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A structured Scrum-Based Teaching Learning Framework: Design and Empirical Validation for Enhanced Academic Performance

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ABSTRACT

Agile methodologies, predominantly scrum, have proved potential for supporting student-centred learning; yet their implications in education often lacks a structured pedagogical framework with clearly defined roles, artifacts and events. This study proposes a structured scrum-based teaching learning framework that systematically adapts scrum principles to the academic environment. The framework was implemented and empirically evaluated using student data by comparing academic performance under scrum based and traditional teaching approaches. The comparative analysis disclosed that students taught using scrum-based approach achieved a higher average academic performance (68.91) than those taught using the traditional approach (62.99), with the observed difference being statistically significant ($p < 0.001$). Semester wise analysis demonstrated consistently higher performance for the scrum-based group. A dashboard was developed to support systematic comparative, supplementary, and predictive analysis of student data. Placement related and predictive analyses provided additional exploratory insights; though academic performance remained the primary basis for the framework validation. The findings suggest that the proposed framework can support a structured, iterative, and learner centred teaching-learning process through systematic planning, monitoring, feedback, review and continuous improvement. The study contributes a structured approach for adapting scrum in higher education and provides empirical evidence for its potential to enhance student academic performance.

Keywords: Scrum, Agile Education, Teaching-Learning Framework, Student-Centred Learning, Academic Performance, Higher Education

1. Introduction

Higher education continues to rely on traditional, instructed-centered teaching models designed for a steady, predictable learning environment. Such models typically fix the syllabus, sequencing and assessment criteria before a course begins. Current educational tools often fail to meet the practical needs of teachers and students, making them difficult to integrate into daily classroom activity (Mbiada et al., 2023). This reflects a major problem like cultivating adaptable, self-directed learners, yet prevailing pedagogical structures were not built with this goal (López-Alcarria et al., 2019). To meet these expectations, teaching approaches like student centered, iterative and feedback oriented are required. Agile inspired teaching values adaptability over prescriptive methods, collaboration over individual accomplishment, and continuous improvement over maintaining existing practices (Krehbiel et al., 2017). Agile methodologies specifically scrum offer a structured means of endorsing this cycle. Agile originated as a substitution to rigid, plan driven development, prioritizing individuals and interactions, working increments and responsiveness to the changeover strict upfront planning (Pressman, 2010). Scrum operationalises these values through defined roles, time boxed sprints, and recurring artifacts that structure how a team plans, executes and reflects- mechanisms that maps naturally onto classroom's need for feedback and incremental improvement (Parsons & MacCallum, 2019). This alignment has motivated several efforts to adapt agile to education. Early work mapped agile principles directly onto teaching activities, showing conceptual compatibility with student centred pedagogies (Dewi & Muniandy, 2014). More recent work has developed a curriculum to train educators in agile practices (Fitsilis et al., 2025) and hybrid frameworks combining agile with instructional design for educational software (Mbiada et al., 2023). These efforts although largely operate at the level of principles, curricula, or software tools rather than offering a fully specified, scrum-based classroom framework with defined roles, events and artifacts. Consequently, there is a need for structured pedagogical framework that provides a systematic approach for adapting these scrum elements to the educational environment. Moreover empirical evidence evaluating such a structured framework through comparative student performance data remains limited. Addressing this gap, the present study proposes and empirically evaluates a structured scrum-based teaching learning framework. The remainder of this paper is organized as follows. Section 2 presents the literature review, followed by the research gap, research objectives, and research questions. The subsequent sections describe the research

methodology, the original Scrum framework, and the implementation of the proposed framework. The paper then presents the data collection process and the comparative evaluation and validation of the proposed framework. This is followed by data analysis and results, along with the implementation of the analytical dashboard. Finally, the paper discusses the findings, outlines the limitations and future research directions, and concludes the study.

2. Literature Review

Javadi and Tanner (2018) implemented agile teaching framework at Illinois University for required and elective students for project management course. The framework was implemented into two distinct 6 weeks learning period where in the first period they applied scrum methodology of 2-week three sprint cycle. This cycle was made up of learning squads, pair-based lab practicals, regular progress interviews and rotated partners followed by retrospectives. In the second 6 weeks cycle, they followed kanban method with rotating learning master role. Pull based system used to achieve the goals defined by instructor to evaluate performance and learning effectiveness. Águila-León et al. (2020) experimented flipped learning and agile methodology (FLA) in applied electrical circuit course for a final project implementation as a case study at the Universidad de Guadalajara, México. The usefulness of this approach is assessed by Motivated Strategies for Learning Questionnaire (MSLQ) which measure changes in students' performance and learning strategies before and after application of the invented method. Muñoz-Arteaga, López-Torres, and Muñoz-Zavala (2023) addresses special educational needs by smearing agile scrum as a guiding framework. The authors find that inclusive education faces many challenges like lack of effective ICT integration and coordinated digital strategies. Authors mention this gap by employing scrum based agile learning methodology within inclusive education settings at Mexican elementary school. The study observed that students with special learning needs such as dyscalculia are more comfortable with responsive learning environments by endorsing adaptation, collaboration and coordination. Jurado-Navas and Muñoz-Luna (2017) observe the educational value of scrum methodology as an alternative teaching approach in higher education. The scrum encourages students' participation through self-organize working groups using collaborative learning and effective communication. This help to bridge the gap between industry education and academia. While learning to adapt changes, students learn via structured group dynamics and develop competencies hence create humanities disciplines rather than engineering. López-Alcarria, Olivares-Vicente, and Poza-Vilches (2019) applied agile scrum methodology in educational settings by steering systematic literature review to foster sustainability competency. By reviewing 11 empirical studies, agile practices were integrated into course design, project-based learning, group assignments, syllabus organization, and continuous feedback mechanism. By structuring course into continuous iterative cycle, with defined roles and continuous assessment replaced traditional end of course evaluation to real time adjustments into teaching strategies. Pócsová et al. (2020) acknowledged substantial gap between orthodox instructional approaches and essential skills required by employers like, problem solving abilities, team work, critical thinking and communication. This gap is addressed by redesigning the course structure into sprint-based modules where in teacher is product owner and partially a scrum master. The students operated in self-organising teams and followed scrum practices like, sprint planning, daily scrum meetings, sprint review and sprint retrospective. User stories are structured via mathematical tasks with predefined outcomes and evaluated through written examination and collaborative team presentations. The outcomes demonstrate that scrum framework can be effectively expanded beyond IT disciplines and can contribute in both academic and development of essential soft skills in engineering education.

