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Chapter 6
Instructional Approaches for Learner Engagement in Large Classes

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ABSTRACT

Large class sizes are frequently necessitated by financial, resource, and logistical constraints. Teaching large classes presents pedagogical challenges impacting instructional quality and student learning, with student engagement emerging as a critical issue. This chapter explores instructional approaches to mitigate potential negative effects on engagement and learning, based on a rapid literature review. Key approaches identified include instructional strategies, active learning, collaborative learning, technology integration, flipped classrooms, peer instruction, learning assistants, and frequent formative assessments. Results highlight active learning and technology-enhanced strategies as strongly correlated with improved student engagement and academic outcomes, particularly when effectively integrated. The practical implementation challenges are resource demands, and increased instructor preparation. The chapter concludes with recommendations for prioritising structured collaborative activities, interactive technologies, and targeted instructor training

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to enhance engagement.

INTRODUCTION

Large class sizes have increasingly become a reality in higher education institutions globally, driven by financial constraints, increased numbers of students, resource limitations, and logistical pressures. The necessity to manage resources efficiently whilst also accommodating increased demand often necessitates the adoption of large class formats. These large classes can present pedagogical challenges, including limited personal interaction, student isolation and increased complexity in classroom management. These challenges can have a direct adverse effect on student engagement, satisfaction, learning outcomes, and ultimately, institutional reputation (Bond et al., 2020; Fredricks et al., 2004).

Maintaining student engagement in large classes is important because of the risk of students feeling disconnected or passive, leading to reduced participation, lower academic success and higher dropout rates. Engagement itself has multiple dimensions, including behavioural, emotional, and cognitive (Fredricks et al., 2004; Kahu, 2013). Behavioural engagement involves active participation in class activities, emotional engagement relates to students' feelings towards educators and learning environments, and cognitive engagement requires deeper mental investment/ intellectual commitment in understanding the class material (Henrie et al., 2015; Zepke, 2015). Because of this complex nature of engagement, fostering an effective environment in large classes requires thoughtful, evidence-based instructional approaches tailored to mitigate these inherent challenges.

This chapter aims to address a critical gap in the existing literature by systematically evaluating strategies focused on enhancing student engagement in large class contexts. Using a rapid literature review approach (Smela et al., 2023; Tricco et al., 2015), aided with a generative AI tool, this work synthesises recent empirical studies that employed direct methods to measure student engagement. The effectiveness of instructional interventions, including active learning, collaborative learning, technology integration, flipped classroom models, peer instruction, learning assistants, instructional strategies, and frequent formative assessments, are assessed in this chapter.

The key research question in this chapter is: "What instructional approaches enhance student engagement in large classes?" To address this question, the following specific objectives were developed:

1. Identifying instructional interventions tailored for large classes.

2. Evaluating the effectiveness and impact of interventions on measurable dimensions of student engagement.
3. Assessing the practical and logistical considerations when implementing strategies in a real-world setting.
4. Developing recommendations that support educators and academic institutions to improve student engagement.

This chapter seeks to provide a practical set of recommendations for improving pedagogical practices in large class settings, contributing to better student experiences and educational outcomes.

EDUCATIONAL INTERVENTIONS FOR ENHANCING ENGAGEMENT IN LARGE CLASSES

Overview of Selected Instructional Interventions

Addressing the inherent challenges of maintaining student engagement in large-class environments necessitates carefully selected instructional interventions substantiated by robust educational research. Based on the prevailing evidence from prior studies, this chapter has selected eight instructional strategies that were deemed suitable for large-class settings: active learning, flipped classrooms, collaborative learning, peer instruction, instructional strategies, technology integration, frequent formative assessment, and learning assistants. These strategies were selected as they were found to have empirical support, scalability, and potential to enable active participation, higher-order thinking, and more effective peer interaction within large student cohorts.

The selected interventions closely align with widely recognised theoretical frameworks on student engagement. According to Fredricks et al.'s (2004) multidimensional model, effective engagement strategies must concurrently target behavioural, emotional, and cognitive domains. Many of the selected interventions, including active learning, collaborative learning, and technology integration, aim to engage students behaviourally through direct participation in class activities, cognitively through analysis, and emotionally through peer-to-peer interactions and interactive (formative) feedback mechanisms. Strategies such as collaborative assignments, frequent formative assessments, and interactive instruction are also presented within Kuh's (2001) theory, which emphasises high-impact educational practices. By directly aligning practical approaches with these established theories, the study offers educators and policymakers an evidence-based justification for prioritising specific pedagogies within large-class contexts.

Instructional Strategies

Instructional strategies form the foundational pedagogical practices that underpin effective communication and structured teaching. In large-class contexts, clear instructional strategies help educators articulate learning objectives, organise content systematically, and maintain effective communication despite limited individual interaction. These strategies can all assist in a variety of ways to manage large classes efficiently, facilitating understanding, and ensuring that key learning outcomes are addressed (Bond et al., 2020).

Active Learning

Active learning is typically characterised by educational practices where students directly engage in the class through activities that promote analysis, synthesis, and evaluation. Common active learning methods include problem-solving exercises, case studies, in-class discussions, and interactive group tasks. The extensive existing literature supports active learning, highlighting the significant improvements in students' academic performance, critical thinking, and engagement, particularly within Science, Technology, Engineering, and Mathematics (STEM) education and similarly structured disciplines (Freeman et al., 2014; Prince, 2004). Active learning approaches are valuable in large-class settings, as they can help to counteract passive learning tendencies associated with traditional lecture formats.

Flipped Classrooms

The flipped classroom model reconfigures the traditional instructional lecture and tutorial by delivering content outside of class time, usually via pre-recorded videos, readings, and online modules. Classroom sessions are then based on an interactive student-centred approach with activities such as collaborative problem-solving and discussions. This approach intends to maximise instructor-student interactions, therefore enhancing engagement through active participation and cooperative learning. Flipped classrooms have grown increasingly popular because of their alignment with several contemporary educational methods that emphasise active student engagement and deeper cognitive processing (Knight & Wood, 2005; Caldwell, 2007).

Collaborative Learning

Collaborative learning involves educational activities where students perform tasks in teams. This approach strengthens and facilitates peer-peer interactions, teamwork, and mutual accountability, which in-turn helps to foster deeper engagement,

higher-order thinking, and improved interpersonal skills. In the context of large-classes collaborative learning approaches like team projects, group discussions, and structured peer activities can help to counterbalance the limited time an instructor can have student interaction. This is intended to promote a sense of community and shared responsibility for learning outcomes (Carlos et al., 2023).

