SCALE-M: A Holistic Framework for Student Engagement, Outcomes, and Real-World Readiness

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***Abstract*—This study introduces the SCALE-M framework--Structured, Contextualized, Active Learning Ecosystem with Multimodal Integration to address the limitations of traditional lecture-based teaching in professional education. Integrating six pillars—structured segmentation, contextualized content, active participation, learner autonomy, embedded formative feedback, and multimodal integration—SCALE-M combines the strengths of established pedagogies within an outcome-based, brain-aligned design. Applied in an "Introduction to Cyber Security" lesson, the model improves student engagement, accessibility, and real-world application. A survey of 72 engineering faculty indicated strong acceptance, particularly for its structured delivery and real-time feedback, though preparation time and resource needs were noted as challenges. SCALE-M's scalable, adaptable design offers significant potential to enhance teaching effectiveness and learning outcomes across disciplines.**

***Keywords*—Outcome Based Education, Formative Embedded feedback, Teaching Learning Framework, SCALE-M, Structured Model**

***ICTIEE* Track— Innovative Pedagogies and Active Learning**

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I. INTRODUCTION

THE traditional method of teaching and learning is lecture method where the teacher explains concepts and learners are passive listeners. Thakur S et al., 2025; Long Q et al., 2025 This method helps the learners listen and understand the basic concepts and facts in all fields of education like engineering, medicine, law management courses etc. It also includes regular lectures, tests, group discussions and group work to explore real world situations in the form of project work.

Berge Z L. et al., 2013, It also allows faculty to cover a wide range of subjects effectively, even in large classrooms or auditoriums. However, since workforce needs changes often, the traditional method still provides a strong foundation for advanced, hands-on, and interactive learning.

However, with rapid technological changes in businesses, factories, and industries, traditional professional teaching is gradually diminishing. Mishra B K et al., 2025.

They often lack practice-based learning, critical thinking, problem-solving, and teamwork skills essential in today's workplaces. As a result, they may not fully prepare students for diverse real-world jobs and opportunities. Teacher-centered methods also reduce student participation, overlook different learning styles and speeds, and offer few chances for independent learning. To survive in industries creativity and innovations are necessary. The old methodology itself is not sufficient to give flexibility, collaboration, communication, and digital practices to workplaces because they change rapidly. Digital practices are frequently used to achieve the current generation's learnings, which differ from those of previous generations. Technology-driven, interactive, and visual learning methods are preferred over traditional lecture-based education. Group learning, experiential opportunities, self-learning, flexibility, and information availability are further opportunities to keep in mind. In addition to game-based learning, ongoing feedback, and engaging activities, this generation has a diverse range of experiences, learning styles, and career goals, which means that more inclusive and flexible teaching approaches are needed to keep them motivated.

Nurtanto M. et al., 2022. With the wide variety of educational tools and techniques available in the 21st century, traditional teaching can be made more dynamic, engaging, and practical. Online platforms like NPTEL, Coursera, edX so on, video lectures, interactive simulations, virtual labs, e-books, e-contents Ekayana, A. A. G. et al., 2025, game-based learning like Kahoot for quiz are available for students at present. Pratama, W. et al., 2023 Assessment, Communication, and mode of taking tests are made easy by using tools like Microsoft teams, Google Classrooms, LMS tool, Gamified platform and AI based learning assistant to cater the different needs of students.

Faculties need to design the materials to match the teaching approach, thus making lessons engaging and effective. Multimedia resources can help students understand difficult subjects and keep up their interest.

In the professional courses innovative teaching techniques are a necessary part of filling the gaps between theory and practical knowledge and applications which are rapidly evolving in today's world. Using old methods, students are no longer sufficiently prepared for the complex, dynamic, and technology advancements in industries. The innovative approaches like project-based learning, case studies, simulations, flipped classrooms, promote higher levels of student engagement, Ekayana AAG et al., 2025 it also improves their problem-solving and critical thinking skills.

