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# Managing complexity in cross-cohort classrooms: strategies for effective implementation of real-life projects

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**Introduction:** Real-life project-based courses aim to enhance student learning by integrating authentic projects into the curriculum. However, the complexity of these projects, due to their VUCA (Volatile, Uncertain, Complex, and Ambiguous) nature, can pose significant challenges, especially for students new to the concepts and skills being taught. This study addresses the overarching question: "How can a systematic model be developed and implemented to effectively manage teaching and learning through developing a real-life project in a hybrid cross-cohort environment?".

**Methods:** The study was conducted within an Instructional Systems Design (ISD) course in a hybrid cross-cohort class structure. A diverse class of 27 students with varying backgrounds participated in the course. Data were collected through surveys, interviews, and instructor observations. The implementation process involved multiple student cohorts, primary stakeholders of the project, subject matter experts, and instructors.

**Results:** The study resulted in the development of the proposed 3 Square model to manage hybrid cross-cohort learning environments. Students engaged in developing a real-life project—a public awareness website for Persons with Disabilities (PwD) in a university environment. They navigated the complexities of coordinating within a cross-cohort classroom and developed critical skills such as autonomous decision-making and effective communication. Outcomes included efficient time management, achievement of project objectives, and tangible learning outcomes such as mastering ISD topics, using new tools, and working collaboratively in a group.

**Discussion:** The findings highlight the importance of leveraging diverse student knowledge and experience to manage challenges in cross-cohort classrooms for complex projects. Practical implications are discussed for instructional design and teaching strategies in diverse educational settings, emphasizing the need for systematic approaches to facilitate real-life problem-based learning tasks.

**Conclusion:** This study provides a retrospective evolution of a systematic model for hybrid cross-cohort learning environments. It identifies teaching-learning challenges, determines appropriate instructional strategies, and evaluates the effectiveness of solutions in facilitating real-life project-based learning. The insights gained contribute to managing diverse educational settings and enhancing instructional design practices.

KEYWORDS

multi-cohort, instructional strategies, hybrid learning environment, project-based learning, instructional system design model

## 1 Introduction

The field of teaching-learning in classrooms has witnessed significant changes in the past decade. With the evolution of diverse classroom structures, new instructional strategies are necessary to ensure optimal learning outcomes for students. One such structure is the cross-cohort class structure (Pourmohammadali et al., 2020), also referred to as mixed-cohort in some literature (McMoran, 2016), which includes students with varying experiences and knowledge levels to approach a problem together. The major challenge here is ensuring the completion of a real-life project in a cross-cohort environment, especially in a hybrid mode while ensuring each cohort has some takeaway from the course. The proposed research study examines the strategies learned from teaching an Instructional Systems Design (ISD) course in a cross-cohort class structure. The study was conducted in a university setting where students from diverse backgrounds and educational experiences were enrolled in the course. The institute's PwD (Persons with Disabilities) *cell* (based on the terminology used by the institute), needed to create a 'disability awareness training program' and the instructors took up that task as an opportunity to enable hands-on learning in the ISD course. This research study aimed to explore the challenges faced by the stakeholders in managing the class and the instructional strategies that were implemented to effectively teach the course as well as execute the real-life project.

### 1.1 The ISD course design

The ISD course was conducted in a graduate-level program at a Technology University in Mumbai, India over a typical spring semester duration of five months (January–May). The course was designed to provide students with an understanding of the principles and practices of ISD involving standard assessment methodologies such as mid-semester and end-semester examinations, including viva. The course had a heterogeneous mix of students, with varying levels of prior knowledge and experiences not explicitly in the field of instructional design or disability studies related domains. The class also had students from different cultural and linguistic backgrounds. The students were divided into three cohorts: Cohort X (mostly freshmen)—credit-bearing students ($N = 10$), Cohort Y (mostly sophomores)—Immediate seniors of X cohort who had some experience in ISD and wanted to participate in the project ($N = 8$), and Cohort Z (mostly upperclassmen)—anyone who wanted to participate in the course ($N = 9$). Cohort X consisted of total novices in ISD. These students had little to no prior knowledge of ISD and needed to learn the basics from scratch. Cohort Y was for those with medium experience in ISD, meaning they had either attended the course before and/or had some project management experience. Cohort Z was mostly senior students/postdocs—those with high experience in either ISD or project management. This cohort included students who had taken the course before and also served as Teaching Assistants (TAs) in the previous semesters. The instructors divided the students into four groups (A, B, C, and D) to ensure that they worked together in diverse groups. They ensured that at least one member from each cohort was present in each group. This move aimed to create a diverse and inclusive learning environment, where students could learn from each other's experiences and skills. More details about cohorts and groups along with student demography are explained in section 6.2.1.

The ISD course focused on concepts like ADDIE (Davis, 2013; Peterson, 2003), TPACK (Koh, 2019; Lee and Kim, 2014; Koh et al., 2015), and LCM model (Murthy et al., 2018; Shah et al., 2022) etc. However, by bringing in the real-life PwD project, the course became slightly complex. On one hand, students had to learn ISD topics, on the other hand, they had to do the project on the go. This increased the complexity as this is not a standard practice in an academic environment, especially in an ISD course to create and deliver a solution for a real-life problem within the course limitations.

### 1.2 The VUCA nature of the real life course project problem

The course project under consideration aimed to develop an awareness product for the PwD cell. The project's nature is VUCA, which stands for Volatile, Uncertain, Complex, and Ambiguous (Seow et al., 2019; Pan et al., 2021). The project was volatile due to the unclear objectives and development requirements. This is because the course is not designed to teach product development but ISD. Moreover, the PwD cell did not specify which product to develop and why, leaving the project open-ended and subject to change. Second, the project was uncertain as the end goal was unspecified and the path to it was also not evident apriori. While students in Cohort X are credit-taking and have a stake in the project's outcome, others could have been mere observers who are not officially auditing. Thus, the project's success depends on the engagement of only a select group of individuals. Third, the project was complex due to the specialized nature of the work involved (having an in-depth knowledge about specific disabilities). Students were expected to learn and develop a project simultaneously, without outsourcing any part of the work. The complexity of the project makes it challenging for students to produce a product that meets the expectations of the institute PwD cell. Last, the project was ambiguous because the focus on PwD is not linked to the course's instructional delivery framework. This made it difficult for students to understand the connection between ISD topics and the project's emphasis on PwD. Thus, the VUCA nature of the course project made it challenging for students to develop a product for the institute PwD cell.