Peer Instruction

Peer instruction is an interactive teaching method leveraging peer-to-peer interactions to facilitate deeper conceptual understanding. Typically, educators pose conceptual questions, after which students discuss their reasoning in pairs or small groups before reconvening for class-wide discussion. This method encourages students to articulate, clarify, and defend their understanding, reinforcing learning through social interaction.

Peer instruction can be effective in large classes, as it utilises student interactions to maintain intellectual engagement and continuous active participation (Prince, 2004; Mulryan-Kyne, 2010). By encouraging students to discuss and verbalise their reasoning with peers a deeper understanding of the course material is typically obtained. As with collaborative learning, peer instruction can also help mitigate anonymity in large classes, therefore enabling students to become more emotionally and behaviourally engaged.

Technology Integration

Technology integration refers to incorporating educational technology to facilitate interactive and active learning environments. Effective use of technology in large classes includes audience response systems (clickers), interactive web-based quizzes (which can include gamification), collaborative digital platforms, and multimedia resources that encourage real-time student participation as well as provide immediate feedback. Strategic technology integration can aid in transforming passive learning environments into dynamic active learning classes and is strongly linked to enhanced student engagement, attendance, and retention of material, especially when combined with active pedagogical strategies (Laird & Kuh, 2005). However, for technology-enhanced engagement strategies to be truly effective, they must account for disparities in students' access to digital tools and connectivity. Students from underrepresented or disadvantaged backgrounds can face challenges such as limited access to reliable devices, internet connections, or the digital literacy needed to navigate educational platforms (Banerjee, 2020). If these barriers are appropriately addressed, technology offers significant opportunities to expand access to higher education for remote or disadvantaged communities (Bright & Calvert, 2023).

Frequent Formative Assessment

Frequent formative assessments involve regular evaluations of student understanding through quizzes, polls, or interactive exercises. These assessments enable students to receive immediate feedback as well as inform the progress of learning through to the educators, which in turn allows for timely adjustments in instructional approaches. Frequent formative assessments can help to sustain student engagement by maintaining interaction and reinforcing content understanding throughout the course. They are valuable in large classes, providing easily scalable ways to monitor and enhance student learning without creating significant additional workload for educators (Knight & Wood, 2005).

Learning Assistants

Finally, learning assistants are trained undergraduate or graduate students who support delivery of the course or subject by facilitating small-group discussions, assisting with formative assessments, and providing feedback to students during class. These learning assistants can therefore enable more personalised student-instructor interactions, which aids in reducing student anonymity and enhances learning experiences. This approach effectively supports active learning and collaborative activities, which can improve engagement outcomes in large-class environments (Deslauriers et al., 2011; Freeman et al., 2014).

Cultural and Linguistic Considerations

It is crucial to acknowledge the complexities introduced by the cultural diversity of student cohorts, which can significantly affect the efficacy of these interventions. In Confucian-heritage contexts such as Hong Kong, students may adopt a more passive role in classroom settings, prioritising deference to authority over active participation to avoid "losing face" (Chan & Smith, 2024). Similarly, in educational settings with large international student cohorts such as Australia or the UK, students often self-segregate along national or cultural lines, which can inhibit the intended outcomes of collaborative or peer-to-peer based interventions (Rienties et al., 2013; Hannon & D'Netto, 2007). In settings where English is a medium of instruction but not the students' first language, interventions that rely heavily on verbal engagement or nuanced language use may unintentionally marginalise learners, leading to passive involvement and reduced learning outcomes (Chuang, 2017), Therefore, the success or suitability of any engagement strategy in large classes must be considered in the cultural and linguistic context of the student cohort.

Engagement Strategies and Student Needs

Collectively, these instructional strategies form a coherent, evidence-based framework to address engagement challenges typical of large-class settings. By systematically evaluating the effectiveness, practical logistics, and scalability of each intervention, this chapter provides actionable insights to educators and education institution policymakers to enhance student engagement and academic success in large-class educational contexts.

The suitability of each of these educational interventions to address the crucial student engagement domains of behavioural, emotional, and cognitive identified in Fredricks et al.'s (2004) multidimensional model for student engagement are presented in Table 1.

Table 1. Suitability of selected strategies/interventions mapped to engagement challenges (strategies in rows, challenges in columns)

	Behavioural	**Emotional**	**Cognitive**
Instructional strategies	Medium	Medium	Medium
Active learning	High	Medium	High
Flipped classroom	Medium	Low	Medium
Collaborative learning	High	High	Medium
Peer instruction	High	High	Medium
Technology integration	High	Low	High
Frequent formative assessments	High	Medium	High
Learning assistants	Medium	High	High

Active learning, frequent formative assessments, and technology integration are all particularly effective in enhancing both behavioural and cognitive engagement because they introduce supervised or structured content with which the students are compelled to engage. These structures impose behavioural involvement and so support cognitive engagement through problem-solving tasks, quizzes, or interactive tools which often require students to interact in real time. In contrast, the flipped classroom approach, where the students are expected to engage with lecture material prior to class and use in-class time for discussion or application, shows only moderate effectiveness in the behavioural and cognitive domains. While this model is designed to deepen understanding and encourage preparation, it relies heavily on students' self-discipline and time management outside the classroom. In practice, the actual uptake of pre-class activities is often low, limiting the intervention's potential impact and leaving students underprepared for higher-order tasks in class. As

a result, its effectiveness in driving engagement tends to fall short without strong accountability mechanisms or cultural alignment.

Collaborative learning, peer instruction, and learning assistants stand out for their high effectiveness in supporting emotional engagement. These interventions foster a sense of belonging and shared purpose by promoting active questioning and interaction among students. These features can contribute to reduced feelings of isolation and increase motivation which is especially important in large cohorts where students may otherwise feel anonymous. Working with peers to solve problems or teach one another creates social bonds and reinforces learning through dialogue and explanation.

Instructional Strategies
Eight key strategies were reviewed: active learning, flipped classroom, collaborative learning, peer instruction, instructional strategies, technology integration, frequent formative assessments, and learning assistants.
Interventions mapped to Fredricks et al.'s (2004) engagement model.
Collaborative and active learning particularly effective in behavioural and emotional engagement.

METHODS

Rapid Literature Review Article Selection

A rapid literature review based on the PRISMA guidelines (Tricco et al., 2015) was conducted to evaluate systematically and synthesise empirical evidence related to instructional approaches enhancing student engagement in large classes. This method comprised four key steps: (1) initial identification and preliminary screening of potentially relevant studies based on titles and abstracts, (2) eligibility determination applying explicit inclusion and exclusion criteria as shown in Table 2, (3) full-text screening to exclude studies without direct measurements of engagement or inaccessible full-text articles, and (4) final synthesis and analysis aided by generative artificial intelligence (AI) large language model (LLM) technology to extract key methods, results and conclusions from each study.