These methods nurture the student's creativity teamwork skills and prepare them for taking up professional roles in the modern world. Learning is made more flexible and self-directed by incorporating the digital tools and technologies. Lester, H. C. et al., 2024 Combining the different well established teaching

methodologies encourages active student participation and could create a learner-centered environment that enhances understanding and guarantees that the students pursue lifelong learning.

II. PROPOSED MODEL

It is imperative that old methodologies be replaced with more dynamic, learner-centred approaches due to the rapid changes in educational technology and the diverse variety of students in higher education Archana M. S . et al., 2022; Honnurvali, M. S. et al., 2022. SCALE-M, which stands for Structured, Contextualized, Active Learning Ecosystem with Multimodal Integration, is a comprehensive educational framework created to meet the demands of the students. To address issues like passive student engagement, time constraints, lack of differentiation, and the difficulty of applying theoretical knowledge to real-world problems, among other issues, SCALE-M is an instructional design model that integrates teaching strategies in a structured organized way.

TABLE I
COMPARISON OF SCALE-M OVER OTHER MODELS

Dimensions	SCALE-M	Other Models (PBL, IBL, Flipped, SRL)
Holistic Integration	Combines the strengths of multiple approaches (PBL, case-based, flipped, SRL, multimodal learning) into a cohesive framework.	Typically focused on a single aspect. PBL on real-world problems, IBL on inquiry, Flipped model of content delivery.
Structured + Contextual	Emphasizes both structured delivery (segmented content) and contextual relevance (anchored in real-world problems)	PBL/IBL often lacks initial structure; Flipped assumes pre-class preparedness; SRL may lack context
Active Learning Ecosystem	Creates a continuous ecosystem of interaction, peer learning, and formative assessment	Other models may be episodic or lack seamless integration of feedback loops
Multimodal Integration	Uses visual, auditory, kinesthetic, and digital tools to cater to diverse learning styles	Many models (e.g., PBL or IBL) rely primarily on verbal or cognitive interactions
Scalability and Flexibility	Designed to work across disciplines and formats (online, hybrid, F2F); adaptable to class size and learning outcomes	PBL and IBL are often resource-intensive and hard to scale without institutional support
Aligned with Brain-Based Learning	Leverages research on cognitive engagement, reflection, repetition, and sensory activation	Traditional models don't always align explicitly with cognitive science
Embedded Formative Feedback	Integrates real-time feedback mechanisms (minute papers, low-stakes quizzes, digital polls) into the session design	Others may treat feedback as post-session or separate activity
Designed for Outcome-Based Education (OBE)	Naturally incorporates Bloom's Taxonomy, assessments, and student learning outcomes (SLOs) into planning and delivery	Others may require external alignment efforts for OBE compatibility

When the concept is applied to outcome-based education (OBE), where students learning objectives are precisely defined and evaluated, it works effectively. Without overwhelming teachers or students, it provides a systematic way to integrate Bloom's Taxonomy, active participation, and real-time assessment and embedded feedback into every lesson. SCALE-M aligns training with the way the brain learns best by using multiple senses, dividing lessons into discrete chunks, and incorporating formative feedback.

A. Pillers of SCALE-M Model

1) Structured Segmenting: In structured segmentation the overall class time into timebound macro segments that incorporate audio visual and kinesthetic activities, formative feedback, peer interactions, and content delivery into one session.

Use 10- to 15-minute micromodules with reflection exercises or other activities in between. Kaushik, P. et al., 2017 Distinguish "Need-to-Know" from "Nice-to-Know" content clearly to control cognitive load and guarantee depth of comprehension.

2) Contextualizing Content: To increase relevance and recall, start each topic by connecting it to a real-world or sector-specific issue Wen S.F. et al., 2023 Connect abstract ideas with realistic professional examples by using real-world case studies, current affairs, or regional issues.