### 1.3 Complexities of the challenges associated with the course project problem

There were several complexities of the challenges associated with the project. These are as follows:

#### 1.3.1 The complexity of the task itself

Working on a project with a team of learners who are new to a particular subject matter can be a daunting task that requires a lot of effort and attention (Guo, 2004). It is essential to provide them with the necessary guidance and support to help them navigate through the learning process and become proficient in the field. The key to success in this scenario is to ensure that the team is getting towards completion, one step at a time. It is crucial to set clear objectives and milestones that are achievable and realistic, enabling the team to measure their progress and stay motivated. To achieve an acceptable level of quality, it is essential to pay attention to every detail of the project. This involves carefully planning each stage of the project, identifying potential issues, and taking proactive steps to mitigate them. It also involves regular communication and feedback to ensure that everyone is on the same page and working towards the same goal.

### 1.3.2 The hybrid cross-cohort classroom environment

The class in question was a complex one, consisting of multiple cohorts and delivered in a hybrid format. While this approach offered a lot of flexibility and opportunities for engagement, it also posed some unique challenges. One of the biggest challenges was to ensure that every member of each cohort had a meaningful learning experience, despite the differences in their location, learning style, and access to resources (Tan and Jones, 2008). To make things more challenging, the team had to cater to different needs and expectations. For instance, some students were taking the class for academic credit, while others were attending it for personal enrichment. This meant that the instructors had to ensure that the class balanced academic rigour and practical relevance while accommodating different levels of prior knowledge and experience (Gorlatova et al., 2013). To keep everyone engaged and motivated, the instructors had to use a variety of tools and techniques. These included interactive lectures, group discussions, peer feedback etc. The class also had to leverage technology to bridge the gap between the physical and virtual worlds.

### 1.4 Scope of this research article

This research article aims to provide a detailed explanation of the process and strategies used culminating in a model to manage complexities while effectively addressing a real-life problem that arises in a cross-cohort class. By complexities, we refer to the overall complexity as an umbrella term, rather than individual VUCA aspects. This exploratory research focuses on the challenges that are specific to a cross-cohort class and the methods used to overcome them. A thematic analysis of the student reflection journal (Dunlap, 2006) was used for validation of the model. Additionally, some standard metrics have already been addressed in works that cover—(i) interest (Badhe et al., 2023), (ii) student engagement (Shah and Iyer, 2023), (iii) hybrid class structure (Khwaja et al., 2023), (iv) agency (Srivastava et al., 2023), and (v) learning of student cohorts (Soodhani et al., 2023). By presenting these works as a reference, this article provides a comprehensive analysis of the methods used to manage complexities in a cross-cohort class and the metrics used to evaluate the effectiveness of these methods.

## 2 Literature review

Managing complexity in cross-cohort classrooms and implementing real-life projects requires multifaceted approaches. Experiential learning through real-life projects simulating consulting firm dynamics has proven effective, with coordination and time management being crucial factors (Cano et al., 2006). Integrating technical, behavioral, and contextual competencies in postgraduate programs, along with project complexity evaluation, enhances learning outcomes (de los R'ıos Carmenado et al., 2011). The POOL model framework, which facilitates multidisciplinary collaboration, helps students manage complex design problems and technological challenges in undergraduate digital media design education (Fleischmann and Daniel, 2013). To address project complexity, strategies focusing on knowledge production and flexibility are recommended, with their effectiveness varying based on the type of complexity encountered (Floricel et al., 2018). These approaches collectively emphasize the importance of practical experience, interdisciplinary collaboration, and adaptive strategies in managing complexity and implementing real-life projects in educational settings.

### 2.1 Strategies for effective implementation of real-life projects

Implementing real-life projects in cross-cohort classrooms can enhance learning by connecting theoretical knowledge with practical application. Some effective strategies discussed in the literature are as follows:

Educational research has identified several key strategies that enhance the effectiveness of real-life project implementation in educational settings. *Interdisciplinary collaboration* has emerged as a crucial approach, where students are encouraged to work across different subject areas to address complex problems (Almulla, 2020). The study emphasizes that this collaborative approach fosters a broader understanding of concepts and their real-life applications, enabling students to develop more comprehensive problem-solving skills.

A significant paradigm shift has occurred in educational methodology through the adoption of *problem-led learning approaches* (Marra et al., 2024). This transformation moves away from traditional solution-led methodologies towards approaches where students actively identify and explore real-world challenges as part of their learning process. Research indicates that this shift has profound implications for student engagement and learning outcomes, as it more closely mirrors real-world problem-solving scenarios.

The *integration of technology* (Meng et al., 2023) has become increasingly vital in modern educational environments. A recent study (Herna'ndez-Ramos et al., 2021) highlights the importance of leveraging digital tools and platforms to facilitate collaboration and project management among students, particularly when dealing with geographically dispersed learners. The implementation of interactive digital narratives and data visualization tools has proven (Demir and O'nal, 2021) especially effective in helping students analyze and understand complex systems, providing them with practical skills that are directly applicable to real-world situations.

### 2.2 Some existing models for managing complexity in cross-cohort classrooms

Recent educational research has highlighted several innovative learning models that have shown promise in enhancing student engagement and learning outcomes. Among these, the *Cohort-Based Learning Model* (Rajendran et al., 2024) has emerged as a significant approach to educational design. This model strategically groups students with similar starting points to progress together through

10.3389/feduc.2024.1471702

their educational journey, thereby fostering a strong sense of community and shared learning experiences. However, research has identified scaling challenges associated with this model, particularly due to the need for uniformity in curriculum and student backgrounds, which can present difficulties in accommodating varying skill levels[1,2].

To address these challenges, educators have developed several effective strategies within the cohort-based framework. Dynamic grouping has proven particularly successful, where students are grouped according to varying proficiency levels to encourage collaboration on complex problems, thus enabling differentiated instruction. Additionally, flexible pacing has been implemented as a key strategy, allowing instructors to adjust the pace of lessons to meet individual learner needs while providing supplementary support through mentoring and additional resources.

*Systems Thinking Approach* (Betts, 1992) has also gained prominence as an educational framework, particularly in addressing complex real-world issues. This approach integrates systems thinking into the curriculum, encouraging students to understand and analyze complex interdependencies in real-world scenarios. The implementation of this approach requires several strategic elements, including restructuring curricula to emphasize interdisciplinary projects, developing practical assessments based on systems thinking methodologies rather than traditional testing methods, and providing comprehensive training for educators in systems thinking approaches.

These existing models, when effectively implemented, represent a significant evolution in educational practice. Their combined application offers potential solutions to many traditional educational challenges while preparing students for the complexities of real-world problem-solving. The literature suggests that successful implementation requires careful consideration of institutional context, student needs, and available resources, highlighting the importance of flexible and adaptive approaches to educational design.