For the fourth step, OpenAI GPT-4 Turbo (128k, temperature set to 0) was employed to extract detailed and nuanced information from each included study systematically. The steps of this structured prompt method are presented in Table 3. This structured AI-driven method offered substantial benefits, including enhanced consistency across reviews, significantly improved accuracy by reducing potential for human error or human bias, and notable efficiency and timesaving advantages

compared to traditional, manual data extraction methods. Using generative AI facilitated replicable results and enabled rapid parallel processing of multiple studies, thus overcoming limitations typically associated with human-based analysis.

To ensure clarity, consistency, and accuracy in the extracted data, additional detailed instructions were explicitly incorporated into the generative AI prompt:

1. Precise formatting guidelines required that each response element be systematically placed on a new line, thus ensuring enhanced readability, uniformity, and ease of subsequent synthesis.
2. Clear differentiation was mandated between direct and indirect measures of student engagement. Specifically, "direct measurement of student engagement" was clearly defined to include feedback collected directly from students (e.g., surveys, interviews) and explicit activity-based metrics (e.g., attendance, online engagement time, grades). This distinction significantly improved the accuracy of categorisation and analysis.
3. Explicit clarification was provided that only engagement measurement methods explicitly described in the studies should be categorised as engagement measures. This measure prevented confusion between general instructional methods and actual direct measures of student engagement.
4. Detailed examples illustrating acceptable means of measuring "in-class activity participation" (e.g., clickers, polls, interactive activities) were provided to further enhance specificity, consistency, and accuracy in the method for identification process.

These comprehensive instructions provided explicit and systematic guidance for the generative AI, ensuring precise determination of eligibility and meticulous extraction of specific study details for synthesis. The structured approach not only ensures reproducibility but also comprehensive and rigorous data extraction for robust analysis across all studies included in the review.

Initially, a total of 102 references were identified through targeted database searches and screened based on their titles and abstracts. After removing duplicates and during the screening stage, seven studies were excluded because of the absence of explicit direct measures of student engagement. Subsequently, the remaining 51 studies proceeded to a detailed full-text screening stage, during which two additional studies were excluded owing to the unavailability of full texts. Consequently, a total of 49 empirical studies successfully met all eligibility criteria and were included in the final synthesis and comprehensive detailed analysis as shown in Figure 1.

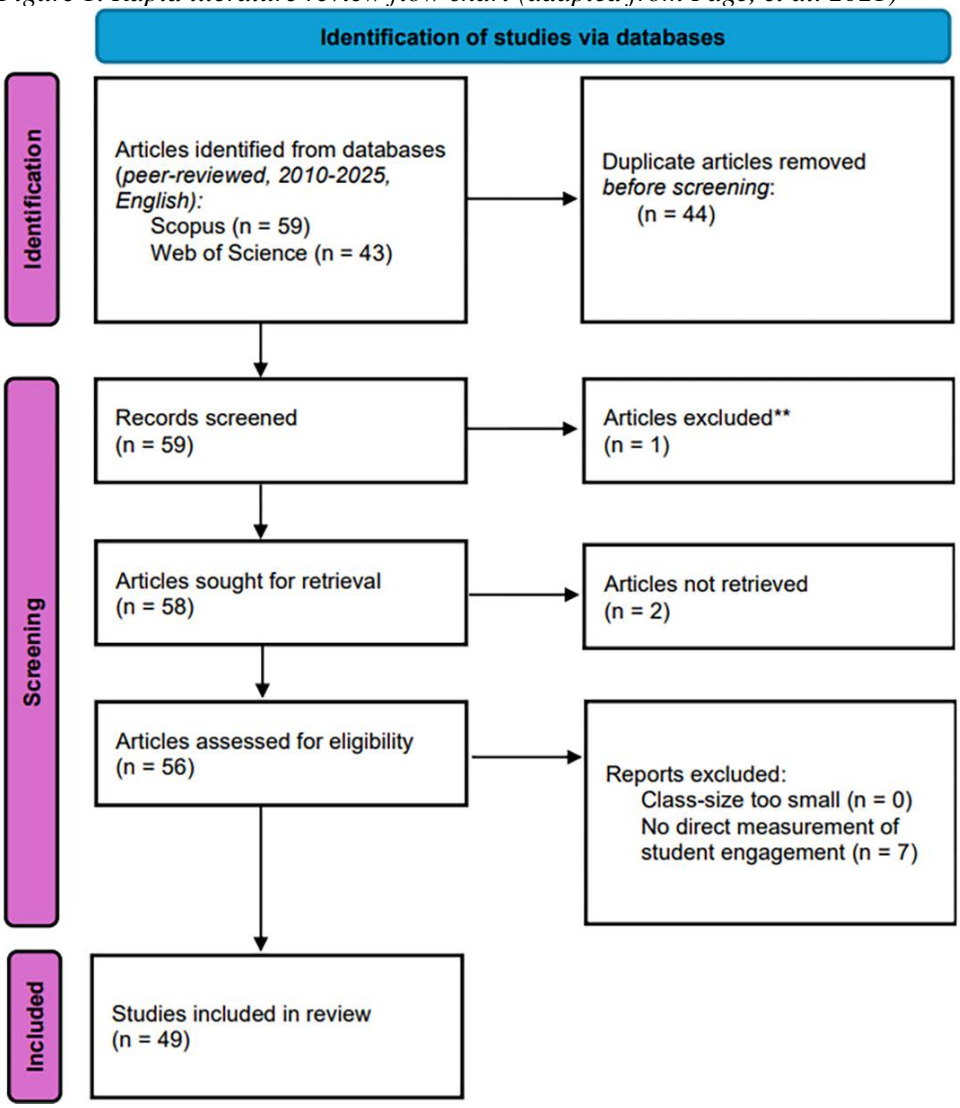
Table 2. Search terms used in rapid review

Topic and cluster	**Search terms**
Engagement	"student engagement" OR "student motivation" OR "student participation"
Class size	"high-enrolment" OR "high-enrollment" OR "large enrolment" OR "large enrollment" OR "large class")
Instructional interventions	"instructional strategies" OR "active learning" OR "flipped classroom" OR "collaborative learning" OR "peer instruction" OR "technology integration" OR "frequent formative assessments" OR "learning assistants"
Student engagement	"student engagement" OR "student motivation" OR "student participation"
Publication Year	2010-2025
Publication Type	Peer reviewed articles