3) Active Participation: Use structured participation techniques to help students become active co-creators of knowledge rather than passive recipients of information. Suji Prasad S J et al., 2023. Assign responsibilities or prompts to guarantee accountability in team-based activities, and incorporate at least one interactive activity per session, such as Think-Pair-Share, peer training, role-play, or small group conversations.

4) Learner Autonomy: This pillar of SCALE-M model addresses the diverse learners in a classroom. The model focuses on framing the lessons in such a way that it supports diverse levels of learners by customizing the learning path. The faculties can provide "Explore or Know More" content for the advance learners to learn in depth. Streamlined notes, guided assignments and recaps would help the beginners to grasp the concepts effectively.

5) Embedded Formative Feedback: SCALE-M considers feedback as real-time and is coupled with each session planned for a particular lecture rather than as a separate activity. This improves teaching and encourages self-reflection. Including short quizzes or one-minute summaries can help the faculties to gauge the student understanding. The "muddiest point" reflections in each class helps the faculties to identify the confusions or knowledge gaps among the students and modify the further lessons accordingly.

6) Multimodal Integration: By combining several learning models, SCALE-M can increase accessibility and student engagement. Multimodal integration can consider the activities

like role-plays, podcasts, expert interviews, diagrams, videos, simulation, etc. It incorporates at least one such component in every lecture. It can also make use of tools such as screen readers, Menti-meter, and Kahoot to guarantee that all students are involved.

SCALE-M provides a student-centered, sustainable, and scalable teaching model that may be applied to a variety of academic programs. It enables faculties to deliver meaningful and enriching learning experience promoting critical thinking, teamwork, and real-world application by combining the features like structured design, contextual relevance, active engagement, learner autonomy, embedded feedback, and multimodal content delivery. SCALE-M framework has several strong advantages over other alternative teaching strategies like Problem-Based Learning, Inquiry-Based Learning, Flipped Classrooms, or Self-Regulated Learning etc. Table I shows a comparison of features of the SCALE-M approach over other standalone models.

B. SCALE-M on Course Introduction to Cyber Security

On experiment basis the SCALE-M model was implemented on the subject Introduction to cyber security (Open Elective) for a batch of engineering students that comprised students from diverse branches. Table II depicts a sample implementation of SCALE-M model, a 50-minute lesson-plan for the subject Introduction to Cyber Security on the topic "Email Spoofing: A Cybercrime." No matter the subject, SCALE-M can be applied universally. All the six components of the SCALE-M framework were incorporated into this lesson plan.

TABLE II
SCALE-M IMPLEMENTATION: LESSON PLAN FOR THE TOPIC "EMAIL SPOOFING A CYBERCRIME"

Time	Segment	Activity Description	SCALE-M Alignment
5 min	Ignite & contextualize	Start with a 90-second news clip about a recent, large-scale phishing scam. Use Menti-meter to ask, "Have you ever received a suspicious email or text? What made you suspicious?" A word cloud of responses is generated live.	C (Contextualizing) M (Multimodal)
10 min	Micro-Lecture 1	The instructor provides a concise explanation of Cybercrime: Definition and origins. E-mail Spoofing: What it is and how it works, using a simple diagram comparing a real vs. a fake email header.	S (Structured)
10 min	Active Analysis	**Activity:** Spot the Spoof (Think-Pair-Share) (3 mins) Students are shown two sample emails on screen - one legitimate, one spoofed. They individually list 3-4 red flags. **Pair** (4 min): In pairs, students discuss their findings and compile a master list. **Share** (3 min): The instructor calls on a few pairs to share one key finding, validating it for the class.	A (Active) C (Contextualizing)
10 min	Micro-Lecture 2 & Feedback	The instructor defines Phishing and Identity Theft as a primary motive. Uses the analogy: "Spoofing is the disguise; Phishing is the con." **Embedded Feedback:** A quick 5-question Kahoot quiz on the definitions of Spoofing and Phishing to check for understanding.	S (Structured) E (Embedded Feedback) M (Multimodal
12 min	Collaborative Problem-Solving	Mini Case Study Students form small groups to analyze a one-paragraph scenario about a university employee falling for a phishing email. **Core Task** (for all): "Identify the specific cybercrimes committed and list two potential impacts on the university." Explore More Task (Learner Autonomy): "Propose one technical and one policy-based countermeasure the university could adopt."	A (Active) L (Learner Autonomy) C (Contextualizing)
3 min	Wrap-Up & Reflection	**Activity:** "Exit Ticket" Students use a digital form or slip of paper to answer: 1. What was the most important takeaway for you today? 2. What one question do you still have? This feedback will be informative to start the next class.	E (Embedded Feedback)