### 2.3 Challenges of VUCA projects in general

The concept of VUCA describes the challenging and unpredictable conditions that organizations face in the modern world. This framework is used to understand and navigate the dynamic and often chaotic business environment. Various research papers have explored the challenges associated with managing projects in a VUCA environment, highlighting the difficulties and proposing strategies to address them. In the context of education, some of them are as follows:

- Domain competence development: there is a significant need for enhancing domain competencies among project developers to navigate the complexities and uncertainties of VUCA environments (Bodea et al., 2020).
- Curriculum adaptations: educational institutions must adapt their curricula to prepare students for VUCA environments, emphasizing active learning and the development of skills to manage volatility, uncertainty, complexity, and ambiguity (Fernandes and Afonso, 2021).
- Technological integration: leveraging AI and other advanced technologies can enhance learning and competence development, equipping project developers with the necessary skills to handle VUCA challenges (Bodea et al., 2020).

### 2.4 Challenges of VUCA projects in cross-cohort environment

The challenges of VUCA projects in a cross-cohort environment, particularly in a classroom setting, are multifaceted. The work of Green et al. (2019) and Audunsson et al. (2018), both highlight the need for flexibility in curricula and the importance of instilling a positive view towards teamwork, respectively. The study by Guo and Cheng (2019) emphasizes the changing structure of professional capacity and the need for lifelong learning mechanisms, while (Fernandes and Afonso, 2021) discuss the challenges of promoting active learning in the context of VUCA. These studies collectively underscore the need for adaptability, teamwork, and continuous learning in addressing the challenges of VUCA projects in a multi-cohort environment, particularly in a classroom.

### 2.5 Using participatory learning pedagogy to approach the real life project

*Participatory learning* approaches (Mishra et al., 2022) can be effectively applied to create disability awareness training programs. Research suggests that involving community members, including people with disabilities, in the design and implementation of such programs leads to more impactful outcomes (Hayward et al., 2019). These programs can employ multi-modal approaches, incorporating interactive discussions, problem-solving activities, and hands-on experiences to enhance understanding and reduce negative attitudes towards disability (Hayward et al., 2019). Embedding disability awareness into existing curricula, while challenging, can be achieved through subtle inclusive practices and modelling inclusive behavior (Hale et al., 2013). These approaches align with our proposed model by emphasizing active engagement, reflection, and real-world application in fostering disability awareness and inclusion. Table 1 provides an overview of existing literature across three themes: people, pedagogy, and process, utilized for this research.

## 3 Research gaps and corresponding research questions

Although there have been several studies on project-based learning (PBL), cross-cohort classrooms, and VUCA projects individually, there is currently no research that combines all three into one comprehensive study. Education in the modern era requires students to gain real-life industrial project development experience and skills. Thus, teachers need to start incorporating real-life

1 https://www.educate-me.co/blog/cohort-model
2 https://www.chieflearningofficer.com/2022/04/06/three-ways-to-design-a-cohort-learning-experience-that-will-transform-the-way-your-managers-lead/

TABLE 1 An overview of existing literature across three themes: *people, pedagogy, and process*, was utilized for this research.

| | Models for managing complexity in cross-cohort classrooms | Strategies for effective implementation of real-life projects | Challenges of the VUCA project that gets addressed |
|---|---|---|---|
| People | Cohort-based Learning | Interdisciplinary collaboration | Domain competence development |
| Pedagogy | Participatory Learning | Problem led learning approaches | Curriculum adaptations |
| Process | Systems Thinking approach | Integration of Technology in curriculum | Technological proficiency |

projects in their courses. Therefore, it is important to get a perspective on how to implement such courses. This research study addresses the overarching question: *"How can a systematic model be developed and implemented to effectively manage teaching and learning through developing a real life project in a hybrid cross-cohort environment?"*

Sub-questions that support the overarching question are:

> Q1: What challenges and complexities did the instructors face in managing a hybrid cross-cohort class environment?
>
> Q2: What instructional strategies and models appropriately addressed these identified challenges?
>
> Q3: How effective was the proposed model in addressing the challenges of real-life problem-based learning tasks in a cross-cohort environment?

In the following sections, each sub-question is addressed individually. While Question 1 reflects the instructors' perspectives, Question 2 covers two main areas: instructional strategies and the subsequent evolution of the proposed model. Question 3 primarily draws the answer from anecdotal evidence found in voluntary student reflection journals, as well as standard metrics, to validate the model's effectiveness.

# 4 Addressing Q1: challenges instructors encounter in managing a hybrid cross-cohort class environment

Implementing project-based learning in a multi-cohort hybrid environment presents several intricacies, which can be categorized into two main areas of concern: (a) complexities related to managing projects and facilitating effective learning, and (b) challenges associated with coordinating across different cohorts in a hybrid classroom setting.

Within the context of project-based learning, the complexities can be further broken down into:

A lack of familiarity with the subject domain of the project:

- Understanding core principles of the subject (in this case, Instructional Systems Design)
- The rapid progression from novice to semi-subject matter expert (SME)
- Completing the final product and obtaining approval from the project agency

Furthermore, the complexities of managing a hybrid classroom with multiple cohorts include the following challenges:

- Coordinating activities and communication across different cohorts
- Balancing and managing instructional delivery in both virtual and in-person settings

# 5 Addressing Q2: instructional strategies and models that appropriately addressed these identified challenges

The project undertaken was a complex one, with several challenges that needed to be addressed in order to achieve the desired outcome. The task involved developing a product related to PwD using the principles of ISD. To achieve this goal, the task was broken down into four points, each of which required a specific approach.

## 5.1 Familiarization

The first challenge was to address the unfamiliarity of the PwD topic. To overcome this, two intensive workshops were conducted by subject matter experts from a PwD support group NGO called 'Ummeed'[3]. Ummeed provides specialized care for most developmental disabilities and focuses on areas of training, research and advocacy. It is now one of the country's leading NGOs, much respected for its work in the field of children with disabilities. These workshops were designed to help the students gain an in-depth understanding of the subject matter. The experts also provided ongoing advice to the instructors regarding the quality of the final product. To ensure that the final product was of high quality, periodic user surveys and evaluations by the experts were conducted. Below is an excerpt from the *reflection journal* by a cohort X student.

> "Today's session and interaction with the Ummed team has given very in-depth and personal insights about understanding the challenges faced by learners with disabilities because till now we have brainstormed all these based on our superficial assumptions, so it was really useful to listen to the real instances shared by them."

