odds ordinal logistic regression using the polr() function from the MASS

package on R. The responses have been grouped as “never”, “rarely”, “sometimes”, “most of the time” and “all the time”, with responses grouped in an order (<1, 2-4, 4-6, 7-8, and >10 years). Some respondents chose not to answer the question and have therefore been grouped as “NA”. In this ordinal regression, a statistical association between teaching experience and frequency of PBL usage has been established. The dependent/outcome variable has been set as pbl_freq and the independent/predictor variable as experience_band. The model does not indicate a significant linear association between teaching experience and frequency in the use of PBL ($\beta = -0.177$, SE = 1.252, $t = -0.142$, $p \approx 0.89$). Therefore, within the sample the observed differences do not support a linear trend in an ordinal regression model. The large standard error and p-value indicate a highly uncertain trend.

As a secondary analysis, PBL was further categorized into binary outcome and its analysis was performed with linear regression. PBL was found to not have been associated with the binary PBL-use outcomes ($\beta = -9.60$, SE = 2797.44, $z = -0.003$, $p = .997$). The very large standard error suggests a sparse dataset, therefore the binary model was not used as the primary analysis. The model was based on 56 observations (n= 56) with a null deviance of 10.03 and a residual deviance of 10.00 indicating very little deviance after including teaching experience.

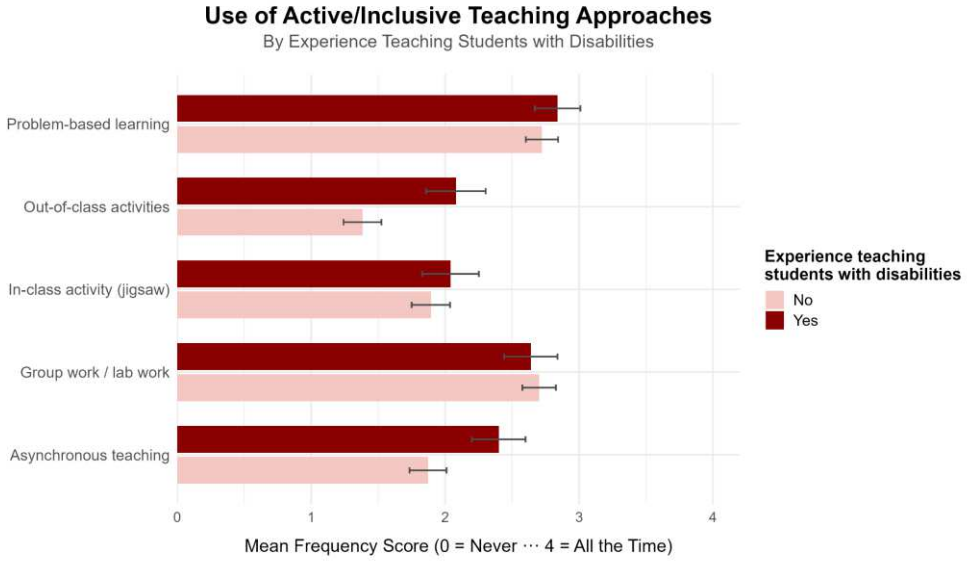


Fig 7: Use of active/inclusive teaching approaches by experience in teaching students with disabilities.

To examine if previous experience in teaching students with disabilities led to a reported use of more active and inclusive approaches, the faculty responses were divided into two groups, those who reported previous teaching experience (n = 25) and those who did not report previous teaching experience (n = 47). For this, five teaching approaches were compared; group/lab work, in-class activity (jigsaw), asynchronous teaching, out-of-class activities, and problem-based learning (PBL). Scoring was done on the basis of teaching frequency which ranged from 0 (never) to 4 (all the time).

Faculty who reported experience in teaching students with disabilities reported a higher mean use of asynchronous teaching compared to those without prior experience. The difference was statistically significant according to the Wilcoxon rank-sum test ($p = 0.045$). Similarly, faculty with more experience also reported a higher use of out-off-class activities ($p = 0.011$). For the other approaches, no other statistically significant differences were observed between faculty with and without experience teaching students with disabilities. Mean scores for group/lab work for both the groups were similar($p = 0.915$). Likewise, the same was observed for in-class activity ($p = 0.693$) and use of PBL($p = 0.700$).

Overall, faculty with previous experience in teaching students with disabilities reported a greater use of asynchronous learning and out-of-class teaching approaches, while no such trend was observed for group/lab work, in-class jigsaw activities, and PBL.