1) S- Organized Segmentation

To avoid intellectual overload for the students, the 50-minute class was divided into short and brief segments. It switched between engaging student activities and brief 10-minute micro-lectures. Felder R M et al., 2024 By designating fundamental ideas as "Need-to-Know" (such as definitions of phishing and spoofing), this structure also emphasizes important knowledge and makes a clear distinction between most important and less important aspects of the topic.

2) C - Contextualizing the Content

Using a recent news article and a survey on the student's individual experiences, the lesson is instantly grounded in a real-world setting. The "Spot the Spoof" exercise and a real-world case study help students grasp the importance of abstract ideas like "Email Spoofing" by making them tangible.

3) A - Active Participation

Throughout the lesson, students transition from a passive to an active state. They must analyze, discuss, and solve problems using a variety of structured activities, such as the group case study and Think-Pair-Share, rather than only listening. Every learner is guaranteed to be cognitively engaged as a result.

4) L - Learner Autonomy

Different skill levels are supported by the model. All students finish the case study's primary goal; however, those that pick thinks up quickly can use the "Explore more" option to take on a more challenging task. This allows faster learners to

comprehend concepts more deeply without displacing others.

5) E - Embedded Formative Feedback

The continuous low stake evaluation is incorporated into the lesson. Prior exposure is measured by the first Menti-meter survey. The Kahoot quiz at the middle of the session gives real time comprehension and assessment. By gathering information on what went well and what is still unclear, the final "Exit Ticket" enables the teacher to adapt the following class.

6) M - Multimodal Integration

To accommodate different varied learning styles and make the subject more digestible, the lesson plan purposefully combines a variety of sensory modes. It integrates the senses of sight, movement and sound.

1. *Visual:* Email header diagrams, news snippets, and Audio and Video case studies.
2. *Auditory:* Peer discussions and instructor explanations.
3. *Interactive/Kinesthetic:* Taking part in group activities and using online interactive tools like Menti-meter and Kahoot.