3 https://ummeed.org/

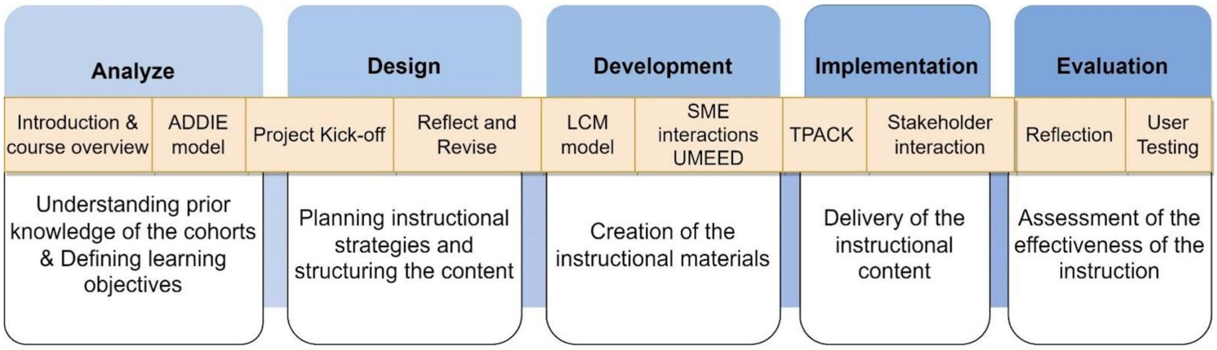


FIGURE 1
Process showing how PBL was infused with ISD topics.

## 5.2 Focus on core learning

The second challenge was to ensure that the learning of ISD was not compromised. To overcome this, the instructors covered all core topics related to ISD, as mentioned earlier. The students were asked to constantly connect these concepts with the product they were developing, which allowed them to apply the principles of ISD in a meaningful way. Below is an excerpt from *reflection journal* by a cohort X student.

> "My reflections/learnings from the session:
>
> The participatory approach we follow (interaction with SME and stakeholders) in the design of the website and training material is essential and should be extended to our own projects.
>
> Resources in the proposed PwD website should be presented in a concise manner (minimal information which is less scattered) and information hierarchy has to be followed.
>
> Following TPACK framework[4] in the development of resources helps in better integration of educational technology tools.
>
> Both in-class assignments helped in getting a better picture of the TPACK framework. But more time was required for discussion. I need to work on more examples to understand the concept of TPACK framework better."

## 5.3 Fostering learnability

The third challenge was to develop an advanced understanding of chosen disabilities; a subset of disabilities was chosen based on PwD student demographics and advice from SMEs. To achieve this, each group was allocated a specific disability. They used extensive publicly available vetted resources[5] and conducted surveys with stakeholders and support groups. They periodically cross-verified their findings with experts to ensure the validity of their knowledge. Below is an excerpt from *reflection journal* by a cohort Z student.

> "While interacting with PwD cells and doing user study, I learned different dimensions that need to be covered while doing need analysis of the user, as well as the need to keep one dimension always open."

## 5.4 Developing competency

The fourth and final challenge was to ensure the acceptance of the proposed solution in real-life situations. To achieve this, a website for PwD awareness was developed[6]. The website was publicly available after due diligence and expert committee evaluation at the institutional level. To date, it has been accessed over 800 times from multiple countries, with the resources pages having an average of 100 accesses. This achievement is a testament to the quality of the final product and the hard work put in by the students. Below is an excerpt from the *reflection journal* by a cohort Y student.

> "For me creating LeDs[7] with content and voiceover was enough, but while preparing for website content videos I learned much about the animation video that we can create can also be a good LeD and can be utilized in teaching practice."

The Figure 1 shows how PBL was infused with ISD topics.

Figure 1 presents a detailed tabular representation outlining the stages of the instructional design process within the context

4 TPACK (Koehler and Mishra, 2009) is a model for thinking about teaching knowledge and how the different types of knowledge a teacher has about the content they are teaching, the ways they teach the content, and the tools they use to support how they teach.

5 https://sites.google.com/view/iitb-pwdcell-training/additional-resources_1

6 https://sites.google.com/view/iitb-pwdcell-training/home_1

7 In the context of the Learner-Centric Model (LCM), LeD stands for Learning Dialog. It refers to a specific type of interactive video designed to enhance learner engagement and understanding within Massive Open Online Courses (MOOCs).

10.3389/feduc.2024.1471702

of the ADDIE model. It is segmented into five distinct phases: Analyze, Design, Development, Implementation, and Evaluation. Each phase is further divided into specific tasks or components related to the instructional design process. The Analyze phase focuses on understanding the prior knowledge of the learners and establishing clear learning objectives. The design phase concentrates on the planning of instructional strategies and the structure of content to facilitate effective learning. This phase includes Project Kick-off and Reflect and Revise activities to ensure the alignment of instructional strategies with the defined objectives. The Development phase involves the creation of instructional materials that support the learning objectives. It encompasses tasks such as utilizing the LCM model and incorporating interactions with Subject Matter Experts (SMEs) to enhance the effectiveness of the instructional materials. Next is the Implementation phase, which centres around the delivery of instructional content to the learners. It involves stakeholder interaction and effective communication during content delivery to ensure the successful implementation of the designed instructional content. Lastly, the Evaluation phase focuses on assessing the effectiveness of the instructional design and learning outcomes. Activities such as Reflection and User Testing are included to gather feedback and continuously improve the instructional process. Elaborating on the Instructional Design Process, the Analysis Phase forms the foundation by understanding the learners' needs and clearly defining learning objectives. In the Design Phase, instructional strategies are planned, and content is structured to align with the defined objectives. The Development Phase sees the creation of instructional materials based on the design phase to facilitate effective learning experiences. In the Implementation Phase, the designed content is delivered to the learners, emphasizing stakeholder interaction and communication for successful implementation. The final phase, Evaluation, assesses the effectiveness of the instructional design through reflection and user testing, ensuring continuous improvement.

## 5.5 Addressing the coordination among cohorts in hybrid classroom setup

In order to ensure better coordination among the students in a hybrid class, the instructors used a *reflection journal*. This was an asynchronous model of facilitating cross-cohort interaction and peer learning. The purpose of a *reflection journal* is to encourage students to think critically about what they have learned, and to provide them with a platform to express their opinions and share their reflections with their peers. This document provides a space for knowledge-sharing, where students can read and comment on each other's views and opinions. Reflection opportunities are given to students in an asynchronous mode so that the learning space remains dynamic and interactive.