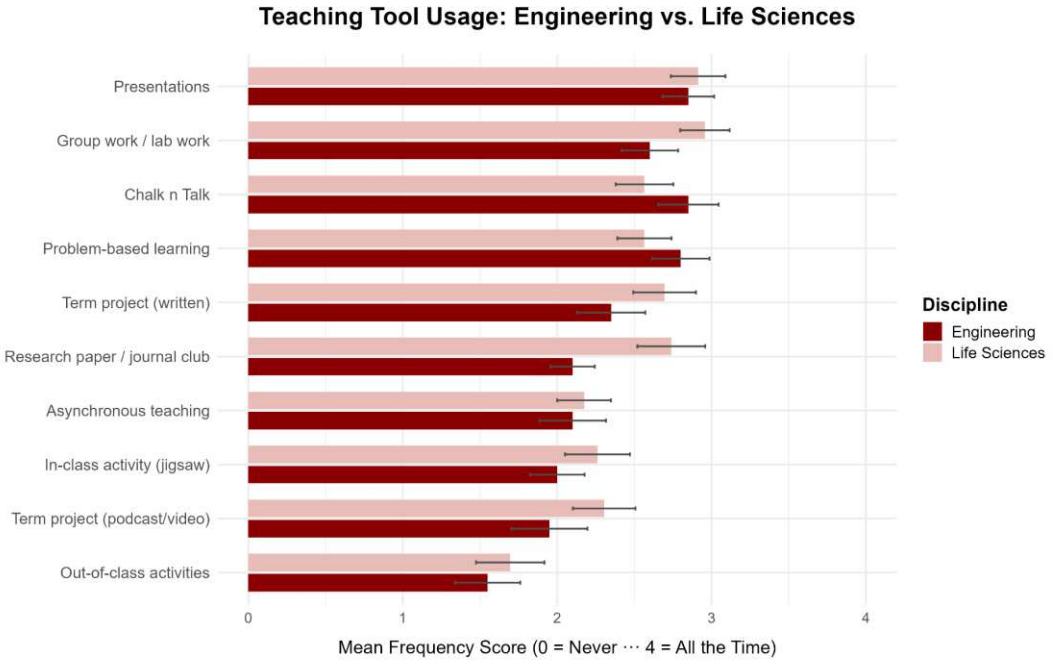


Fig 8: Teaching tool usage among Engineering and Life Sciences faculty.

To examine if Engineering (n =20) and Life Sciences (n = 32) faculty reported differences in teaching practices used, we compared mean frequency scores for ten teaching approaches. Scoring was done from 0 (never) to 4 (all the time). Differences between both the teaching groups were analyzed using independent-samples linear models and Wilcoxon rank-sum tests.

The largest difference can be observed for research paper/journal club use. Life Sciences faculty reported higher mean frequency of use of the mentioned approach than the Engineering faculty. This difference was statistically significant in both, linear model ($p = 0.023$) and the Wilcoxon rank-sum test ($p = 0.015$). For the remaining teaching approaches, no statistically significant differences were found between the Life Sciences and Engineering faculty. Group Work/Lab Work was reported to be in more use amongst Life Sciences faculty (linear $p = 0.023$, Wilcoxon rank-sum test $p = 0.015$), while PBL use was higher amongst the Engineering faculty (linear $p = 0.365$, Wilcoxon rank-sum test $p = 0.189$).

Similarly, no significant differences were found for term projects - podcast/video ($p =$

0.269), term projects - written (p = 0.256), chalk-and-talk (p = 0.299), in-class jigsaw activities (p = 0.357), presentations (p = 0.798), asynchronous teaching (p = 0.789) and out-of-class activities (p = 0.640).Overall, the results indicate that research paper/journal club activities were reported to be more frequently used amongst Life Sciences faculty than Engineering faculty while the other nine teaching approaches did not differ in use significantly.