Mbiada et al. (2023) claimed that integrating agile methodologies with instructional design models offers more structured, holistic and systematic framework for pedagogical alignment and technical efficiency. Timothy C. Krehbiel et al. applied agile manifesto to teaching and learning in higher education for content-based courses in multiple disciplines. They reported great learner engagement and ownership of learning process to create instructional environment. Lourakis and Petridis (2023) inspected the scrum framework in an online undergraduate physics II course during COVID 19 lockdown. The study evaluates scrum feasibility in a remote STEM context and impacted student progression and soft skill development. The authors assigned professor as a product owner, a Ph.D student as a scrum master and students as a self-managed scheme. Scrum practices followed in a specific sprint cycle. Findings discovered that scrum participants achieved higher success rate than traditional participants. Despite small volunteer sample, the students reported improvements in communication, collaboration, critical thinking and time management to enhance academic performance and soft skill development. Scott et al. (2016) studied aligning scrum teaching strategies with students learning, improves outcomes in an undergraduate software engineering education. Grounded in the Felder–Silverman Learning Style Model focused on active and reflective dimensions and tested the meshing hypothesis. From the two experimental studies, students taught scum concepts using either active (practical) or passive (Theory) instructional methods, followed by a capstone project and assessment. Results showed a cross over interaction; active learners achieved higher scores with active instruction, and reflective learners achieved more score with passive instruction. The study provides personalised scrum instruction based on learning preferences. Elnour (2020) studied application of scrum in an education and technology course to boost 21st century learning skills among university students. The study executed 12 step scrum-based process across five sprints where teacher

acted as a product owner and students worked in self-organizing teams to design educational products targeting real world needs. Scrum practices like sprint planning, stand up meetings, reviews and retrospective were integrated into project-based learning. Results showed improvements in collaboration, creativity, self-regulation, metacognitive skills and academic performance. The relevant literature is systematically reviewed and summarized in table 1.

Table 1. Literature review of scrum framework application in educational settings

Authors	Context / Course	Agile Approach Used	Implementation on Design	Key Practices Applied	Outcomes / Contribution	Future Scope / Challenge
Javadi & Tanner (2018)	16-week undergraduate Project Management course, Illinois State University;	Scrum + Kanban	Two 6-week phases within the course	Scrum: 3 × 2-week sprints, Kanban: LearningMaster, pull-based learning,	Improved collaboration, iterative learning, reflection, student engagement	Agile classroom implementation
Águila-León et al. (2020)	Applied Electrical Circuits course, Universidad de Guadalajara, México	Flipped Learning combined with Agile methodology (FLA)	Case study implemented for a final project; pre- and post-intervention evaluation	Combination of flipped classroom model with iterative agile practices; project-based learning;	Improvement in student performance, motivation,	Need empirical validation across disciplines;
Muñoz-Arteaga, López-Torres, and Muñoz-Zavala (2023)	Inclusive education setting in a Mexican elementary school;	Scrum-based Agile Learning (AL) methodology	Case study applying Scrum framework within an inclusive education model to support e-learning	Iterative learning cycles, flexibility and rapid adaptation, collaboration among educators and families,	Improved adaptability, better integration of technology in inclusive education	Need for stronger ICT infrastructure, systematic digital coordination strategies
Antonio Jurado-Navas et al.	Higher education course in the Humanities discipline	Scrum methodology	Implementation of Scrum as an alternative teaching methodology through self-organized student working groups	Formation of self-managed teams, continuous communication with instructor, adaptive project execution	Enhanced student participation, better time and resource management	Need for empirical performance measurement,
Pócsová et al. (2020)	First-year undergraduate course)	SCRUM framework (adapted for education)	Course divided into four modules functioning as sprints; exercises conducted using iterative sprint cycles	Sprint Planning, Daily Scrum (weekly reporting), Sprint Implementation (team-based problem solving),	reduced failure rate; improved student engagement; enhanced	Need for balanced experimental groups; application to other courses (e.g., Mathematics 2);

Lourakis & Petridis (2023)	Undergraduate Physics II course (Electronics Engineering), fully online during COVID-19 lockdown	Scrum framework (strict adherence to 2020 Scrum Guide)	Two implementation phases with multiple Sprint cycles; remote collaboration via Discord and Zoom; backlog aligned with course learning outcomes	Sprint Planning, Daily Scrums (with burndown charts), Sprint Reviews (presentation + Q&A), Sprint Retrospective; Product Backlog and Sprint Backlog	Higher success rate (63% vs 34%); improved average exam grade; enhanced engagement;	Small volunteer sample; scalability concerns for large classes; need for multiple Scrum Masters;
Scott, Rodríguez, Soria & Campo (2016)	Undergraduate Software Engineering course (Systems Engineering BSc), Argentina	Scrum framework integrated with Felder–Silverman Learning Style Model (FSLSM)	Two-year experimental study (2013–2014); students classified as active or reflective learners using ILS questionnaire;	User story definition and splitting; Agile estimation	Evidence of cross-over interaction supporting meshing hypothesis	Small sample size; limited statistical significance;
Elnour (2020)	Education Technology course; Female Special Education students; Qassim University (Saudi Arabia)	Scrum methodology (EduScrum-inspired, project-based)	12-step process mapping model; 5 Sprints (~12 weeks);	Sprint Planning; Stand-up meetings; Scrum board (To Do–Doing–Done); Sprint Review (formative assessment);	Improved 21st-century skills	Limited to single cohort (female students); no control group; reliance on survey data;

Table 1 recapitulates the implementation designs, key outcomes, contributions, challenges, future research directions of existing scrum based educational settings. The studied literature specifies that agile methodologies particularly scrum have been progressively approved in educational settings to support student centred learning. The existing literature lacks a unified pedagogical framework for systematic implementation of scrum in educational settings. Moreover, roles and responsibility differ considerably across existing implementation, which indicates lack of consistent role definitions within educational settings. These limitations highlight the need of comprehensive students centred agile framework that integrates structured sprint cycles, collaborative learning, continuous feedback, flexible assessment and clearly defined stakeholders' roles.

2.1 Research Gap

The existing literature reveals that in educational environments, agile methodologies specially scrum is progressively implemented which endorses active learning, iterative improvement in teaching learning. Few studies focused on course specific or tested scrum implementation instead of proposing a student centered identical framework which can be systematically simulated in academic environment. Secondly the literature reveals that as agile emphasize collaboration and self-learning, there is a limited attention to clearly defined roles and responsibilities in educational settings. This absence leads misalignment between agile principles and student-centred learning which results variation in instructional control and learner participation. The study also remark improvement in learning outcomes and soft skills, but inadequate research relating agile based educational frameworks with long term educational outcomes. This research focus on how student-centred educational framework contribute better outcomes which largely focus on academic performance and hence, it addresses the gaps by employing scrum based educational framework with clearly defined roles to improve overall teaching-learning process enhancing students' preparedness and better academic outcomes.

2.2 Research Objectives

1. To develop a structured scrum-based teaching learning framework by systematically adapting scrum

roles, artifacts, and events to the educational environment.

2. To implement the proposed framework in an academic program using structured learning cycle and continuous feedback to support student centred teaching and learning.

3. To empirically validate the effectiveness of the proposed framework by comparing the academic performance of students taught using scrum based and traditional teaching approaches.

2.3 Research Questions

RQ1: How can scrum roles, artifacts and events be systematically adopted to develop a structured scrum-based teaching learning framework for an academic environment?

RQ2: How does the implementation of proposed scrum-based teaching learning framework through structured learning cycle and continuous feedback support student-centered teaching and learning?

RQ3: Does integrating Agile Scrum practices into coursework improve the industry readiness and employability skills of master's level students?