Apart from the *reflection journal*, a running set of Google slides called *class response deck*, project planning notes and lecture slides—collectively called as 'shared documents' was extensively used as a medium for students to respond to in-class activities and keep track of all interactions.

# 6 Addressing Q2: evolution of the proposed solution—the 3 square model

The 3 square Model is a retrospective framework that evolved as an outcome of the combination of various instructional strategies and processes used for addressing the challenges. It comprises three interconnected squares (layered with each other), designed to complement each other. The framework is used to visualize a hybrid classroom environment where students, instructors, primary stakeholders, and subject matter experts collaborate to develop solutions for real-world problems.

## 6.1 The overall design process

### 6.1.1 The pedagogy

In the instructional framework for teaching Instructional System Design (ISD), a flipped classroom model was strategically adopted to enhance student engagement and learning outcomes. In this approach, students were first exposed to course topics and supplemental materials through the Learning Management System (LMS). This digital platform served as a repository for various resources, including lecture notes, instructional videos, and readings, allowing students to familiarize themselves with the content before attending class.

During class time, students were divided into small, diverse groups that focused on a think-pair-share (Kaddoura, 2013) activity. This activity was carefully designed to align with a systems thinking approach, which encourages learners to understand interconnections and the holistic nature of systems in development. By engaging in this collaborative exercise, students were prompted to think critically about the theoretical concepts presented in the ISD curriculum. In this process, students first contemplated their ideas, and then paired up to discuss and refine their thoughts. Finally, each pair shared their insights with the larger group, promoting a dynamic exchange of perspectives. This method not only deepened their comprehension of complex theories but also enabled them to apply these concepts practically within their specific project contexts. The flipped classroom model effectively empowered students to bridge the gap between theory and practice, encouraging them to critically analyze and deploy ISD principles in real-world system development scenarios. As a result, students were better equipped to appreciate the nuances of the subject matter, fostering a richer educational experience that highlighted both theoretical foundations and practical applications.

### 6.1.2 The design phases

The development of our model was guided by a practice-driven design methodology, consisting of several systematic phases that ensured a thorough and effective approach. Each phase was specifically aligned with significant themes identified in the existing literature, allowing us to ground our work in established knowledge. These thematic connections not only enhanced the relevance of each phase but also facilitated a cohesive integration into the overall model. As a result, each phase contributed to the development of a distinct component of the model, ultimately creating a comprehensive framework that reflects both theoretical insights and practical applications.

Phase 1: stakeholder requirements analysis—here in this phase, semi-structured discussions with key stakeholders were performed emphasizing on:

- Faculty members focusing on key aspects of ISD teaching
- Students from different cohorts identifying their purpose in this course
- Primary stakeholders and SME selection
- Analyzing Client requirements to identify specific challenges and needs, and documenting them in a shared platform

Phase 2: iterative design process

- Created a preliminary model based on stakeholder inputs
- Conducted expert validation sessions
- Implemented feedback cycles with stakeholders
- Refined model through iterative improvements

Phase 3: validation and refinement

- Collected quantitative and qualitative data on implementation effectiveness
- Conducted stakeholder feedback sessions
- Made evidence-based refinements to the model

The final model emerged through this systematic process, grounded in theoretical frameworks and multiple stakeholders' practical requirements. This methodological approach ensures that the model addresses real needs while maintaining academic rigour.

## 6.2 Understanding each square

### 6.2.1 The first square – "*the actors*": the students' cohorts and groups

The first square (shown in Figure 2)—the innermost white square, represents the hybrid classroom environment. It consists of seven interconnected rectangles that depict both cohorts—X, Y and Z (vertically) and groups (e.g., A, B, C and D) (horizontally). These interconnected rectangles are intended to visualize the interaction between students who work together to develop solutions for real-world problems. To promote unity and collaboration among students from different backgrounds, the instructors decided to categorize them into three distinct cohorts. Cohort X was comprised of individuals entirely new to ISD and included credit-bearing students who had minimal to no prior knowledge of the subject and required a complete introduction to the fundamentals. Cohort Y catered to those with some experience in ISD, including individuals who had previously taken the course and/or possessed some project management experience. Cohort Z was specifically designed for those with extensive experience in ISD or project management, encompassing students who had taken the course before and also served as Teaching Assistants (TAs) in previous semesters or had advanced project management skills, such as currently supervising other researchers as a Postdoc. The distribution of students in the class is shown in Table 2.

To enhance information sharing and collaboration among all student cohorts and groups, various documents, such as a *reflection journal* for personal insights, a dynamic set of Google Slides known as the *"class response deck"* for real-time responses, project planning notes, and lecture slides, were combined into a collection termed as the "shared documents." These versatile documents served as a platform for students to actively engage in in-class activities, exchange ideas, and maintain a comprehensive record of all interactions. The components referred to above are associated with this model, specifically referring to square 1. This structure has been formulated based on established practices, and it's important to note that no novelty or originality is being asserted.

### 6.2.2 The second square – "*the stakeholders*": the facilitators and the intended product

The second square in the model is a symbolic representation of different stakeholders. The top triangle represents the instructors who play a crucial role in guiding the students as they work on their solutions. The adjacent yellow triangles symbolize the primary stakeholders—students with disabilities (PwD students) and the subject matter experts (PwD SMEs)—who provide valuable input and feedback throughout the solution development process. The lower triangle represents the final product or solution as required by the client that aims to address a real-world problem. It also highlights the involvement of the primary stakeholders and subject matter experts in the development of the final product, along with periodic feedback from the client. Positioned at the centre of the second square, the first square fits in and complements the overall illustration by providing a more detailed representation of the classroom environment. Figure 3 provides a visual representation of the second square of the 3 square model.

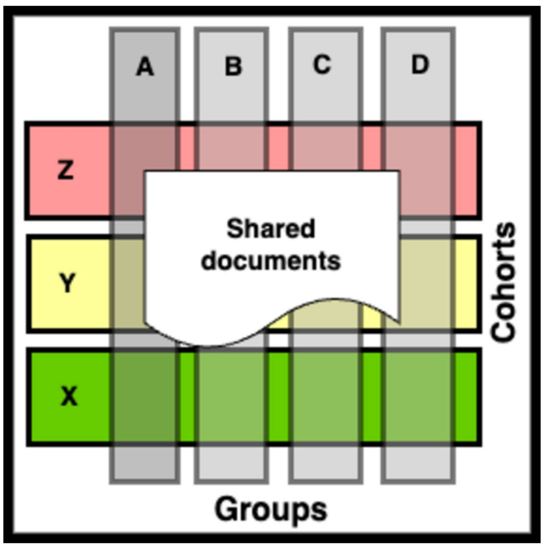


FIGURE 2
The first square of the 3 square model.