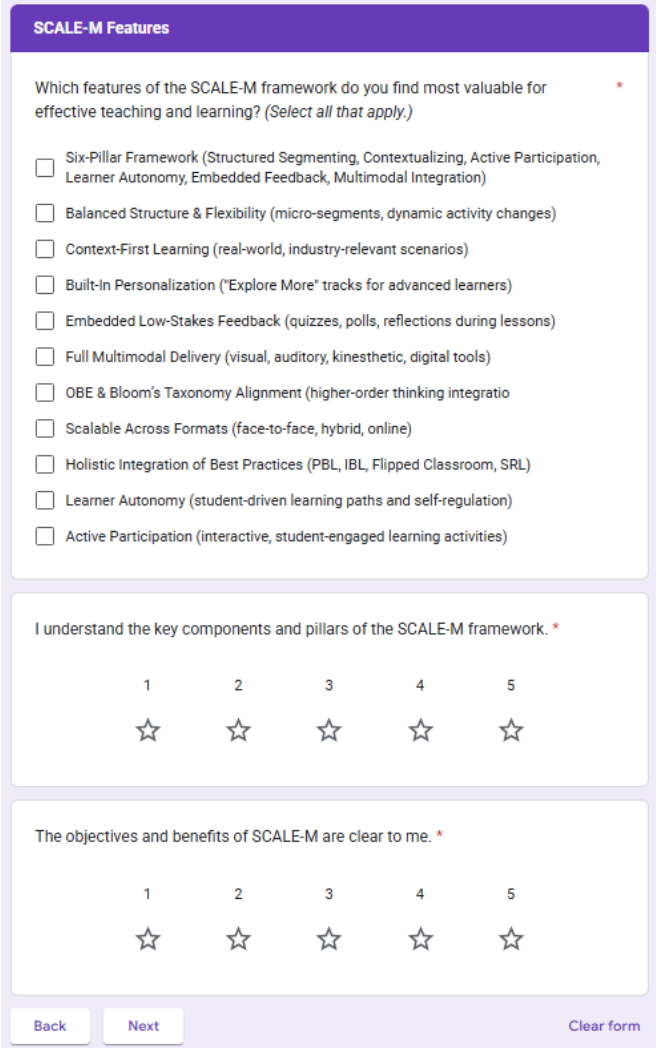
The use of SCALE-M approach indicated that active learning strategies – such as think pair share, flipped classroom activities, and structured group discussions – significantly boosted student participation, even in large or totally online classes. This method encourages fair participation by utilizing assigned responsibilities and real time interactive assignments, guaranteeing that even more reserved or silent students had the chance to make significant contributions. When asked to apply synthesis, or integrate concepts across courses, many students struggled, even though many of them performed well when memorizing basic facts. This pattern emphasizes how crucial it is to use a variety of evaluation techniques that go beyond mere recollection, allowing teachers to capture deeper levels of comprehension.

Students' on-going formative feedback was essential for improving the training. Throughout the term, their continuous feedback enabled teachers to make timely changes that improved learning assistance, pace, and clarity. Additionally, the organized format of SCALE-M proved beneficial in splitting lectures into manageable chunks and focused on critical "Need-To-Know" content. This finally Resulted in a more structured, concentrated and encouraging learning environment by ensuring that fundamental ideas where fully covered without hurrying.

III. RESULTS AND DISCUSSIONS

To investigate the characteristics and level of acceptance of the proposed SCALE-M model, a survey was conducted among the Computer Science and Engineering faculties of Vidyavardhaka College of Engineering. An overview of a model was shared with the respondents. The 72 responses collected reflect the faculty's understanding and perspectives on the model, as many had not yet implemented it in practice. The survey included questions designed to identify the most accepted features of the model and the potential challenges in its implementation. For transparency, the full survey instrument is available through the provided link.

Survey Link:
https://docs.google.com/forms/d/e/1FAIpQLScMKdb44M0OUEKRiyao9_gCN6D2aPGxjd15nr1hu-JNpN4tXA/viewform?usp=header