3 Research Methodology



Fig. 1 Research Methodology

Figure 1 illustrates the six-phase research methodology followed in this study. Phase 1 (Conceptualisation) reviews the literature on agile/Scrum applications in education and identifies the research gap — the absence of a structured Scrum-based pedagogical framework — producing a formal Research Gap Statement. Phase 2 (Framework Development) transforms conventional Scrum roles, artifacts and events into their academic equivalents (Director, HOD, Faculty Team and Students; List of Subjects, Unit Plan and Subject Exam; Daily Lesson Plan Tracking, Result Review and Feedback), yielding the proposed Scrum-Based Teaching-Learning

Framework. Phase 3 (Implementation) applies this framework empirically by comparing a Traditional Teaching control group against a Scrum-Based (18-day sprint) experimental group. Phase 4 (Data Collection) gathers academic performance data — Semester Performance Index and subject-wise marks — from both groups over equivalent periods. Phase 5 (Data Analysis) applies descriptive statistics and comparative significance testing (e.g., t-test) to this data. Phase 6 (Validation & Conclusion) interprets the results, evaluates the framework's effectiveness, and draws conclusions and future-work directions. As summarised at the base of the figure, the overall design is a quantitative, empirical, comparative/intervention study conducted on two batches of MCA students, with teaching approach (Traditional vs. Scrum-Based) as the independent variable and academic performance (SPI and subject-wise scores) as the primary dependent variable, analysed using Excel and SPSS/R — giving each phase a traceable output that feeds directly into the next.

4 Original Scrum Framework

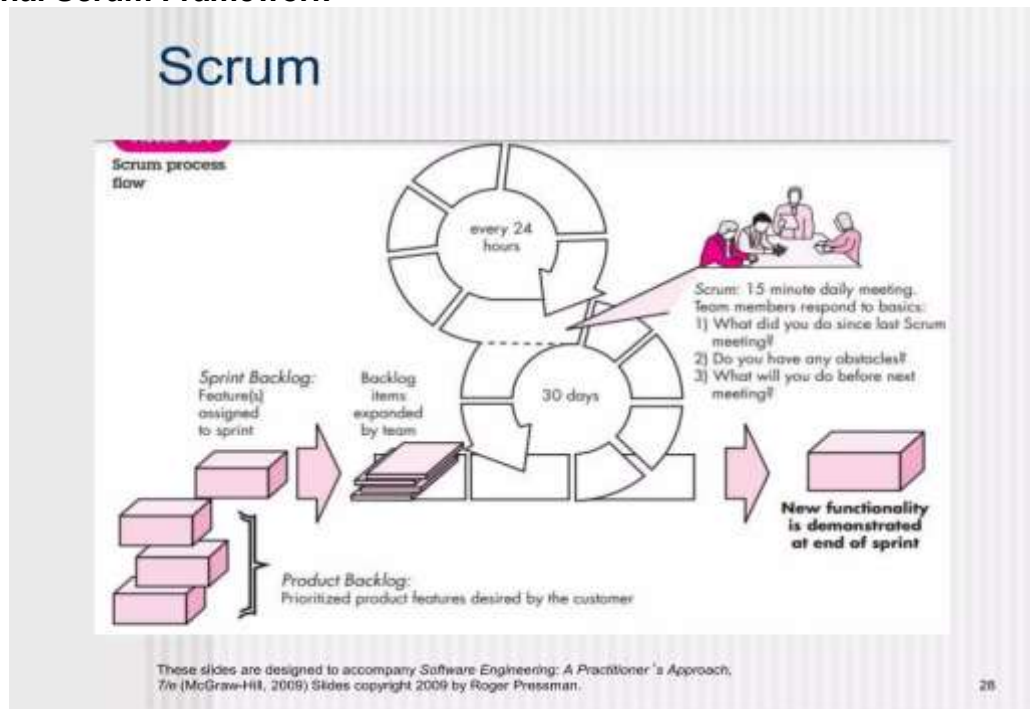


Fig.2 Scrum Framework [15]

https://drive.google.com/file/d/0B4FvADGfA7T8S3lCNE1lZlpQc1E/view?resourcekey=0-O9gbq1v6Nhr4ZisAbOJ_hg

Figure 2 illustrates the conventional scrum framework, which provides the foundation for the proposed framework of this study. Scrum organizes the development process through defined roles, artifacts and events that support iterative and incremented work. The framework highlights short development cycles, continuous progress monitoring, regular interview and feedback. These core elements provide structured basis for adopting scrum principles to the teaching-learning environment. In the present study, these scrum elements are systematically mapped to corresponding educational roles, artifacts and events to develop structured scrum-based teaching learning framework. The resulting mapping and proposed educational framework are presented in the following section.

Table 2. Scrum to Education Transformation Matrix

Dimension	Conventional Scrum	Educational Transformation	Proposed Framework
Roles	Product Owner	Academic decision maker	Director
	Scrum Master	Process Facilitator	HOD
	Development Team	Teaching Team	HOD + Faculty
	Customer	Learning recipient	Students
Artifacts	Product Backlog	Curriculum Prioritization	List of subjects
	Sprint Backlog	Learning/Unit Planning	Unit Plan
	Increment	Demonstrated learning outcome	Subject Exam / Completion
Events	Sprint Planning	Academic / schedule planning	Subject & Schedule planning
	Daily Scrum	Progress Monitoring	Daily Lesson Plan Tracking

	Sprint Review	Learning/Result Review	Result Review
	Retrospective	Reflection and Improvement	Feedback & Improvement

4.1 Implementation

The scrum-based framework was implemented in 2 years MCA (Master of Computer Applications) program at Lok Jagruti Kendra University, Ahmedabad, India. Seeing the short duration of MCA program, and the commencement of placement training from the third semester, subject learning was the essential task for students within the specific time frame. To assess the effectiveness of the framework, students were divided into two batches. Batch 1 was taught using traditional teaching method, whereas Batch 2 was instructed using scrum-based sprint-oriented learning. The overall structure and flow of the implemented framework is shown in figure 3.

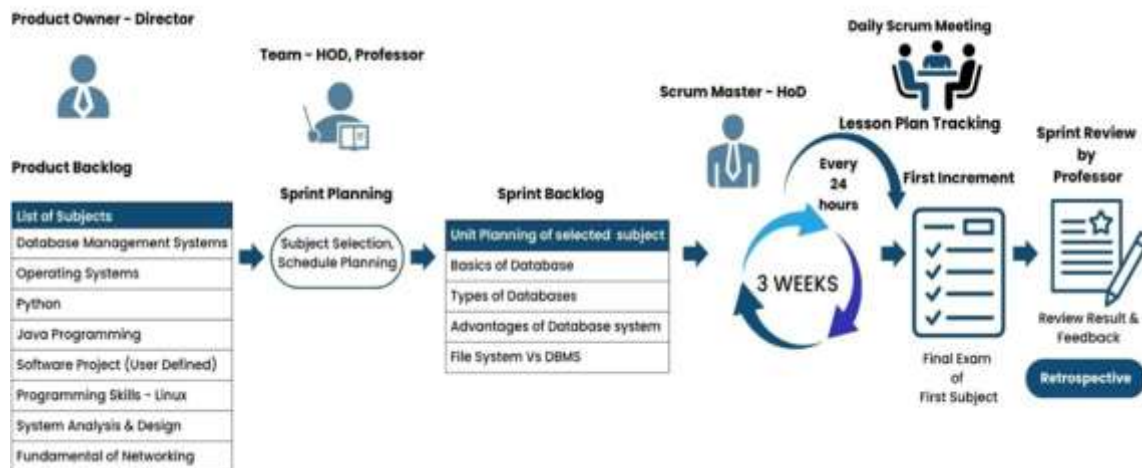


Fig.3 Scrum based implemented teaching learning framework

4.2 Experimental Implementation Setup

University name: Lok Jagruti Kendra University, Ahmedabad, India

Program: Master of Computer Applications (MCA)