TABLE 2 The distribution of students in the class.

| No. of students | Group A | Group B | Group C | Group D |
|---|---|---|---|---|
| Cohort X | 2 | 2 | 3 | 3 |
| Cohort Y | 2 | 2 | 2 | 2 |
| Cohort Z | 2 | 2 | 2 | 2 + 1* |

One participant* from Cohort Z was assigned to whichever group needed extra assistance.

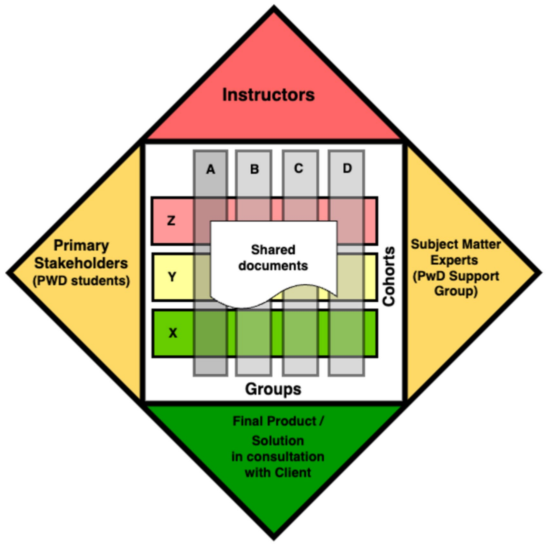


FIGURE 3
The second square of the 3 square model.

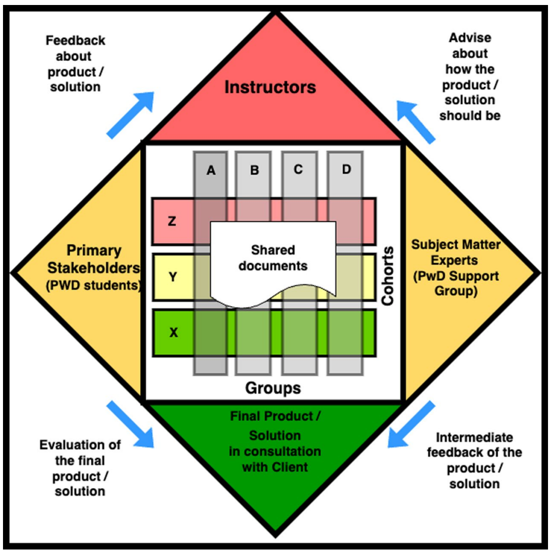


FIGURE 4
The complete 3 square model.

### 6.2.3 The final square – "*interactions and feedback*": towards the final product

In the last phase, the focus is on how the entities in the second phase are interconnected and how these connections are vital for effectively carrying out the real-life project. The primary stakeholders and SMEs have distinct roles in the process of developing the solution. The instructors provide guidance, feedback, and advice to aid students in creating the project's solution. Additionally, the primary stakeholders and SMEs conduct intermediate and final evaluations of the produced product with the client to ensure that it aligns with the project's requirements. This final phase, illustrated in Figure 4, offers a comprehensive understanding of the entire solution development process and the interactions among the different entities in the classroom that lead to a feasible solution.

### 6.2.4 Mapping the complexities of the model

The various components of the model each played a crucial role in tackling the complexities at hand. In the first square, the formation of groups and cohorts facilitated interaction among all stakeholders. Utilizing shared documents such as *reflection journal*s and the *class response deck* provided a platform for individuals to voice their opinions and offer suggestions. Meanwhile, the second square focused on addressing challenges related to the actual project. To combat unfamiliarity with project tasks, orientation workshops and periodic reflections from SMEs were integrated to guide and validate the students' research. The incorporation of real-life experiences into ISD topics ensured comprehensive subject learning. Lastly, the third square ensured that the prototype developed by the students satisfied all necessary requirements and was ready for deployment by the project agency, thanks to continuous inputs and guidance from SMEs and PwD stakeholders. Table 3 provides an overview of how each challenge was addressed. Figure 4 shows the complete 3 square Model.

## 7 Data collection and analysis process

The model's effectiveness was rigorously evaluated through a comprehensive examination of both the quality of the project delivered and various parameters related to student learning. To carry out this evaluation, we meticulously gathered a vast array of data from multiple sources and employed a range of analytical methods to ensure thoroughness and accuracy.

A primary data source consisted of the student reflection journals, which participants were encouraged to maintain voluntarily throughout the project. These journals provided valuable insights into the students' experiences and perceptions. We conducted a detailed thematic analysis of these reflections to identify common patterns and themes, allowing us to assess the effectiveness of the model in a nuanced way.

In addition to the thematic analysis, we performed a careful examination of standard learning metrics. These metrics included a variety of factors such as student learning outcomes, overall interest in the subject matter, student agency, and levels of engagement throughout the project. By analyzing these metrics in conjunction with the reflection journal data, we were able to establish a robust and meaningful relationship between our findings and the functionalities of the three-square model. This comprehensive approach provided a well-rounded understanding of how the model impacted student learning and engagement, leading to valuable insights for future implementations. Table 4 shows an overview of the themes from the reflection journal.

TABLE 3 An overview of how each challenge was addressed.

| Complexity | Methodology used to address | Feature in the 3 square model | Evidence of success |
|---|---|---|---|
| **Complexity of the project** | | | |
| Unfamiliarity with the project task | Orientation and periodic reflections from SMEs | Advise to Instructors<br>Feedback to students | Periodic user survey and evaluation ensuring gradual familiarity. |
| Learning of ISD as a subject | Connecting back topics of ISD to the product | Semester Evaluation by instructors | Average high score of students |
| Journey from Novice to Expert | Validation of student researched information by SMEs | Feedback and Quality Check | *reflection journal* document excerpts |
| Real life acceptance | Validation from PwD stakeholders (PwD students + institution evaluation committee) | Feedback and Quality Check | Acceptance of the final product by the institute evaluation committee for public usage. |
| **Hybrid classroom coordination challenges:** | | | |
| Coordination across cohorts | Categorization of cohort as per prior subject knowledge and project management experience<br>Group formation with Cross-cohort | X, Y and Z cohort | Soodhani et al. (2023) |
| | | A, B, C, and D group | *Reflection journal* document (Srivastava et al., 2023) |
| Coordination across hybrid mode | *Reflection journal document* | Hybrid setup Online documentation and workspaces | Khwaja et al. (2023) |