Table 3. Structured Prompt Method

Step	**Information Extracted**
Eligibility	The study [satisfies/does not satisfy] the conditions to be included in this review
Intervention(s)	"instructional strategies", "active learning", "flipped classroom", "collaborative learning", "peer instruction", "technology integration", "frequent formative assessments", "learning assistants" [YES/NO]
Class Size	[60-100/100-200/200+]
Measurement Methods	"Student feedback survey", "Observation during class", "In class activity participation", "Grades (average grades)", "Grades (pass-fail percentage)", "Active time on online learning platform", "Contribution to online learning platform", "Attendance", "Focus group/interview", "Other" [YES/NO]; qualitative impact [negative/neutral/positive sentiment]; quantitative impact [decrease/unchanged/increase]
Resources	[greater/unchanged/lesser resource requirements]
Limitations	Up to five explicitly identified limitations

Figure 1. Rapid literature review flow chart (adapted from Page, et al. 2021)



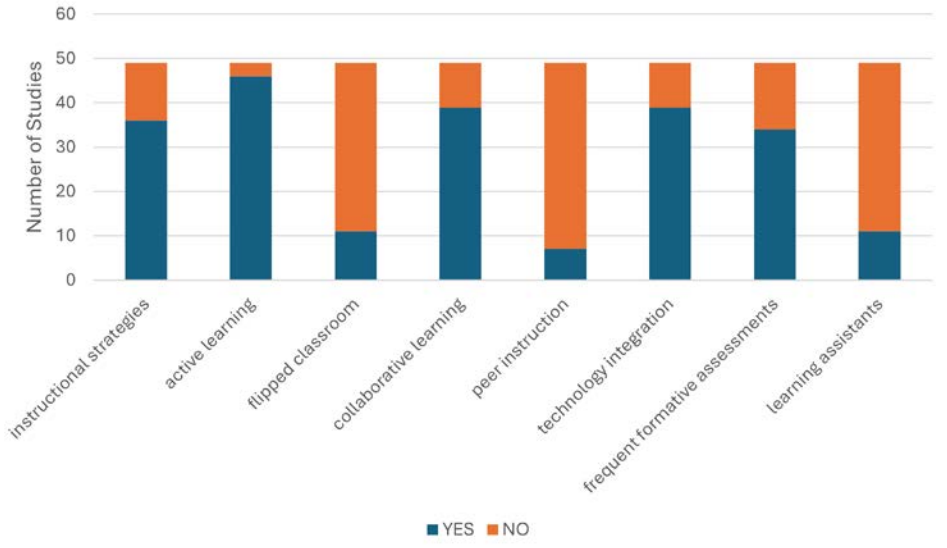
RESULTS

As detailed in Figure 2 all the selected interventions were found in the literature, however, some presented much more prominently, and most studies implemented multiple strategies at the same time. Among the intervention strategies examined,

active learning emerged as the most frequently studied approach, with nearly all reviewed studies incorporating this method, underscoring its widespread recognition as a critical tool for enhancing student engagement. Technology integration, instructional strategies, frequent formative assessments and collaborative learning were also commonplace which indicates their frequent application to challenges associated with large class sizes. Conversely, approaches such as flipped classrooms, peer instruction, and learning assistants were less commonly studied interventions. Their relatively lower prevalence indicates potential barriers to widespread adoption or possible limitations in resource availability, instructor familiarity, or context suitability within larger class sizes.

Overall, the diverse distribution of these strategies reflects a comprehensive, multifaceted approach within the literature to tackle student engagement challenges inherent in large-class educational environments.

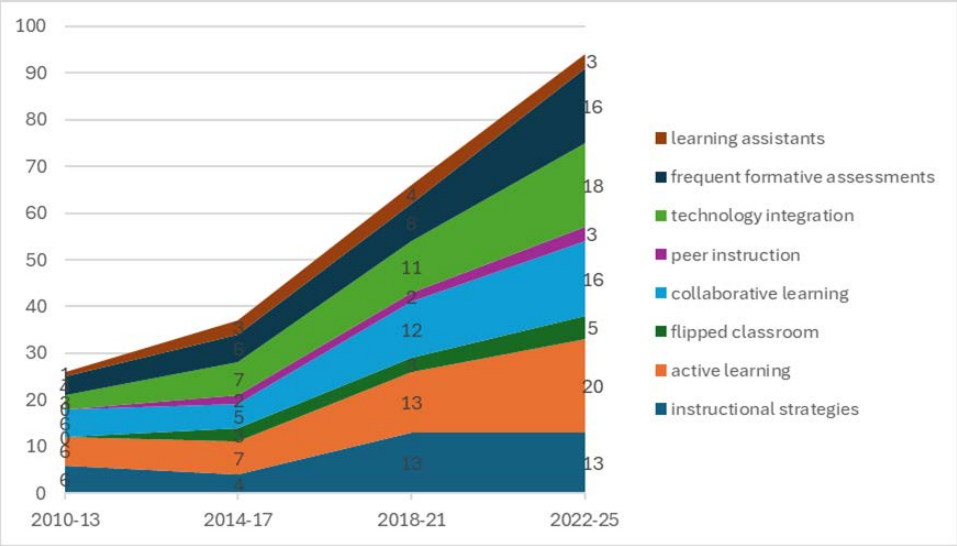
Figure 2. Distribution of engagement intervention strategies studied (Yes=included, No=not included)



The prominence of the selected interventions also varied over time. The collective number of publications which implemented any of these educational strategies trended upwards in the last 15 years, as shown in Figure 3. This trend indicates that the efficacy of various instructional approaches for engaging students in large class sizes has been of increasing academic interest. The intervention strategy of technology integration has experienced the greatest growth in studies, increasing

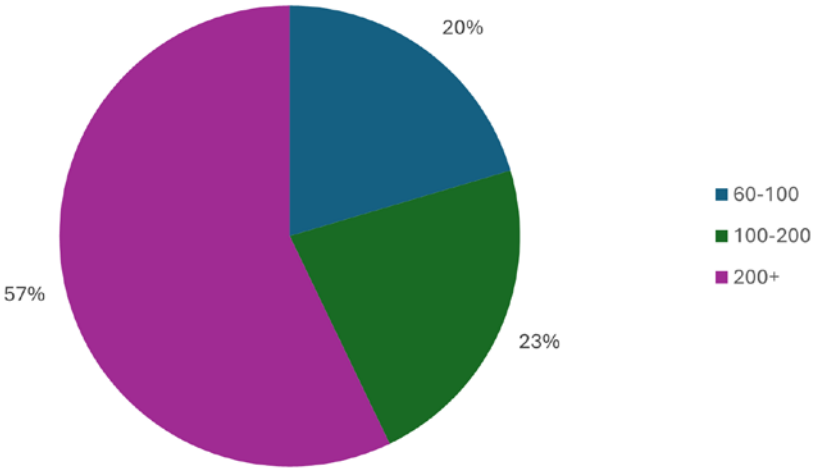
from 3 studies in 2010-13 to 18 studies in 2022-25. This change reflects the recent growth of digital teaching tools and student's access to technology such as laptops and smartphones. Frequent formative assessments, collaborative learning, and active learning also all showed significant uptick in the number of publications studying their impact on student engagement in large classes. While interest in learning assistants, peer instruction, and flipped classroom educational interventions remained relatively low.