Number of students: 300+

Two batches used: Batch 1 and Batch 2

Subjects used in experiment: Programming Languages, Data Structures, Database Management Systems, Communication Skills

Sprint duration: 18 days / 3 weeks

4.3 Implementation of Traditional Teaching Method

This is the first phase of the study, where students were taught using traditional teaching methodology. In this approach, the primary focus is on lectured based teaching, where theoretical concepts are delivered during classroom sessions via professor. The teaching process focuses on syllabus completion, topic wise explanation, and individual assignments. Students attend regular lectures and laboratory sessions, where programming concepts and theoretical topics were explained by professor. Assessments were conducted through internal evaluations, assignments, laboratory exercises, and semester examination. In this teaching method, the student's participation is mostly limited to classroom discussion and individual task completion. The academic performance of students is measured using subject wise marks, Semester Performance Index (SPI), and overall percentage, obtained in the semester examination. The data collected from this batch serves as the base line for comparing the effectiveness of the scrum-based teaching learning framework.

4.4 Implementation of Scrum-Based Sprint Learning

Scrum based teaching learning framework is applied to introduce iterative and collaborative teaching learning in an academic environment. The framework adapts the core elements of scrum framework – roles, artifacts, and events to align with academic process. The purpose is to expand academic planning, monitoring and evaluation by integrating structured sprint cycles, continuous feedback and collaborative participation of faculty members and students.

4.4.1 Roles Mapping

The director accepts the role of product owner, responsible for defining academic objectives and defining the list of subjects to be delivered throughout semester. Director assures that the academic goals align with institutional policies and curriculum requirements. The head of the department executes the role of scrum master overseeing the overall process, monitors sprint cycles, resolves issues arises during implementation and ensures the academic activities proceed according to the planned activities. The professors and HODs constitute the role of scrum development team and are responsible for planning and executing the teaching

activities within each sprint cycle. Their duty also extends to selecting subjects, planning curriculum, designing lesson plan and content delivery. The students are customers in this framework and actively participate in learning activities defined during sprint planning process and engage in lectures, discussions and practical exercises. Their understanding of subject matter is evaluated through assessments conducted at the end of each sprint.

4.4.2 Artifacts Mapping

The artifacts in the implemented framework resemble to the scrum artifacts used for planning, monitoring, and delivering tasks during a sprint. The list of subjects acts as the product backlog. It includes all the subjects planned for the semester and is prepared by the director. This list aids as a pool of academic tasks that are prioritized and scheduled for execution during the semester. Unit planning links to sprint planning, where each subject is divided into smaller units or topics to be covered during the sprint cycle. This process ensures systematic coverage of the syllabus and facilitates effective time management. The sprint cycle, which spans three weeks, represents the time-bound iteration within which a subject is taught, reviewed, and assessed. This structured duration enables focused learning and allows faculty members to monitor student progress more effectively. The subject selection and schedule planning stage corresponds to the sprint backlog. During this stage, the subject to be taught in the upcoming sprint is selected, and detailed session-wise teaching plans are prepared. The learning content is also categorized into essential and desirable components, covering both theoretical and practical aspects. The final examination of each subject represents the first increment, reflecting the outcome of the sprint which evaluates the students' understanding of the subject taught during the sprint cycle.

4.4.3 Events Mapping

The events in this implemented framework are designed to monitor progress and support continuous improvement in the teaching-learning process. Daily lesson plan tracking links to the daily scrum meeting. During these sessions, the HOD reviews the daily progress of teaching activities, identifies potential challenges, and ensures that the teaching process aligns with the sprint plan. At the end of each sprint cycle, review result and feedback sessions are conducted, which correspond to the sprint review and retrospective meetings in Scrum. During these sessions, the results of the subject examinations are analysed to evaluate student performance. Based on the feedback obtained, necessary improvements such as remedial sessions or modifications in teaching strategies are implemented to enhance learning outcomes. Overall, the implemented framework promotes a flexible and student-centered learning approach by incorporating structured planning, iterative learning cycles, and continuous feedback. Although scrum originated as an agile framework for software development and project management, its structured, iterative, and collaborative nature makes it highly suitable for application in academic environments to improve teaching effectiveness and student performance.

4.5 Data Collection

The dataset employed in this study was derived from the academic records maintained by the MCA department of Lok Jagruti Kendra university for two distinct student batches. The first batch is taught using the traditional teaching methodology, while the second batch was instructed using this scrum-based sprint teaching learning framework. More than 300 students were considered in the study, ensuring an adequate sample size for analysis. The dataset includes key academic variables such as subject-wise marks, semester performance index (SPI), and academic performance. Subject-wise marks were collected for core subjects including programming concepts, data structures, database management systems, and communication skills. These marks reflect students' understanding of course content and serve as a primary indicator of academic performance. The semester performance index (SPI) was collected for each student as a measure of overall academic performance across subjects within a semester.

4.6 Comparative Evaluation and Framework Validation

The proposed scrum-based teaching learning framework was empirically validated using student academic data collected during its implementation. The effectiveness of the framework was assessed by comparing the academic performance of the students taught using the proposed scrum-based approach with that of the students taught using the traditional teaching approach. The comparative evaluation focused primarily on academic performance indicators, including overall and subject-wise student performance. This comparison provided empirical evidence for assessing the effectiveness of the proposed framework in supporting the teaching-learning process. In addition to students' performance, the implementation process was monitored using a dashboard to facilitate the systematic tracking of learning activities and student progress. The dashboard served as a supporting mechanism for process monitoring and did not constitute an independent measure of framework effectiveness. Placement related outcomes were considered only as supplementary observations and were not used as the primary basis for validating the proposed framework, as placement outcomes may be influenced by several other factors beyond the teaching-learning innovations. Therefore, the empirical validation of the framework was primarily focused on comparative analysis of the students' academic performance data.

5 Data Analysis and Results

This section presents the comparative analysis of student performance and placement outcomes between the traditional teaching methodology and the scrum-based sprint learning framework. The analysis is structured into three key components: academic performance comparison, semester-wise performance trends, and subject-wise performance evaluation

5.1 Academic Performance Comparison

Table 3 presents the academic performance comparison, highlighting the difference in overall student performance between the two teaching methodologies. The analysis is based on the average semester performance index (SPI) of students from both batches. The results indicate that students taught using the scrum-based sprint learning framework achieved a higher average SPI compared to those taught using the traditional teaching approach. This comparative outcome is further illustrated through the visualization shown in Figure 4, providing a clear representation of the performance difference between the two groups.