## 8 Addressing Q3: analyzing the effectiveness of the proposed model

- Project completion—the final product (PwD awareness website) of the project, was completed and delivered to the project agency within the specified timeline (end of May). By closely adhering to the project plan and incorporating regular feedback, the students were able to meet all requirements and expectations, ensuring their satisfaction with the final deliverables.
- Usability of the product—the final product, was not only found to be immensely helpful by the target users (4.2 on a scale of 5) but also highly intuitive and user-friendly (4.1 on a scale of 5) (Soodhani et al., 2023). Through extensive user testing and iterative design improvements, the students were able to create a product that is not only easily accessible but also practical, contributing to high user adoption rates and positive feedback.
- Learning ISD as a subject—throughout the process, the students delved deeply into the principles and practices of Instructional Systems Design (ISD), gaining a comprehensive understanding of how to effectively structure and deliver educational content. By engaging with case studies, practical exercises, and real-world examples, the students emerged with a strong grasp of ISD methodologies and best practices. Following is an excerpt from *reflection journal* by a student talking about their learning in ISD with the project:

> "I learned the steps in ADDIE model, and how they are applied in a real scenario through the example discussed in the class on the problem of training new recruits to follow SOP in an organisation. In class discussions the point of "review and revise" was stressed upon (at some point during the lecture), which an ID person has to (or may) do post every stage during the ADDIE, as method of course correction during the path. One interesting use of the 'speaker note' feature of the Google slide came up, where it can be used as a section to store feedbacks/ corrections from other members in a collaborative learning environment (or when working in teams). The software interface affords different kinds of interactions when compared to 'comments' feature in an online word processor (such as Google docs)"

- Development of real-world problem solving skills—the students actively developed and honed their skills in navigating VUCA projects, demonstrating remarkable resilience and adaptability in the face of challenging and rapidly changing scenarios. Through a series of simulations and hands-on experiences, they learned to thrive in dynamic environments, applying strategic thinking and agile decision-making to overcome obstacles. Following is an excerpt from *reflection journal* by a student talking about their learning while collaborating:

1. *Inter-group critique: we observed other groups' ideas, ways of representations and made notes of what could work for them and what idea from others could be picked for us.*
2. *Intra group refinement: we added new points from others discussion into our own work. We rethought over the problem statement etc.*

By engaging in a range of collaborative projects and activities, the students showcased exceptional teamwork and communication skills, particularly in a hybrid setting involving peers from different cohorts. Their ability to effectively collaborate and leverage diverse perspectives not only enriched the learning experience but also highlighted their capacity to thrive in varied work environments, serving as a testament to their adaptability and versatility.

Table 5 shows a summary of the proposed model's effectiveness based on claims and evidence. Table 3 shows an overview of how each challenge was addressed.

TABLE 4 Themes from reflection journal.

| Themes | Overall effect | Evidence |
|---|---|---|
| Cohort based learning. diverse perspectives | Positive | "Working in diverse groups made it even more effective as each of us had different strengths and experiences like me and [REDACTED] were working on the content part, [REDACTED] ma'am was leading us and helped in organizing the content to make a story for the video…" |
| Increased motivation and bonding | Positive | "Brainstorming session and discussion with your partner really helps to formulate the steps of instructions." |
| Learning and Skill development | Positive | "I learned a very good tool to create infographic videos—Animaker and H5P." |
| Time management issues | Neutral (Mixed of both positive and negative reactions) | "The project initially felt overwhelming because the kind of feedback cohort X has to take and review it accordingly within a given stipulated amount of time is exceptional."<br>"After completing this course, I am more confident in creating interactive content, making a timeline and sticking to that, validating the content at different stages and supporting the research, design, creation and feedback through ISD concepts, how multiple meetings can help in bringing everyone on the same page and most importantly how to work in team." |
| Group dynamics, participation and collaboration | Neutral (Mixed of both positive and negative reactions) | "Since this was the first time such a project-based course was tried with multiple cohorts, the next iteration of cohort design could have the cohort X in the centre stage and make more clearer boundaries that allowed upward and downward flow of knowledge across cohorts. |
| Scheduling | Negative | "The PwD cell project work discussion in hybrid mode is quite difficult for collaboration." |

TABLE 5 Summary of the proposed model's effectiveness based on claims and evidence.

| Layer | Claims | Supporting evidence |
|---|---|---|
| Square 1 (actors) | Cross-cohort and cross-group collaboration is effective in solving VUCA PBL problems | 1. Data from reflection journal<br>2. Client acceptance of final product demonstrating successful VUCA problem resolution |
| Square 2 (stakeholders) | Stakeholders serve an essential supporting role to actors in solution development, with their experience bridging theoretical knowledge and practical application | 1. The value of Integration of stakeholders in PDLC is well known<br>2. Student reflective journals documenting the value derived from stakeholder engagement |
| Square 3 (feedback and interactions) | Multi-directional feedback loops are crucial:<br>a) Primary stakeholder (PwD student) feedback to instructors guides product utility<br>b) Subject Matter Expert (SME) feedback to instructors aids in VUCA scoping<br>c) Client interactions facilitate precise deliverable identification | 1. Evidence of operationalized client feedback in iterative refinement processes for instructional design<br>2. Student entries in reflection journal |

# 9 Discussion: additional evidence of standard learning metrics from student feedback

## 9.1 Ensuring student's interest

The study conducted on the course by Badhe et al. (2023) delves into the strategies that instructors can use to sustain students' interest throughout a semester-long ISD course. The researchers identified the various course-level strategies implemented by the instructor and their impact on triggering, immersing, and extending interest among students. We found similar examples in the *reflection journal*. The researchers found that having a diverse group of students with different levels of expertise in the course provided a better opportunity for collaboration and teamwork. The social value of the PwD website project, along with its potential impact, played a crucial role in maintaining a high level of interest and moral responsibility among the participants. The students spent hours brainstorming ideas, creating and curating training resources, presenting their work in front of the entire class, and incorporating changes and feedback from different stakeholders. The feedback received from stakeholders, end-users, and experts at different time points provided an authentic test bed for the product developed by the students. The study highlights that working on a real-world problem, acquiring essential skills, managing task deadlines, and delivering desired product deliverables provided ISD students with valuable experience in managing a real-world instructional design project. This experience expanded their horizons and helped them understand the challenges of PwD and their role as individuals contributing to a shared goal—the PwD website. The findings of the study suggest that instructors need to understand students' interests and align them with course projects to sustain their interest throughout the course. While it requires intensive efforts, effectively aligning students' interests with course projects can help instructors design effective learning strategies and promote interest-driven creators.