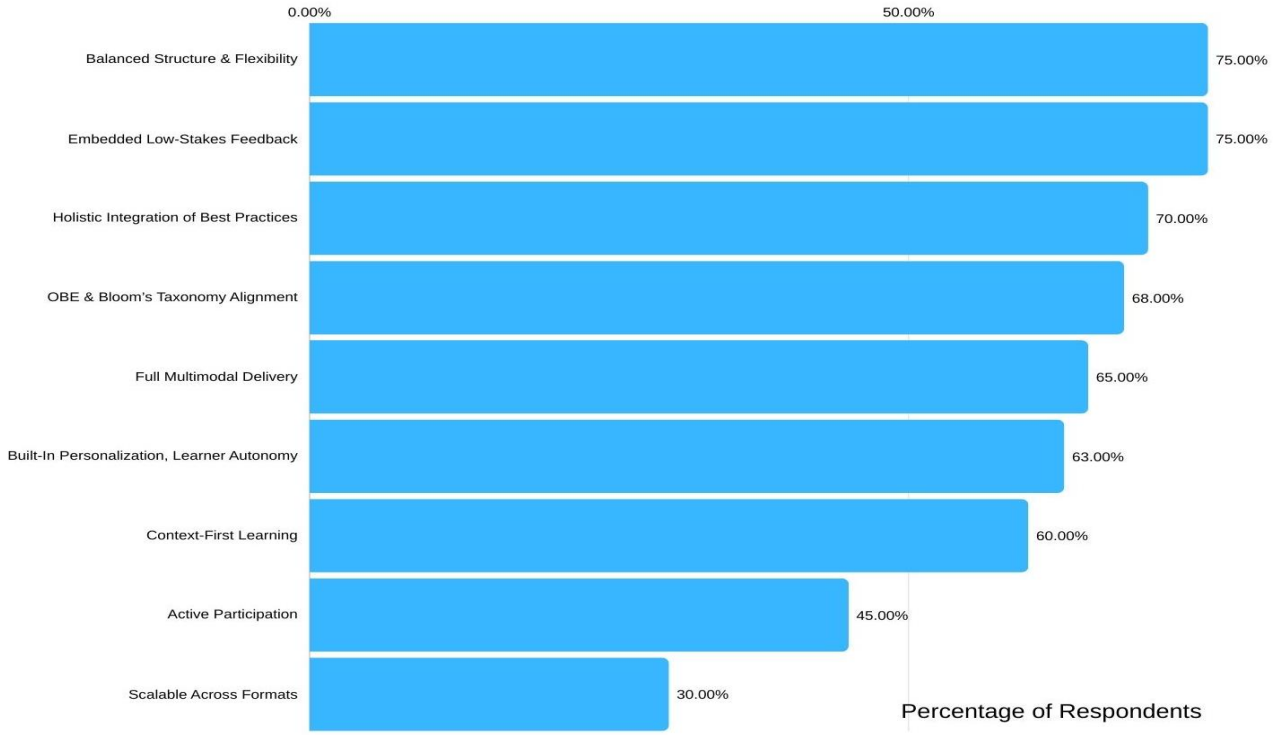


Fig. 1. Average Ratings of Key Features in the SCALE-M Model (in %)

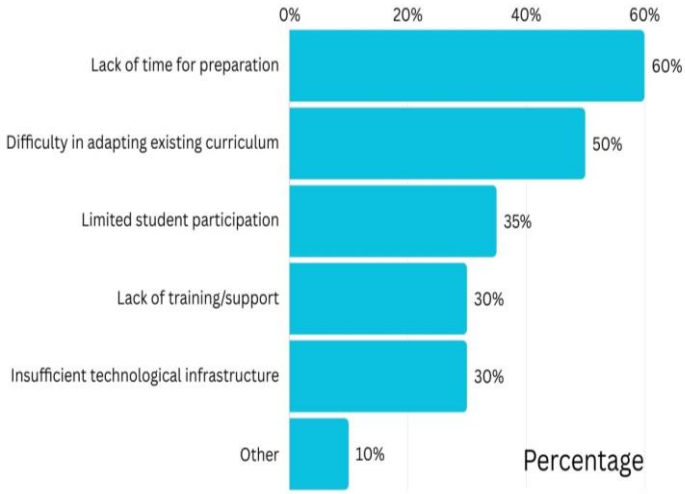


Fig. 2. Key Challenges in Implementing the SCALE-M Model (in %)

Fig. 1 shows the survey responses on most accepted features of SCALE-M model and Fig. 2 shows the possible implementation challenges of SCALE-M model. As per the survey, SCALE-M model's favorite features are embedded formative feedback and structured segmentation. Structured segmentation helps make course planning more organized and encourages active participation. Students can immediately get their questions answered with embedded formative feedback, which also helps teachers correct mistakes and routinely assess students' learning. Students can talk more freely, ask questions, and learn without worrying about criticism when they receive anonymous comments. Since it requires a lot of work to create a lesson plan for each topic in accordance with the curriculum, 60% of the faculty felt they did not have enough preparation time. They recommended that the curriculum be created with topics that are pertinent to current events and demands of the future in mind. Although academics stated that their institute strongly supported their use of the approach, a few were concerned about its success due to the limited time available for preparation.