Figure 3. **Distribution of engagement intervention strategies studied over time**



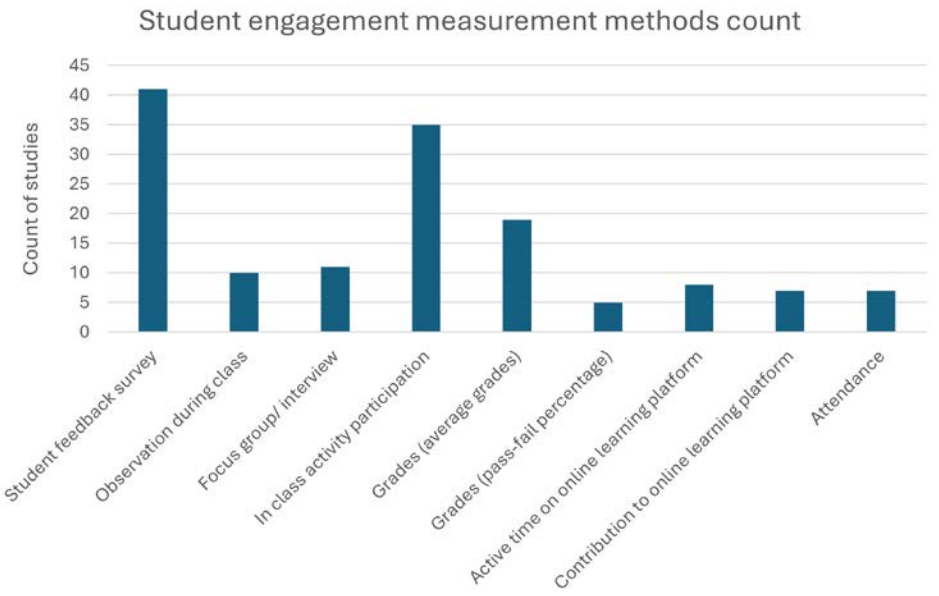
The distribution of studies according to class size reveals a notable preference for examining very large classes (200+ students), with this representing the majority of the studies reviewed as shown in Figure 4. This trend indicates that researchers and educators recognise the challenges associated with the largest class settings. Classes with 100-200 students were moderately represented, while smaller large classes (60-100 students) were the least studied group. The predominant focus on very large classes underscores the importance of developing and refining interventions explicitly designed to scale effectively and sustainably for extensive student cohorts.

Figure 4. **Distribution of class size for selected studies**



Analysis of student engagement measurement methods across the reviewed studies reveals a clear preference for using student feedback surveys, making this the most frequently employed method. This is followed closely by the measurement of in-class activity participation, demonstrating an emphasis on direct behavioural indicators of student engagement. Average grades were also moderately used as an engagement metric, while observation during class, focus groups or interviews, online platform metrics, attendance, and pass-fail grades were notably less frequently employed. This distribution highlights a strong reliance on self-reported data and direct classroom activity participation to gauge student e engagement in large classes, as shown in Figure 5.

Figure 5. **Student engagement measurement methods count**



Qualitative impact analyses indicate predominantly positive sentiments for almost all engagement measurement methods. Student feedback surveys yielded overwhelmingly positive feedback, with very few instances of neutral sentiment. Observations during class and focus group interviews similarly reflected predominantly positive responses, further validating the effectiveness of studied interventions, as shown in Figure 6.

Quantitative impact assessments consistently demonstrated improvements in student engagement. In-class activity participation was most frequently associated with increased engagement, followed by average grades, both strongly indicating positive effects. Metrics, such as active time and contributions to online learning platforms and attendance, also mostly showed increases but were less frequently studied. Pass-fail percentage grades showed the least frequent but still predominantly positive outcomes, as shown in Figure 7.

Figure 6. **Measurement methods - qualitative impact**

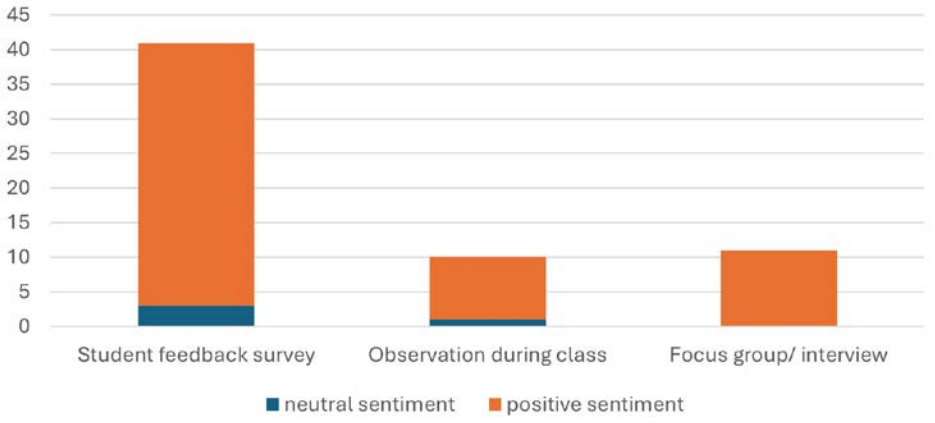
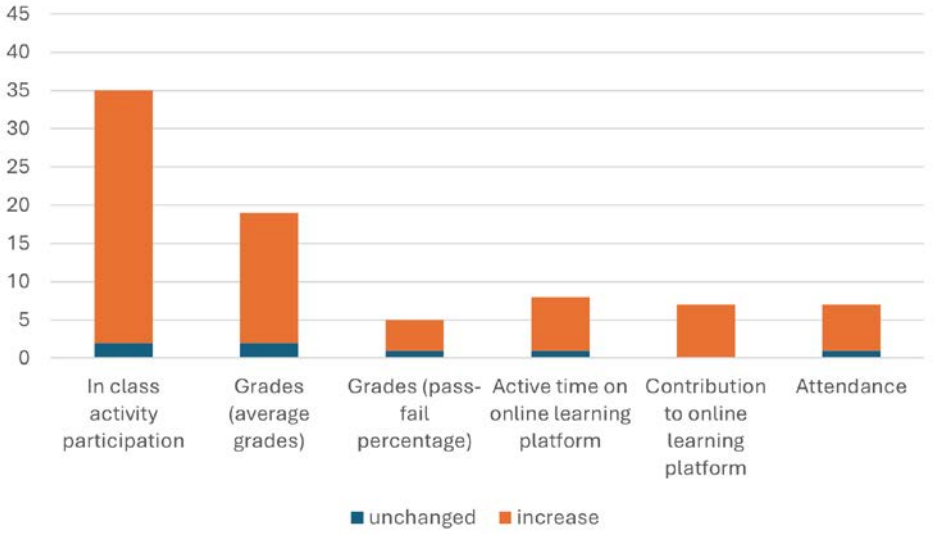