## 9.2 Maintaining learner engagement

The engagement of learners in the course was evaluated (Shah and Iyer, 2023) using a variety of methods, including survey responses, classroom observations, participation in learning activities, and examination of the learners' final project output. These methods enabled the researchers to gain a comprehensive understanding of the learners' engagement and their learning experience. The course drew a diverse group of participants, with 69% of the participants falling in Cohort Y and Z, which indicates the cross-cohort approach appealed to them. This approach allowed learners from different cohorts to interact and collaborate with each other, which fostered a sense of community and belongingness among the participants. Furthermore, 77.8% of participants acknowledged learning from others through these cross-cohort interactions. Testimonials from different cohorts highlighted the importance of these interactions in their learning experience, which is consistent with a previous study that reported inter-cohort connections as an essential experience for learners. Participants consistently attended the course, even without an attendance policy, demonstrating their engagement in the course. The factors that helped sustain their engagement were identified as the teaching methodology, cross-cohort interactions, and PBL. The pedagogical design presented in this study shows how instructor actions can support cross-cohort collaboration and engagement in this integrated learning approach. The design includes several elements, such as clear learning objectives, well-structured learning activities, and opportunities for peer-to-peer learning and collaboration. Participants' motivation to express and actively engage with the course was reflected in their active participation in non-graded *reflection journal*. This activity allowed learners to express their creativity and engage with their peers in a low-stakes environment. The cross-cohort course teams successfully developed the project website, which was subsequently handed over to the Institute for eventual hosting on their official platform. This project allowed learners to apply their learning in a real-world context and collaborate with their peers to achieve a common goal. Overall, the course's pedagogical design and teaching methodology fostered learner engagement and collaboration, resulting in a positive learning experience for the participants.

## 9.3 Sense of agency

The study conducted by Srivastava et al. (2023) aimed to explore three important research questions. Their paper's first research question examined the level of agency that X cohort students experienced while designing an ISD module. The paper's second research question aimed to identify the key features that characterized the interaction between the X cohort and other cohorts. Finally, their third research question focused on investigating how the learning of X cohort students was affected by their interaction with other cohorts. The findings of the study showed that the X cohort students were able to maintain their independent and interpersonal agency even in the presence of senior members.

The grounded theory methodology used in the study allowed researchers to gain a deeper understanding of the X cohort students' interactions with experienced members of the group. This played a significant role in their exercise of agency and learning. To understand the X cohort's perception of different aspects of agency, Likert scale measures were used. Comparing the responses of the X and Y cohorts, it was found that the X cohort's perception of agency was almost at par with that of the higher cohort. However, there were variations within the X cohort, indicating that a strong sense of agency was not uniformly distributed. Despite this, their lower variations in confidence level and higher mean score suggested that the ISD course met the larger learning objectives outlined at the beginning of the course. These objectives included applying ISD models and designing and creating content for relevant stakeholders. Overall, the study provided valuable insights into the dynamics of the X cohort's interaction with other cohorts and highlighted the importance of maintaining independent and interpersonal agency in the learning process.

## 9.4 Reflections from credit-bearing students

A recent paper (Soodhani et al., 2023) presents a detailed account of the experiences and learnings of students who took part in a real-life project for an instructional design course. Despite initial concerns about meeting course objectives and time constraints, the students discovered that this approach yielded significant benefits for understanding course topics and acquiring practical skills such as effective time management, communication, and collaboration. The project-based learning approach enabled the students to apply their theoretical knowledge to a real-life scenario, providing them with a deeper understanding of the subject matter.

The students also gained valuable insights into project management, including scoping down the project, setting shared objectives, defining multiple checkpoints, and providing continuous feedback and reflection. These factors were essential in ensuring the successful implementation of real-life project-based learning. Through this approach, the students encountered several challenges that further reinforced the value of this instructional design approach. The challenges included time management, effective communication, and collaboration with team members. However, these challenges provided an opportunity for the students to develop their problem-solving skills and improve their ability to work effectively in a team-based environment. In conclusion, the paper emphasizes that real-life project-based learning is a valuable instructional design approach that can provide students with practical skills and a deeper understanding of course material. The success of this approach depends on having shared objectives, scoping down the project, multiple checkpoints, and continuous feedback and reflection.

### 9.5 Additional observations

The 3 square model can be implemented using simple technology. As described, a low-tech collaboration platform, like Google Slides, can be used to collect students' responses during class activities. This can encourage active participation through public sharing of views, fostering clarifications and meaningful discussions among students and instructors. A cloud-based *reflection journal* (e.g., Google doc) can be used to promote meaningful post-class asynchronous reflections, fostering peer learning and knowledge construction with students and instructors. Designing and maintaining shared documents throughout the course, accompanied by clear guidelines, proved to be sufficient. The students have reported (Badhe et al., 2023) that the *reflection journal* was an interesting and encouraging activity that they enjoyed. They found it to be a great way to connect with their peers and exchange ideas. The reflection activity facilitated opportunities for the students to know others' viewpoints and perspectives, which made the learning experience more enriching and engaging. Overall, both the *class response deck* and *reflection journal* have been a resounding success in the hybrid class, with students appreciating the opportunity to express themselves and engage with their peers in a dynamic and interactive learning environment.

### 9.6 Limitations

While the study presented valuable insights, it is important to note its limitations. These include a sample size of only 27 participants and the lack of a control group, which may make it difficult to generalize the findings to a larger population. To address these limitations and gain a better understanding of the topic, future research with a more comprehensive scope and a larger sample size is necessary.

## 10 Conclusion

In conclusion, this study sheds light on the challenges and benefits of implementing real-life project-based courses within a cross-cohort class structure using a hybrid setup. The findings indicate that a diverse group of students can successfully complete a complex project by leveraging their varied knowledge and experience, honing their skills in autonomous decision-making and effective communication, and managing their time efficiently. The three square model with multiple student cohorts, primary stakeholders, and instructors as architects proved to be an effective approach to managing cross cohorts for complex projects. The practical implications of this study for instructional design and teaching strategies in diverse educational settings cannot be overstated. By integrating authentic projects into the curriculum, educators can effectively enhance student learning and prepare them for the challenges of the VUCA world.

## Data availability statement

The datasets presented in this article are not readily available because non-anonymity. Requests to access the datasets should be directed to syaamantak.das@iitb.ac.in.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

## Author contributions

SD: Conceptualization, Writing – original draft, Writing – review & editing. SI: Methodology, Supervision, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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