Table 3. Academic Performance Comparison

Academic Performance Comparison	
Teaching Method	Average SPI
Scrum	6.89
Traditional	6.3

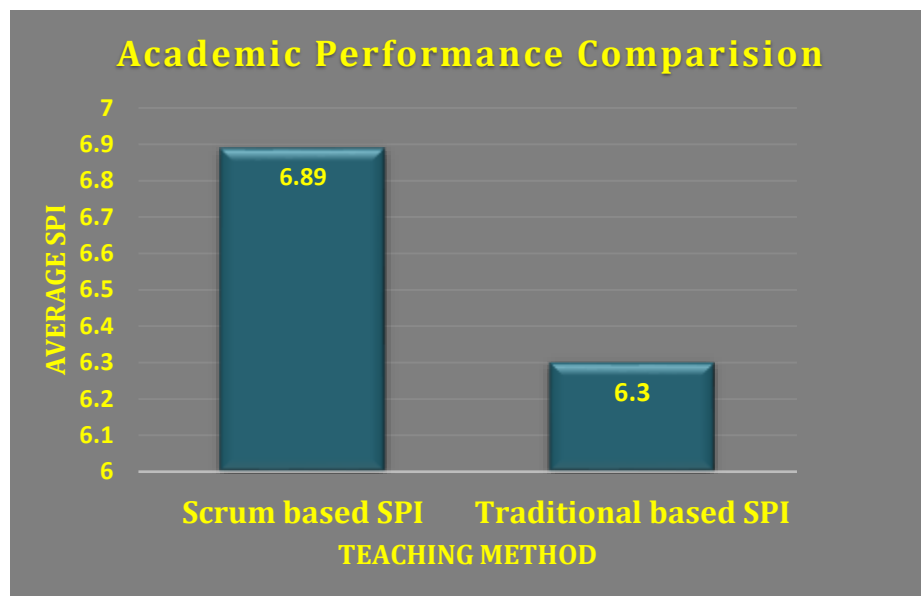


Fig. 4 Academic Performance Comparison Chart

Table 4 presents the average Semester Performance Index (SPI) for Semester 1, Semester 2, Semester 3, and Semester 4 of students taught using the scrum-based teaching learning framework, along with the corresponding average SPI values for students taught using the traditional teaching methodology. The comparison indicates that students exposed to the scrum-based approach consistently achieved higher SPI values across the semesters, demonstrating improved academic performance compared to the traditional method. The same comparative analysis is visually represented in Figure 5, providing a clearer illustration of the performance differences between the two groups.

Table 4. Semester-Wise Performance Comparison

Average Semester wise Performance		
Sem	Scrum	Traditional
Sem 1	7.16	6.5
Sem 2	6.74	6.25
Sem 3	6.36	5.97
Sem 4	7.3	6.46

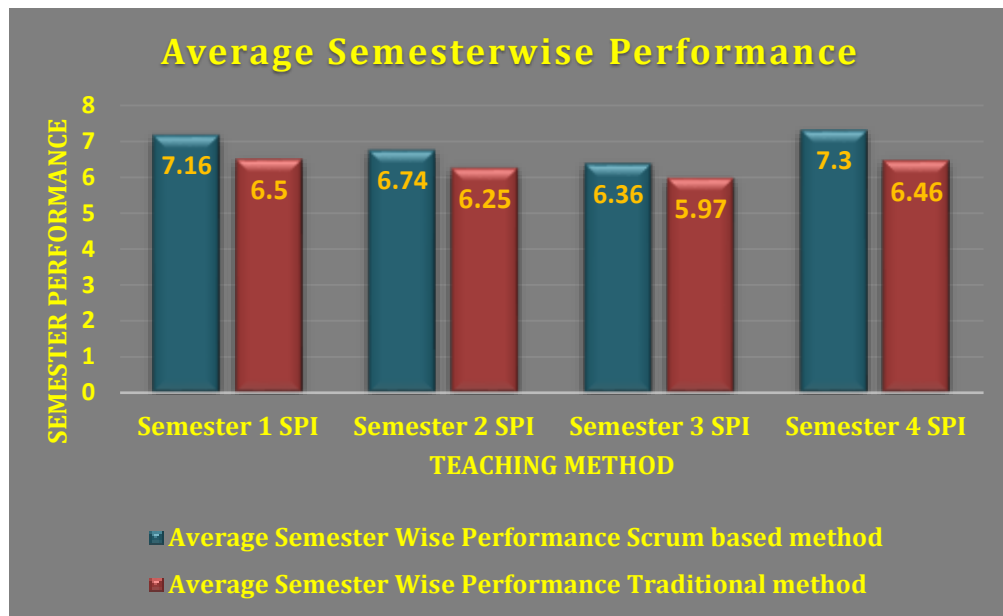


Fig.5 Semester-wise Performance Comparison Chart

5.3 Subject wise Performance

Table 5 represents the average marks obtained in core placement-oriented subjects, including programming in C, database management systems, data structures, and communication skills, were analysed for both batches. These subjects were selected due to their significant relevance in placement assessments. The comparison was conducted between Batch 1 (traditional teaching methodology) and Batch 2 (scrum-based teaching learning framework). The results indicate that, even at the subject level, students taught using the scrum-based approach consistently achieved higher scores compared to those taught using the traditional method. This observation is further supported by the results presented in Figure 6.

Table 5. Subject-Wise Performance Comparison

Subject wise Performance		
Subjects	Scrum	Traditional
Programming in C	59.28	57
Database Management Systems	67.11	57
Data Structures	63.45	63
Communication Skills	60.06	52