Figure 7. **Student engagement measurement methods - quantitative impact**



DISCUSSION

Overview of Key Findings

Student engagement is widely recognised as a key factor in learning outcomes, with higher engagement linked to greater academic success. Based on the analysis of the selected studies on large-class engagement strategies, several notable correlations emerged between teaching instruments and student engagement/performance. Interactive instructional techniques, which included technology integration and active learning, showed the strongest positive correlations with engagement metrics and academic performance. For example, classes that incorporated active learning methods – such as problem-solving activities, discussions, or case analyses – tended to have higher student participation and slightly better assessment outcomes than those relying on a traditional lecture. This aligns with existing research that shows when students are actively involved in learning, they achieve higher exam scores and lower failure rates. This also aligns with other studies, such as Freeman (2014) that found 22% of students failed under active learning vs 34% under lecturing.

Collaborative learning strategies also correlated with improved engagement, i.e. courses that used group work, peer instruction, or team-based projects saw students more frequently on-task and intellectually invested. In contrast, more passive, instructor-centred approaches were associated with lower engagement. Traditional large lectures – where students listen without interaction – showed either weak or negative correlations with engagement, also re-iterating other studies that found large classes relying on lectures often yielded reduced student involvement and minimal participation (Kerr, A 2011).

Another key finding was the role of technology-enhanced strategies. The data indicated moderate positive correlations between the use of educational technology and student engagement levels. Classes that employed tools like audience response systems (clickers), learning management system quizzes, or online discussion boards tended to report higher attendance and attentiveness. This suggests that technology, when used purposefully (e.g. for quizzes or polls), can stimulate interaction even in classes of several hundred students. Notably, these tech-enabled practices often went hand-in-hand with active learning – for example, educators used clicker questions to quiz students on concepts, prompting peer discussion and feedback. Such techniques likely kept students accountable and mentally engaged throughout the session. Other studies have also found that information technology for educational purposes correlates strongly active and collaborative learning (Laird & Kuh 2005).

In summary, the dataset's most critical correlations highlight that active learning, collaborative activities, and interactive technology use are all linked to higher student engagement and better performance in large classes, whereas purely lecture-based

instruction correlates with lower engagement. These patterns reinforce the idea that even in high-enrolment settings, how one teaches makes a significant difference in how students engage and succeed.

CRITIQUE OF EXISTING LARGE-CLASS TEACHING RESEARCH

Reinforcement of Existing Literature

Situating these results in the context of prior research on large-class teaching reveals a mix of reinforcement and productive contradiction. Our findings closely align with a well-established body of literature advocating for active learning in large classes (Freeman et al., 2014; Prince, 2004), reinforcing that interactive methods lead to improved engagement and outcomes. For example, research in a 200+ student physics class showed that replacing lectures with research-based active instruction significantly increased student attendance, attention, and understanding (Deslauriers et al., 2011). Similarly, in a large introductory biology course, adding more student participation, frequent in-class assessment, and cooperative problem-solving improved students' conceptual learning compared to a lecture-heavy format (Knight & Wood, 2005). These parallels underscore that our rapid literature review results reinforce the prevailing evidence that, even in classes of hundreds, students learn and engage more when they must actively think and interact during class. In this sense, the findings strengthen the case made by prior scholars, such as Prince (2004), that student-centred methods work across various scales. It is encouraging to see that large class size need not preclude high engagement, so long as educators adopt effective pedagogies.

Technology Integration

Results of the rapid literature review on technology use in large classes also mirrors existing research, with some convergence and divergence. Consistent with prior studies, we found that classroom technology, like student response systems ("clickers") can boost engagement in large lectures. Past literature reviews have noted that clickers, when used for interactive questioning, have positive effects on student participation and attentiveness in big classes (Caldwell, 2007). Courses using live polls or quiz apps saw more students participating actively. The broader research on technology in large classes presents some contradictions that are important to acknowledge. Not all studies find uniformly positive impacts of technology; some have reported no significant improvement in learning outcomes when technology

is added to lectures without an accompanying change in pedagogy (Mulryan-Kyne, 2010). This may help explain certain weaker correlations in the rapid review dataset. For instance, while tech-enhanced strategies correlated with engagement, there was no correlation between technology and students' grades. This could be comparable to cases in the literature where simply using online videos which did not automatically deepen learning. The implication is that technology by itself is not a solution to engagement, and the most important aspect is how it is integrated. Prior research also has found small or mixed effects for technology in large classes, unless paired with active learning strategies (Freeman et al., 2014).

Barriers to Implementation at Scale

One of the key challenges approached in this study is the implementation of engagement strategies at scale. Many authors have noted the difficulties educators face in large classes—such as managing group activities among hundreds of students, ensuring accountability, and overcoming student anonymity (where individual students feel "lost in the crowd") (Kerr, 2011). The literature documents that large classes often suffer reduced levels of interaction and active participation by default (Mulryan-Kyne, 2010). The findings of this rapid literature review show how certain strategies can successfully counteract these tendencies for larger classes. For example, we observed that active learning methods correlated with better exam performance on average also supported by Freeman et al. (2014), but we also recognise that not every instructor finds it feasible to adopt these methods in a lecture hall of 200 or more students. This reflects a common theme in the research: while the benefits of active learning in large classes are well-established, practical barriers often hinder implementation (Mulryan-Kyne, 2010). Some investigations have found that even when educators attempt active techniques in big classes, they can face student pushback or uneven results.