Fig. 3. Acceptance Levels of SCALE-M Model Support Features

The findings show that Impact often outperforms Creativity. Fig.4 shows that impact leads in OBE alignment and real-world application, and it receives the top grade of five in student engagement. With a maximum score of 4 in the student engagement, creativity achieves a strong ranking. Yet, it still falls significantly short when compared with the other metrics

analyzed. This suggests that while creativity is important for grabbing students' attention and promoting involvement, it is thought to be the most important component of the SCALE-M model. Instead, components relating to direct student involvement, the explicit alignment of activities with learning objectives, and the ability to transform concepts into practical, real-world applications, tend to hold greater weight for both students and educators these features not only promote comprehension but also strengthen the relevance and authenticity of the leaning experience.

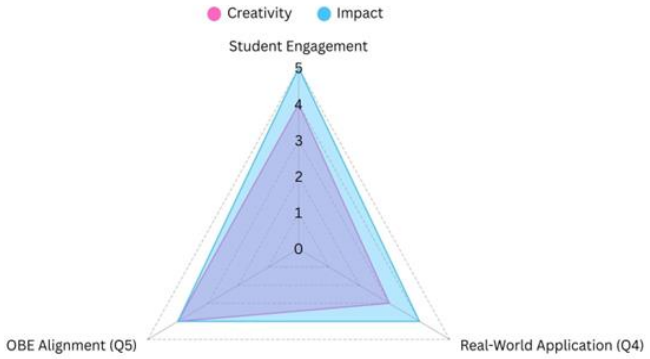


Fig. 4. Creativity vs. Impact Ratings Across SCALE-M Model Dimensions

Fig. 5 shows the overall acceptance and willingness to implement the SCALE-M model.

In the survey conducted there are no two opinions about the effectiveness of the new Framework. It guarantees adaptability across learning objectives, course kinds, and institutional capabilities thereby establishing a student-centered atmosphere that encourages creativity and critical thinking, collaboration, communication and meaningful involvement.

The SCALE-M approach seeks to enhance learning across a range of students with diverse academic backgrounds. Over two-thirds of respondents have adopted the SCALE-M model, and an equal percentage are eager to adopt it A tiny portion are still uncertain or unwilling, suggesting there are apprehension regarding the implementation of the same.

The major constraints include resistance to change, lack of training and resources. Time is another constraint with vast portions to be completed during the given time slot and increased workload on the educator as well as the learners, mismatch with existing traditional structures. With adoption there is need for change in educational policies, more resources and fundings for professional development of the educator, technological infrastructure to make it a success changes in curriculum and assessment structure.