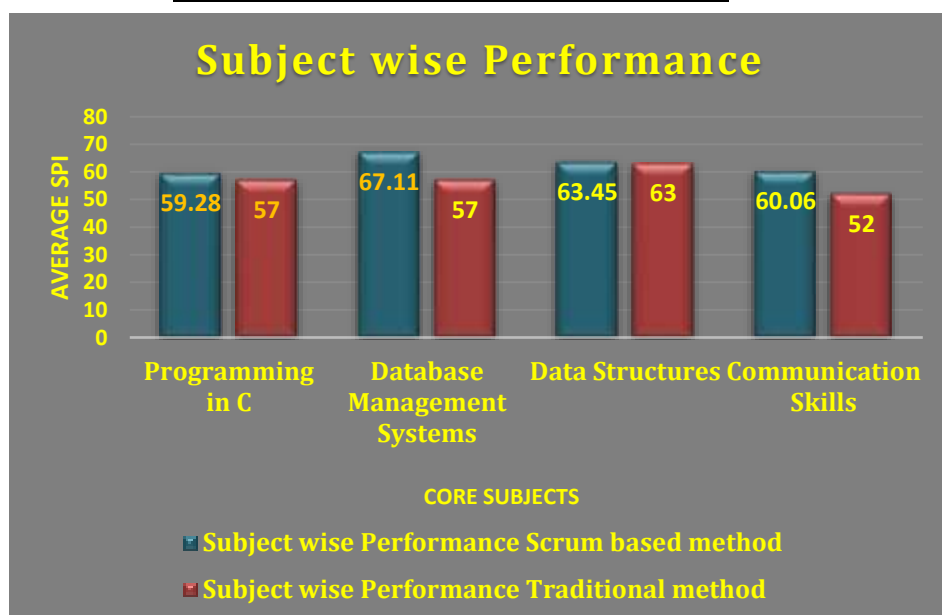


Fig.6 Subject-wise Performance Comparison Chart

5.4 Placement Comparison

Table 6 presents the placement outcomes used to evaluate the impact of the two teaching methodologies. In Batch 1, which followed the traditional teaching approach, 171 out of 436 students secured placements, corresponding to a placement rate of approximately 39.22%. In comparison, Batch 2, taught using the scrum-based teaching learning framework, achieved 260 placements out of 304 students, resulting in a substantially higher placement rate of approximately 85.53%. The marked improvement in placement percentage for Batch 2 indicates the positive influence of the Scrum-based learning approach on students' employability. A graphical representation of this comparison is provided in Figure 7.

Table 6. Placement Comparison Data

Placement Comparison Chart		
Method	Placed	Not Placed
Scrum	260	44
Traditional	171	265

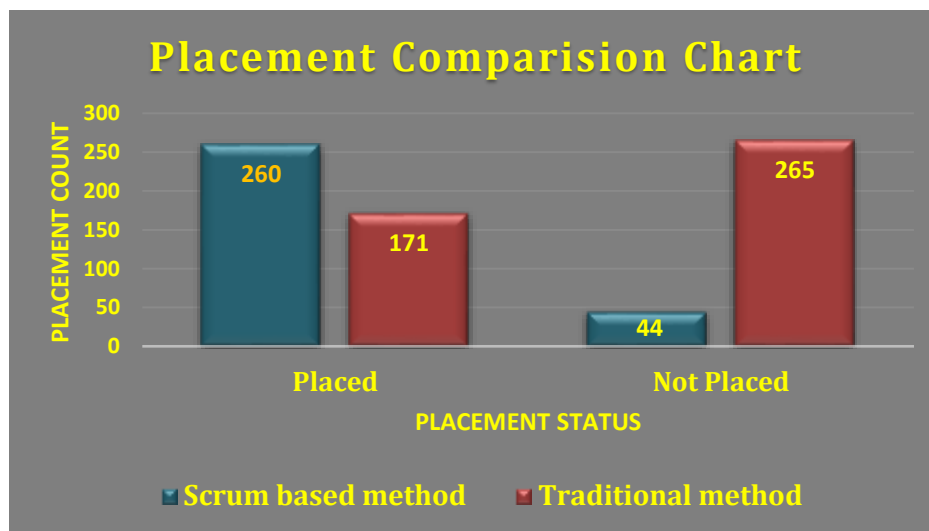


Fig. 7 Placement Comparison Chart

6 Dashboard Implementation

To support methodical implementation and monitoring of the proposed scrum-based teaching learning framework, a dashboard was used to track the progress of academic activities and student learning through the implementation period. The dashboard provides the centralised mechanism for monitoring the planned activities, their progress, and relevant academic performance indicators. The dashboard allows the academic data of the two teaching approaches to be uploaded separately in the spreadsheet format. Following the data upload, the system processes the datasets and generates comparative performance measures. The primary analysis includes the average academic performance of the students under both teaching approaches and identifies the relative difference between the two groups.

The dashboard was designed to support process-oriented nature of proposed framework by providing visibility into the progress of teaching and learning activities. Relevant information related to academic planning, completion of learning activities, student progress, and performance was recorded and monitored during the implementation. This enabled faculty members and academic stake holders to review ongoing status of the teaching learning process and identify areas requiring attention. In alignment in scrum-based approach, the dashboard supported continuous monitoring and review throughout the learning cycle. The information obtained from the dashboard was used during the review and feedback stages to assess the progress of planned activities, and facilitates necessary improvements in subsequent learning activities. It is important to note that the dashboard served as process monitoring and decision support mechanism rather than, an independent measure of evaluating the effectiveness of proposed framework. The empirical validation of proposed framework, was primarily based on comparative analysis of student academic performance under the scrum based and traditional teaching approaches.

6.1 Phase 1 Primary Empirical Validation

Comparative Academic Performance Analysis

The first phase constitutes the primary empirical validation of the proposed framework. Students' academic performance data from the scrum-based teaching learning framework were compared with those obtained

under the traditional teaching approach. The dashboard calculates and presents overall average performance of both the batches and identifies the difference between them. To determine whether the observed difference in academic performance is statistically meaningful, statistical significance analysis was also performed. Moreover, to the overall comparison, semester wise performance was examined using descriptive measures such as mean, standard deviation, minimum value, and student count. A graphical presentation was further used to visualize performance trends across different semester.

As the proposed framework was intended to improve the teaching learning process, academic performance was considered the primary outcome for its empirical validation. The comparative results obtained in this phase therefore provide the principal evidence for evaluating the effectiveness of the scrum-based teaching learning framework.