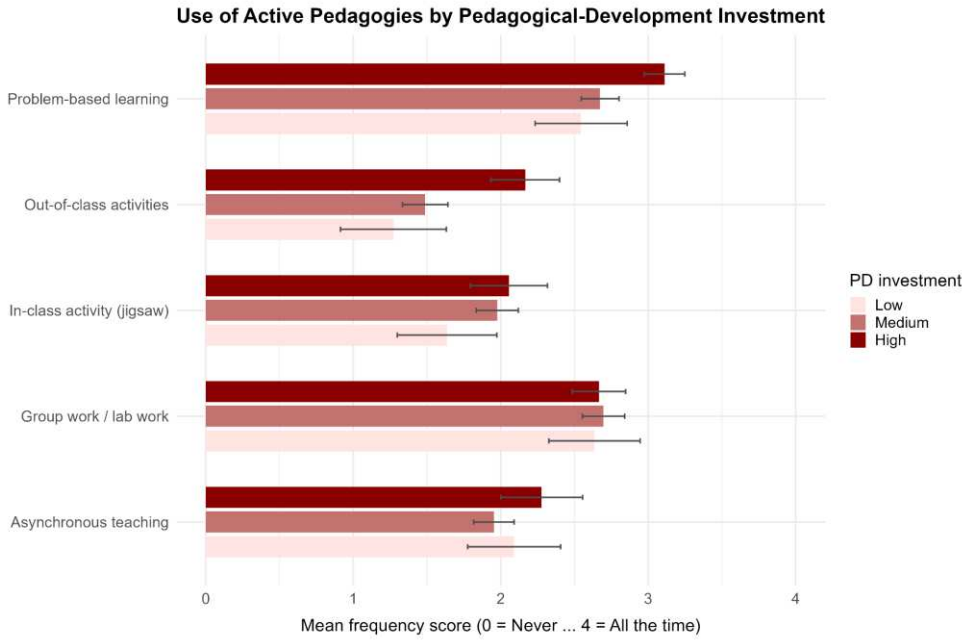


Fig 9: Use of active pedagogies by pedagogical-development investment.

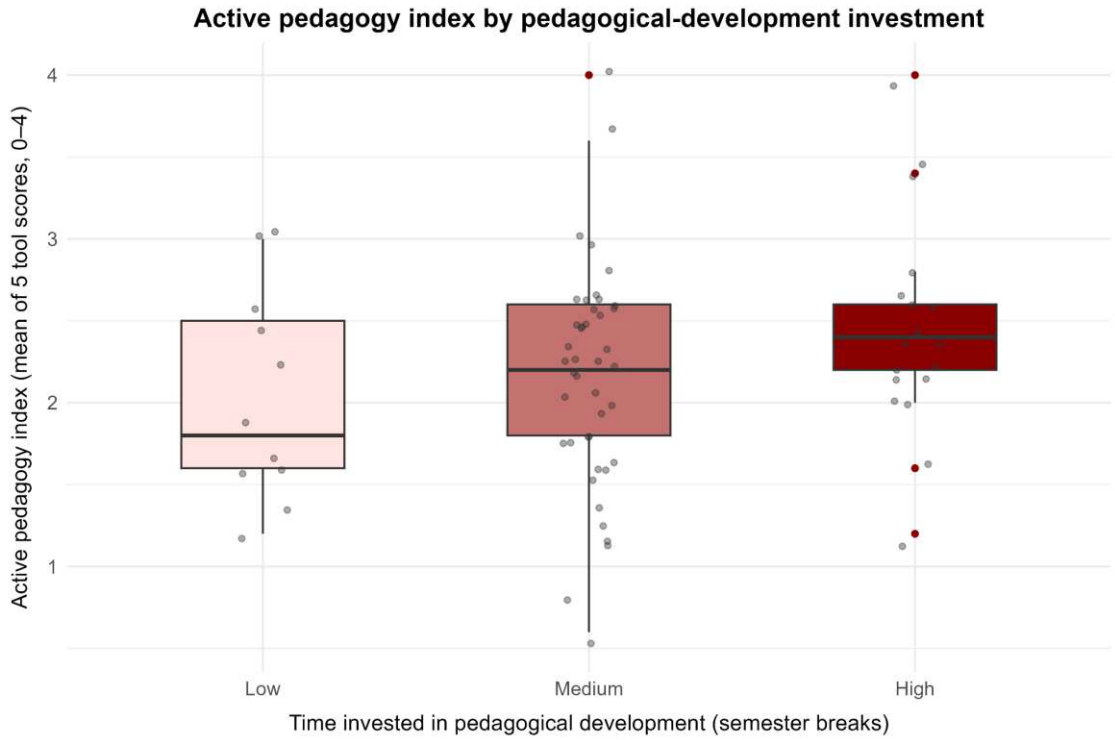


Fig 10: Active pedagogy index by pedagogical-development investment.

For the assessment of investment in pedagogical development and its association with the use of active teaching approaches, faculty were categorized into low, medium and high pedagogical-development (PD) investment groups based on the amount of time that the faculty group spent in developing pedagogical techniques in semester breaks.

Five active teaching approaches were examined; problem-based learning (PBL), out-of-class activities, in-class activity (jigsaw), asynchronous teaching, and group work/.lab work. Teaching frequency was again scored from 0 (never) to 4 (all the time).