Student Resistance and Perceptions

Recent studies have shed light on a potential reason for student resistance to active learning. In a controlled study, Deslauriers et al. (2019) found that students in a large physics class *felt* they learned less with active methods, even though their test scores were higher, presenting a "paradox" where perceived learning diverges from actual learning. This kind of finding is echoed by reports of large-class students sometimes rating active formats as less enjoyable or more chaotic compared to polished lectures (Kerr, 2011). Such contradictions are important in interpreting our dataset: if some strategies showed only mild improvements, it could be because of student scepticism or inconsistent execution at scale. Deslauriers et al., (2019) noted

that over time, however, students often come to appreciate these methods once they see the payoff, and overall evaluations can improve once the novelty wears off. This complexity in student reception is a prominent thread in the literature and serves as a cautionary note. It suggests that effective practices in theory do not always translate seamlessly into practice, especially in large-class environments where logistics and student expectations pose hurdles.

Implementation Challenges in Large Classes
Scaling engagement interventions introduces logistical, cultural, and psychological challenges.
Initial student resistance to active learning is common.
Technology needs pedagogical alignment to succeed.

Application to Large Interdisciplinary Engineering Classes

Applying instructional strategies effectively in interdisciplinary engineering design subjects presents can provide a lot of opportunity to improve learning outcomes but comes with a range of practical challenges. As discussed in the broader literature, the identified instructional methods, such as active learning, flipped classrooms, peer instruction, technology integration, formative assessments, and learning assistants, have the potential to improve engagement, and this holds true for interdisciplinary engineering cohorts. These approaches also align with engineering practice by enhancing skills, such as collaborative problem-solving, creativity, and analytical thinking across a range of engineering disciplines.

Active and Collaborative Learning

In practice, despite their theoretical benefits, implementing these strategies reveals considerable logistical and pedagogical barriers and application in practice not necessarily aligning with the theory. Active learning approaches, for example, require extensive preparation and careful integration of multidisciplinary content into cohesive activities. This significantly increases educators' and syllabus creation workloads for educators. Collaborative learning methods are integral to interdisciplinary engineering design subjects however because of space requirements (i.e. a flat room with groups centred around individual tables) this often necessitates splitting large classes into smaller workshop groups, creating higher operational costs and placing additional demands on institutional resources. For those classes that remain in larger spaces, the environment can become noisy and difficult to manage effectively. Finally, many educational institutions do not yet have enough

spaces that are designed for this collaborative learning, thus further restricting the application of this method in some settings.

Flipped Classrooms

Flipped classroom methods similarly offer valuable opportunities for interactive, cross-disciplinary engagement, yet the broader literature underscores practical challenges such as inconsistent student preparation and engagement with pre-class materials. In interdisciplinary contexts, these issues are often amplified by diverse student backgrounds and cultural differences that contribute to students' reluctance to participate actively or openly engage in discussions.

Peer Instruction

Peer instruction also holds promise by leveraging students' diverse disciplinary strengths; however, existing literature and practical experiences highlight considerable communication challenges, particularly due to varying proficiency in English among international student cohorts. Without effective support structures, language barriers and communication anxieties can become a major barrier to the intended benefits of peer interactions, negatively impacting engagement and inclusion, or worse, resulting in students not achieving the learning outcomes at all.

Technology Integration

Technology integration, while valuable for promoting active engagement, echoes previous literature findings by introducing risks of increased distraction. Interactive technologies like clickers and online quizzes are beneficial when carefully structured, yet without clear usage guidelines and classroom management strategies, they can inadvertently result in students becoming distracted and using their devices for non-course related activities.

Frequent Formative Assessment

The frequent use of formative assessments is consistently shown to boost student engagement through regular feedback; the associated workload brings about a practical challenge, particularly in interdisciplinary settings. Creating relevant assessment tasks across diverse engineering disciplines requires significant instructor expertise and preparation time. Without additional teaching assistant support or effective digital assessment tools, maintaining consistent and timely feedback quality is costly and if feedback is provided late, this can reduce the intended benefits of the assessment.

Learning Assistants and Instructional Coordination

Learning assistants can improve personalised feedback and small-group interactions; however, their successful implementation necessitates training, ongoing supervision, and clear communication strategies as well as an increased teaching team and resultant cost. Managing learning assistants from multiple engineering disciplines adds to both the consistency of guidance but also the complexity, potentially creating a range of challenges for educators and subject co-ordinators.

Summary and Institutional Considerations

In summary, while interdisciplinary engineering design courses can clearly benefit from these instructional strategies implementation needs to be practical and considered ensuring that a range of potential issues are addressed including educator's workload, student preparedness, cultural and linguistic diversity, technological distractions, and logistical complexities. These practical considerations highlight the need for strategic academic institutional frameworks that include educator training and clear policy to achieve sustained engagement and meaningful educational outcomes in interdisciplinary engineering contexts.

Case Study: Active Learning in Large-Scale Engineering Design

At a major urban university in Australia, instructors in a first-year masters interdisciplinary engineering design course with enrolments exceeding 300 students re-worked the delivery model from traditional lectures to active learning workshops. Students from a range of disciplines including mechanical, electrical, civil, biomedical engineering and software engineering were divided into small teams of four to five students for structured, design-based projects.

Each week, students attended two two-hour workshops that began with short instructor-led briefings, followed by group problem-solving tasks. For example, one project required teams to design an e-waste solution at an institutional level. This delivery approach was found to boost engagement and attendance rates in comparison to the traditional lecture delivery method. This approach aligns closely with the existing theoretical frameworks emphasizing the benefits of active learning. For example, Freeman et al. (2014) demonstrated active learning's positive influence on student performance and engagement in STEM education.

However, implementing these workshops also highlighted the challenges identified in previous literature. For example, Mulryan-Kyne (2010) noted that active learning often demands considerable institutional resources and logistical coordination. In

this instance, delivering effective workshops required limiting class sizes to 60 students per session, significantly raising operational costs, and necessitating forty hours of instructor teaching time weekly.

Technology integration also featured prominently with some tasks requiring teams to collaborate on electronic devices to complete online 'project boards' together. Although intended to facilitate collaboration, several common issues were identified as previously discussed by Caldwell (2007) and Laird and Kuh (2005). It was found that the technology occasionally resulted in off-task multitasking behaviour by students and reduced discussion and face-to-face peer interaction, negatively affecting emotional engagement. Kerr (2011) contended that unstructured or poorly managed technology use can distract rather than engage students, especially in large, diverse cohorts. However, in this case, even structured technology-based tasks were observed to contribute to reduced engagement and diminished learning outcomes.