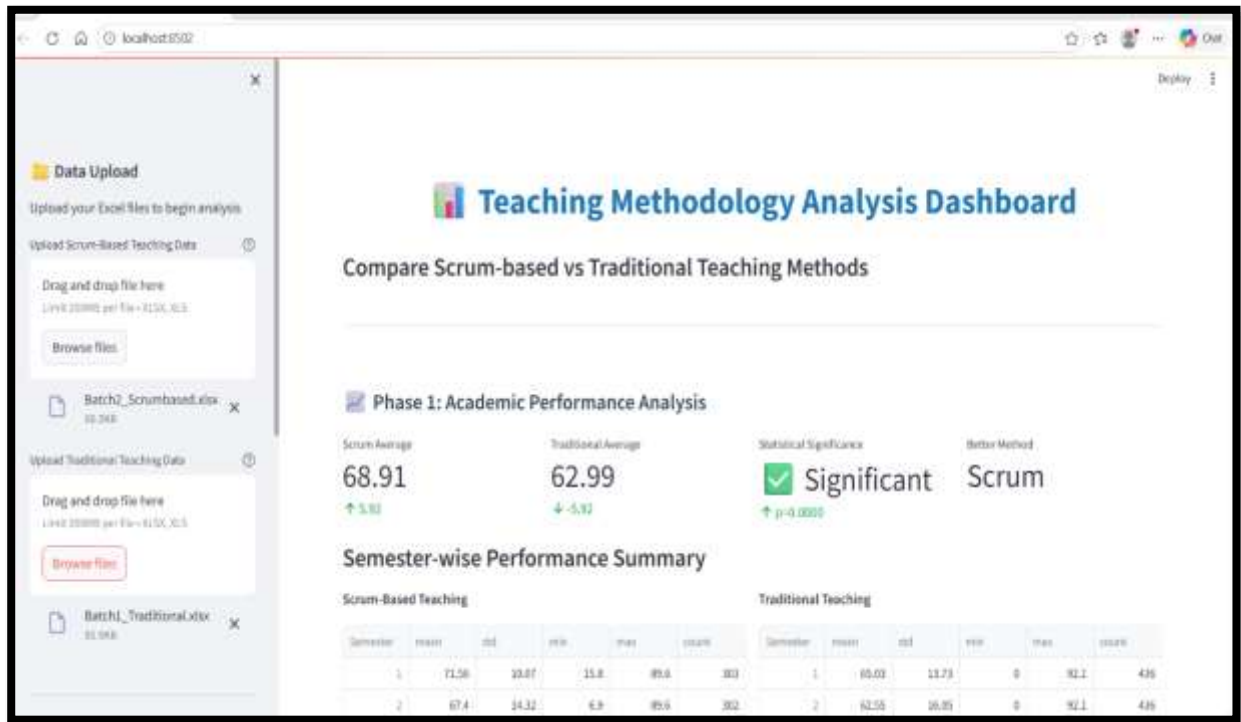


Fig 8 Comparative academic performance analysis

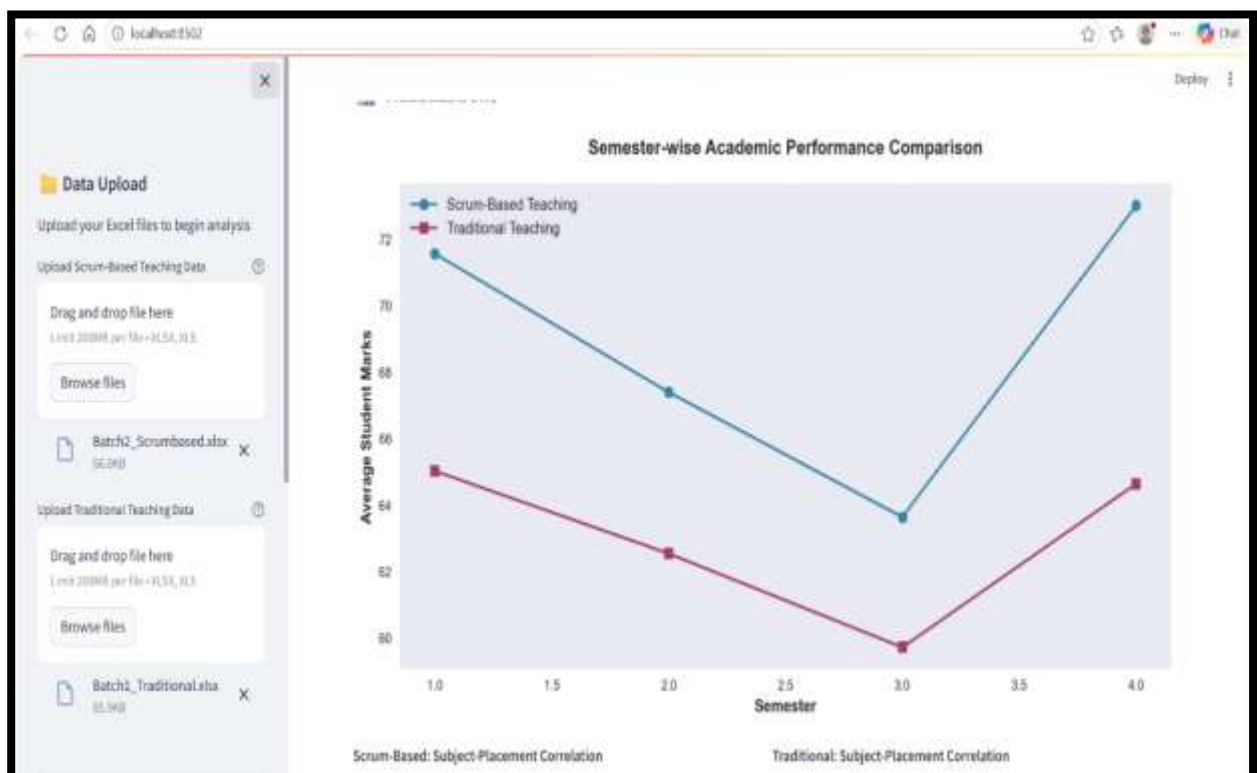


Fig. 9 Comparative academic performance semester graph

6.2 Phase 2 Supplementary Outcome Analysis

Placement Outcome Analysis

The second phase provides supplementary analysis of placement-related outcomes. The dashboard compares placement rates observed in the scrum based and traditional teaching data sets and identifies difference between the two approaches. In addition, the subject-wise performance was examined in relation to placement outcomes through correlation analysis. This analysis provides additional insight into student outcomes, nevertheless it was not considered the primary measure for validating the proposed teaching-learning framework. Placement outcomes may be influenced by several factors beyond the instructional approach, including individual student capabilities, and external employment conditions.

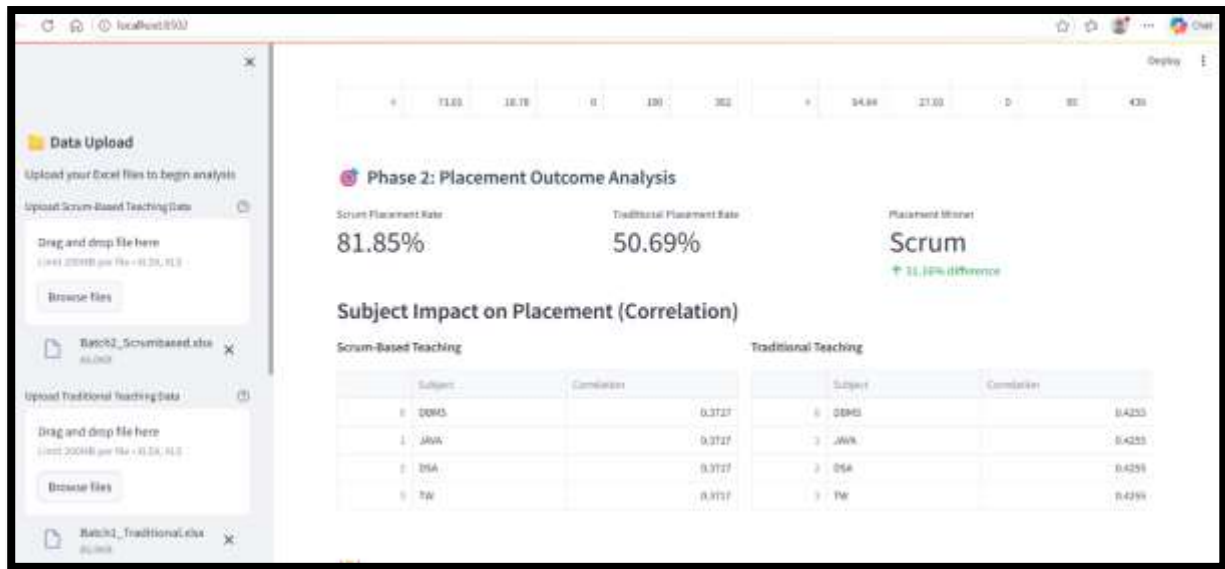


Fig.10 Supplementary Placement Outcome Analysis

6.3 Exploratory Predictive Analysis

Predictive and Statistical Analysis

The third phase extends the analysis through predictive modelling and statistical techniques. The dashboard supports the examination of student outcome patterns using different analytical approaches. Predictive models are evaluated using measures such as accuracy, AUC score, and feature importance while appropriate statistical methods are used to examine relationships and differences within the data. The dashboard also enables the analysis of new student's academic input by generating comparative predicted outcomes based on the scrum based and traditional teaching learning datasets. The generated results include prediction possibilities and confidence measures, thus providing an additional analytical perspective on the potential outcomes associated with the two approaches. This phase is considered as an exploratory extension of the overall evaluation rather than the primary validation of the proposed framework. Its purpose is to demonstrate the additional analytical capability of the dashboard and to explore patterns within the collected student data.