Out-of-class activities showed the strongest association with pedagogical-development in both the analyses. The Kruskal-Wallis test indicated a significant difference among the three groups($p = 0.034$), while the Spearman's rank correlation indicated a positive association between pedagogical-development and the frequency in use of out-of-class activities ($\rho = 0.29$, $p = 0.014$). Problem-based learning also showed a similar pattern. The Kruskal-Wallis test however did not show statistical significance ($p = 0.107$). Spearman's correlation again indicated a positive association between pedagogical-development and

the frequency in use of PBL ($\rho = 0.23$, $p = 0.049$).

For other pedagogy approaches, no statistically significant associations were detected. To assess the overall active pedagogy use, we also calculated an Active Pedagogy Index, where we defined the mean of the five teaching-practice scores. At the composite level, the Active Pedagogy Index did not differ across the pedagogical-development investment groups ($p = 0.243$) and its relation with pedagogical-development investment was also found to be non-significant ($p = 0.097$).

Overall, the results suggest a positive correlation between pedagogical-development investment and the use of particular active teaching approaches like out-of-class activities and to some extent PBL. However, the same pattern was not evident for other active-teaching approaches.

Bias and Limitations:

We sent out this survey to 3316 faculty members across different universities but we have been able to gather only 93 responses. With a 2.8% response rate we could only highlight key instructional trends, the modest sample size reduced overall statistical power and increases the risk of Type II errors (failing to detect existing associations).While their responses do help us reflect on a number of pedagogical issues that currently exist, Mathematics and Chemistry are currently represented by only 5 responses each limiting generalizability and potentially obscuring discipline-specific instructional challenges in these fields. This modest sample size introduces potential self-selection bias, as educators with a pre-existing interest in pedagogical innovation may have been more inclined to participate. Additionally, educators who choose to respond to pedagogical surveys are likely already predisposed to experimenting with active learning. This might also over-estimates baseline adoption of active learning strategies and restricts generalizability to Mathematics and Physical Sciences.

Most respondents ($n = 59$) reported no direct experience teaching students with documented disabilities. This might be due to lack of formal screening protocols, broader structural barriers in admission and physical access, or sample bias wherein educators in inclusive settings were underrepresented. Thus, findings related to classroom accessibility

reflect baseline faculty awareness rather than a comprehensive institutional audit of disability support systems.Consequently, findings regarding inclusive teaching practices reflect baseline faculty awareness and self-reported exposure rather than an institutional audit of disability support systems. The regression modeling linking teaching experience to PBL usage were conducted on restricted subsets ($n = 56$). The resulting large standard errors ($SE = 2797.44$) indicate data sparsity in specific response combinations. Non-significant regression results should therefore be interpreted as inconclusive due to limited statistical power rather than definitive evidence of no underlying association.

Discussions:

Our exploratory survey baseline findings align closely with the pedagogical priorities as mentioned in India's National Education Policy (NEP) 2020, including experiential learning, multidisciplinary education, competency-based assessment, flexibility in pedagogy, and student-centred learning [12]. We have attempted to not only categorise faculty response in STEM HEIs on a Likert scale but also grouped their responses based on their qualitative responses. Majority of faculty members, who responded to the survey, suggested (in their survey comments) widespread adoption of experiential learning strategies that closely reflect the NEP's emphasis on inquiry-based and hands-on learning.However, rather than replacing traditional modes, active learning in Indian STEMM higher education is occurring through a process of pedagogical layering. Traditional techniques remain dominant strategies; chalk-and-talk lectures (Fig. 3b, n = 38 "all the time") and presentations (Fig. 3a, n = 30 "all the time") coexist alongside high engagement in group/laboratory work (Fig. 3c, n = 33 "all the time") and problem-based learning (Fig. 4d, n = 36 "most of the time"). This dual reliance demonstrates that conventional lecture-based teaching remains deeply embedded in postsecondary STEM education despite growing adoption of student-centred approaches. This pattern reflects not simply individual instructor preference, but the practical realities of adapting established teaching practices within rigid curricular constraints, large class sizes, and

existing institutional frameworks.

One of the popular myths regarding education reform is that the teaching methods change with tenure or that the newer teachers are more disposed towards active learning. Our empirical regression analysis disproves this myth (Fig. 6): Using proportional-odds ordinal logistic regression with polr() there is no significant linear relationship between years of teaching experience (experience_band) and the frequency of PBL. This suggests that pedagogical innovation in Indian STEMM is driven more by personal motivation, subject domain, or targeted training than by tenure.