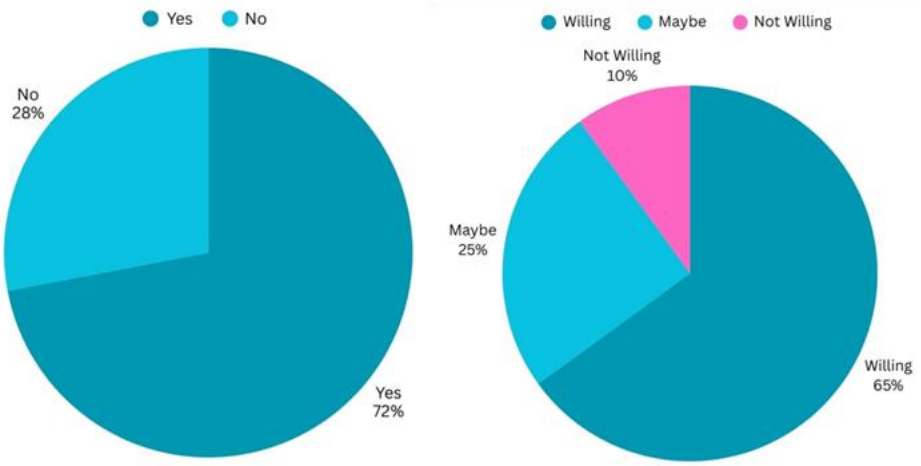


Fig. 5. Acceptance and Willingness to Implement the SCALE-M Model

Despite being highly successful, the SCALE-M approach has severe shortcomings. Sometimes more preparation time is required to design and arrange lessons that combine all 6 pillars. Additionally, certain pillars depend on instructional resources or technologies that may not be always available. In addition, effective implementation requires specific training for professors, which can be troublesome where the resources are insufficient. Furthermore, if each pillar is given equal weight, it could be difficult to implement the structure consistently in large classrooms. Before adopting SCALE-M it is necessary to have clear policy guidelines. Sharing of teaching resources among peer faculty. Adopt SCALE-M in a phased manner in selected departments for specific courses before rolling it out institution-wide; this will help identify challenges and further allow for making improvement.

Constraints of time and workload can be resolved by strategic planning and work can be distributed in a manner that a faculty member is assigned the same subject across multiple sections, which is feasible when the number of sections is large. When a faculty member teaches the same subject in multiple sections, they only need to prepare for one subject, allowing them to manage their time better and focus on lesson planning and model preparation. All faculty members handling the same subject can collaborate by dividing the tasks involved in developing the different components of the model. The resulting model or lesson plan can later be merged and shared with the faculty teaching the same subject in subsequent semesters. This would be a one-time process and can effectively address the issue of insufficient preparation time. Technological requirements include Making available

technological infrastructure in all classrooms for multimodal integration. Providing continuous support, recognizing innovative teaching practices, and integrating SCALE-M into faculty development programs will promote and maximize impact on learning quality.

CONCLUSION

SCALE-M provides structured scaffolding. By incorporating a range of forms and techniques, it benefits different diversity of students. Through its active, multimodal, and contextualized applications, SCALE-M enhances long-term memory and practical applications. While PBL, IBL, Flipped Classrooms, and SRL are all important parts of modern teaching methods, SCALE-M stands out because of its flexible, well-integrated approach that is also aligned with how the brain learns best. Satyanarayana S V et al., 2025 In technical and engineering education, where it is crucial to strike a balance between student diversity, prompt feedback, real-world application, and conceptual rigor, it works especially well. According to the survey results, the faculties think highly of the SCALE-M model. Most of them like its structured segmentation, embedded formative feedback and multimodal integration which promote interactive, student-centered learning Chopra K. et al., 2022. The model's influence is thought to be greater than its creative component, especially when it comes to raising student interest, adhering to OBE guidelines, and relating lessons to practical uses.

It encourages logic, cooperation, and active engagement in a variety of educational surroundings due to its modular adaptable design. SCALE-M combines educational techniques, into one unified system structure, giving students complete educational experience by introducing them to different aspects of the model. In this method, education is a journey that comprises a sequence of organized sections such as interactions, peer learning, and diagnostic evaluations. The SCALE-M ensures active engagement. Regarding the learners the Introduction of models supports diverse learning styles enabling learners with different inclinations to participate effectively. It helps kinesthetic, visual and auditory learners equally. SCALE-M is scalable and versatile. It is capable of being customized for different areas and class sizes. The only requirement is that it must be structured, hence requiring effort from the faculty. SCALE-M can be readily put into effect with existing assets. It demands careful planning and efficient usage in an organized manner. Because the model recognizes areas where learning is weak by means of integrated formative feedback, it enables the implementation of adaptive teaching strategies in a flexible fashion.

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