Institutional Leadership

Institutional leadership in essential for the successful implementation of instructional strategies focused on improving engagement. To enable the adoption of the interventions discussed in this chapter institutional support must be provided across in three key forms: infrastructure, professional development and adjusted educator workload planning.

Infrastructure

Infrastructure support is critical as delivery models shift away from large lecture theatres towards more collaborative learning spaces such as 'flat' rooms with clustered tables which are much more conducive to team based active learning. These spaces should also be equipped with sufficient technology integration and flexible seating arrangements to enable a variety of different classes.

Professional Development

Professional development is also essential to ensure educators not only understand the pedagogical principles underlying these approaches but also gain access to practical strategies for effective implementation in the classroom. It is also important that this professional development assist educators in dealing with a diverse student population with varying cultural backgrounds and management of team dynamics.

Educator Workload

Educator workload is also significantly impacted and must be acknowledged at the institutional level. Additional workloads occur during the implementation and preparation of the interventions as well as the ongoing management, assessment and delivery of the instructional activities. Initial implementation requires curriculum re-design, resource development (including quizzes or activities) as well as familiarisation with technologies and their integration. The ongoing facilitation of the active learning also requires greater time commitment, especially in the case of collaborative learning with increased team co-ordination and increased educator presence.

Equity and Inclusivity Considerations

Large classes can increase equity and inclusivity challenges because of their large scale and subsequent diversity. Peer instruction, collaborative learning, and flipped classrooms, whilst all have benefits in theory, may unintentionally disadvantage particular student groups, including international students, non-native English speakers, and culturally diverse cohorts. Language barriers can significantly impede peer-peer discussions and collaborative learning, causing discomfort and the reluctance to participate. Similarly, flipped classrooms depend on students coming prepared before class, which can disadvantage students unfamiliar with self-directed learning or those balancing substantial external commitments such as work, family or carer responsibilities. To mitigate these equity concerns, educators should clearly scaffold activities by providing clear instructions, structured tasks, and support materials. Assistance should also be provided to students where English is not their first language to improve their English proficiency. By ensuring that groups are culturally diverse and balanced as well as explicitly encouraging inclusive interactions and establishing clear expectations, educators will be more likely to improving learning outcomes for all student populations. Additionally, many of these interventions assume a baseline level of technology access, which may not be universally available across different geographic locations or within all segments of a student cohort. This presents a notable limitation and highlights the need for thoughtful and considered implementation. If implemented with equity in mind, technology-aided student engagement strategies have the potential to improve education access and engagement by connecting students in remote areas, offering flexible access to learning resources, and accommodating diverse learning needs through adaptable digital platforms.

CONCLUSIONS

This study systematically examined instructional strategies aimed at enhancing student engagement and academic performance in large-classes at the tertiary level. The findings further reinforce existing literature by validating that active learning, collaborative learning, and strategically integrated educational technologies effectively counteract common engagement challenges particularly evident in large classes including student passivity and anonymity. Technology based approaches including clickers, online quizzes, and interactive discussion platforms were also found to be highly effective when correctly designed to support active learning and simultaneous interaction rather than mere content delivery.

From a practical standpoint, the results indicate a range of activities educators and educational institutions can prioritise immediately. (1) Educational institutions should support educators by incorporating training and resources that aid them in implementing active learning methods and collaborative activities effectively within classes. This may include professional development programs or increased allocation of teaching assistants as well as investment in technology platforms that facilitate frequent formative assessments and peer-peer interactions. (2) Educators should carefully integrate technology use, clearly defining its purpose to assist in preventing student distraction and ensure that it is applied such that it provides benefits such as instant feedback.

Practical implementation of the mentioned interventions still presents a range of challenges. Active learning and flipped classroom methods require considerable upfront preparation, and successful student engagement with these models often hinges on adequate pre-class preparation and overcoming initial resistance. Equity and inclusivity challenges were also evident in large classes where educators should provide clear scaffolding, structured support, and targeted assistance, especially for culturally diverse cohorts and non-native English speakers. Educators should also clarify that interactions remain inclusive and managing student expectations to help ensure equitable learning outcomes across diverse student populations. Educational institutions need to also recognise and support the additional effort in implementing these strategies and ensure that educators have adequate time, training, and resources.

This study further validates the effectiveness of active, collaborative, and technology-integrated instructional strategies in large classes. It also highlights the importance of careful implementation, faculty support, and planning to maximise student engagement. To improve student engagement, educational institutions should prioritise training, resource allocation, and adoption of blended pedagogical models to ensure educators can overcome inherent logistical and cultural challenges inherent in large classes.

Practical Recommendations for Immediate Implementation

Based on this study's findings, educators and institutional policymakers can immediately prioritise several actionable strategies:

- Structured Collaborative Learning: Employ carefully designed team projects or in-class group discussions supported by clear rubrics and explicit role definitions, ensuring equitable participation.
- Audience Response Systems (Clickers or online polls): to maintain active engagement, promote regular attendance, and instantly gauge student understanding. These can also provide formative feedback for students.
- Formative Assessments: Introduce frequent technologically supported quizzes or polls to provide continuous feedback in order to identify issues early and encourage class participation without significant staff time.
- Instructor Training and Support: Provide targeted training focused on effective classroom management strategies, inclusive instructional design, and optimal technology used to reduce student distractions and enhance overall engagement.
- Incremental Adoption of Flipped Content: Selectively select pre-class content that aligns with interactive in-class activities and progressively adjust based on student preparedness and feedback.

Key Limitations

1. Correlational Nature of Findings

While the study identifies clear relationships between instructional strategies and engagement outcomes, it does not establish causation. Students that reportedly engaged in active learning may have already been more motivated, potentially leading to selection bias.

2. Reliance on Self-Reported Engagement Measures

The majority of the dataset that report student engagement is based on student surveys and self-reported engagement, which introduces subjectivity. Previous studies, such as those by Deslauriers et al. (2019), have highlighted the discrepancy between perceived learning and actual learning outcomes. As such, self-reporting is not necessarily the most reliable indicator of students achieving learning outcomes even if they 'feel' more engaged.

3. Limited Longitudinal Insights

The study focuses primarily on immediate engagement and performance outcomes rather than long-term student success, such as retention rates, progression to advanced coursework, or career readiness. Longer term studies that tracked students over their degree and into the workforce would provide deeper insights into the long-term impact of engagement strategies.

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