The shift toward diversified and continuous assessment observed in our respondents mirrors the competency-based assessment philosophy advocated by NEP. Despite early evidence of NEP adoption, classroom inclusion remains limited. 59 respondents had no prior experience teaching students ,by their own admission, with documented disabilities, with similarly low exposure to neurodiverse and physically disabled students. This is a worryingly high number.

Responders had very low responses to having experience teaching students reported as neurodiverse (e.g., individuals with autism, ADHD, dyslexia, or dyscalculia) alongside only 13 self-reported engagement with physically disabled (PD) students.Faculty with prior experience teaching disabled students ($n = 25$) reported significantly greater use of asynchronous teaching ($p = 0.045$) and out-of-class activities ($p = 0.011$) than those without such experience ($n = 47$). No significant differences were found for group/lab work, jigsaw activities, or PBL ($p > 0.69$) (Fig. 7). These findings suggest that exposure to diverse learners may encourage more flexible teaching formats, while having less influence on core classroom practices.

This might be due to structural barriers and lack of access tools designed to make PD students included and perhaps a lack of diagnostic assessments. While rectifying accessibility for PD students does require institutional support and capital-intensive infrastructure, several tools are now available to make classrooms more neurodivergent friendly through the Universal Design for Learning (UDL) framework and accessible, low-cost instructional technologies.

The coexistence of frequent lecture-based practices with selectively adopted active-learning approaches suggests that pedagogical change may be occurring through layering rather than replacement. This suggests that in Indian STEMM higher education may be better understood as a process of consistent but gradual layering rather than replacement. This pattern is consistent with international evidence showing that conventional lecture-based teaching remains deeply embedded in postsecondary STEM education despite evidence supporting student-centred approaches [13]. The persistence of traditional approaches may therefore reflect not simply faculty preference, but the practical realities of adapting established teaching practices within existing curricular and institutional structures.

Faculty responses suggest that active learning strategies are already in place in several HEIs and extend beyond traditional lectures and include enquiry-based, and communication-oriented activities such as group work or lab work, chalk and talk, presentations and in class activities. We infer that these methods promote higher-order thinking rather than passive content delivery. Several respondents mentioned using semester breaks to incorporate pedagogical techniques into their curriculum which does invoke questions of time, institutional support, and workload required for meaningful pedagogical innovation. Break-time PD investment showed a significant positive association with the frequency of out-of-class activities (Kruskal-Wallis $p = 0.034$; Spearman's $\rho = 0.29, p = 0.014$) and PBL adoption (Spearman's $\rho = 0.23, p = 0.049$).This suggests that the adoption of active and student-centred approaches cannot be viewed solely as a matter of individual faculty preference or motivation. Similar concerns are raised in the wider STEM education literature, where pedagogical transformation has been linked to the availability of institutional resources and support beyond the classroom [13].

Among Life sciences and engineering faculty across ten teaching practices revealed that instructional tools are largely shared across STEMM fields. Life Sciences faculty reported significantly higher usage than Engineering faculty in both independent-samples linear models ($p = 0.023$) and Wilcoxon rank-sum tests ($p = 0.015$).This statistically confirms that while core active learning tools (PBL, group work, presentations) transcend

disciplinary boundaries, specific inquiry-based tools like journal clubs remain deeply rooted in field-specific norms (e.g., literature-heavy Life Sciences curricula). Furthermore, rather than relying exclusively on lecture and exams several respondents described frequent use of formative assessments designed to provide continuous feedback which can have a positive impact on student perception of academics. Our survey responses are consistent with the broader literature on STEM pedagogy, where active learning has emerged as the most frequently studied alternative to traditional lecture-based instruction, and also benefits under-represented students in STEM. Their study review also argued that experiential learning also draws upon Bandura's theory of social learning where new ideas can be learnt by observing others [13].

Thus our baseline data suggests that STEMM teaching is expanding beyond disciplinary knowledge toward communication and public engagement skills. Unlike many global studies that emphasize institutional learning support, respondents frequently describe individual faculty mentoring as an important strategy for promoting student success. The survey also highlights challenges that were not explicitly captured by the survey instrument, including computational diversity, professional skills, and emotional readiness, suggesting areas requiring further investigation.One can argue that Indian STEMM educators are moving toward active, inclusive, continuous, and communication-oriented pedagogy, while also identifying distinctive challenges such as heterogeneous student preparedness, especially computer literacy, language differences, and the importance of personal mentoring.

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