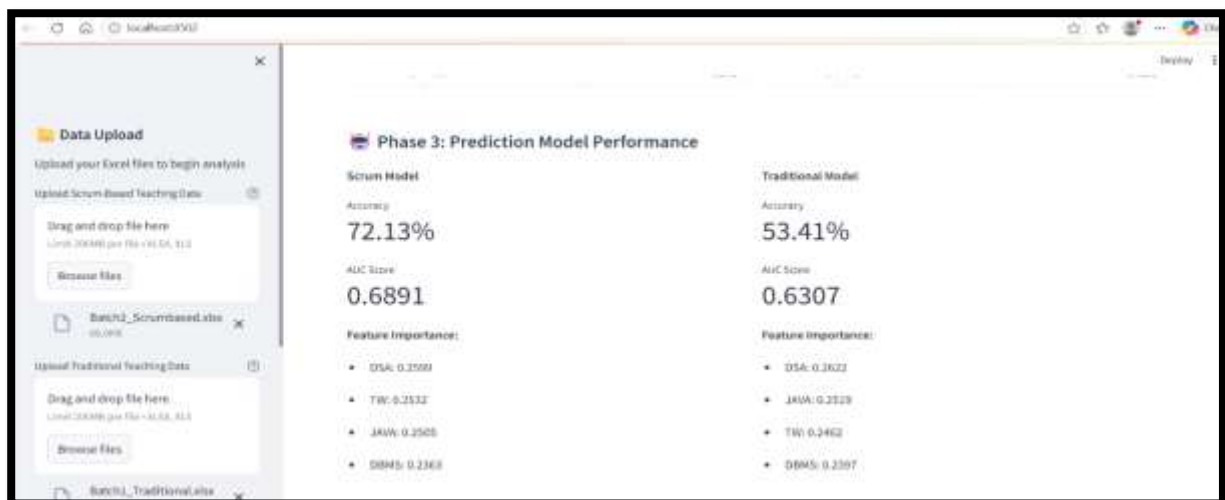


Fig.11 Predictive Analysis

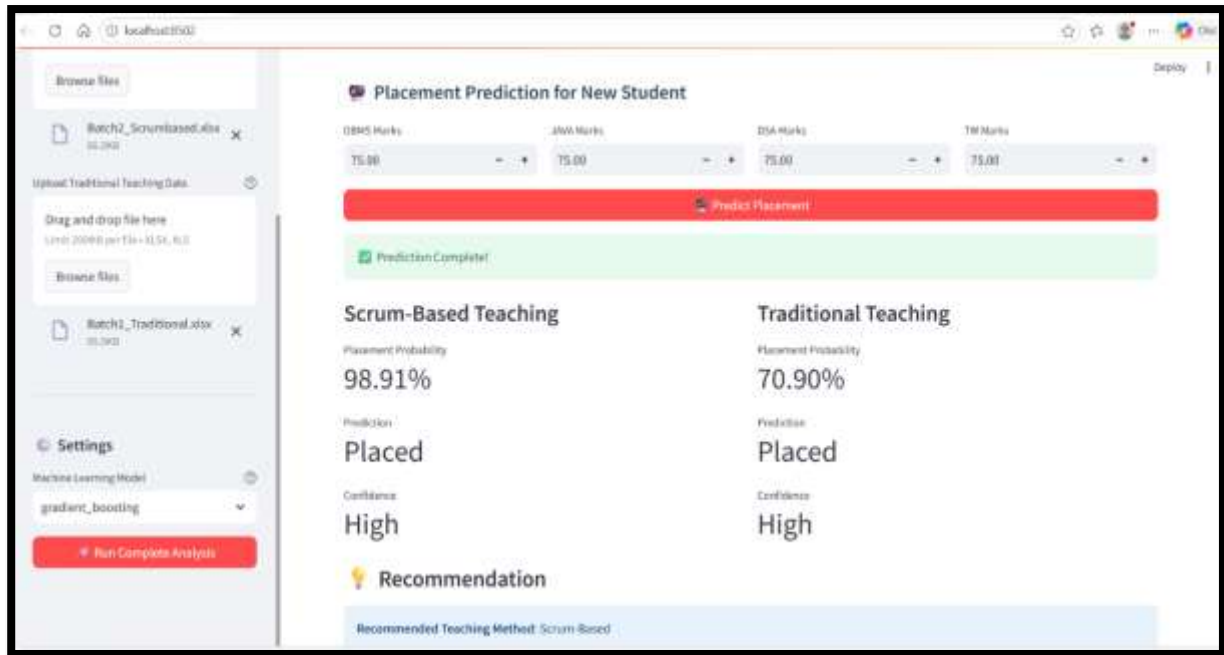


Fig.12 Statistical Analysis

7 Discussion

The findings of this study provide empirical and analytical insights into the effectiveness of the proposed scrum-based teaching learning framework. The primary evaluation was based on a comparative analysis of student's academic performance under scrum based and traditional teaching approaches, while placement related outcomes and predictive analysis were used to provide supplementary and exploratory perspectives. The results collectively indicate differences between the two approaches; nevertheless, the academic performance analysis provides the principal basis for evaluating the proposed framework. The results of phase 1 demonstrate that the students taught using the scrum-based approach achieved a higher overall academic performance of 68.91 compared with 62.99 under the traditional teaching approach, representing a difference of 5.92 marks. The observed difference was statistically significant ($p < 0.001$) indicating a statistically meaningful difference between the performance outcomes of the two teaching approaches. Moreover, the semester wise comparison showed that the scrum-based group maintained a higher average performance across all four semesters. Although performance varied across semesters in both groups, the consistent difference in favour of the scrum-based approach strengthens the empirical evidence supporting the proposed framework. The observed improvement may be associated with the structured and iterative characteristics of the proposed framework. By adapting the scrum roles, artifacts and events to the educational environment, the framework introduces a systematic process for planning learning activities, monitoring progress, obtaining feedback, reviewing outcomes, and making improvements throughout the teaching learning process. Such iterative cycles may provide opportunities for continuous monitoring and timely feedback, thus supporting a more structured and learner centred learning environment. However, the findings indicate an association between the implementation of the scrum-based approach and improve academic performance within the context of this study and should not be interpreted as establishing connectedness beyond the study.

Phase 2 expanded the analysis by probing placement-related outcomes. The scrum-based group proved a placement rate of 81.85%, compared with 50.69% for the traditional teaching group, representing a difference of 31.16 percentage points. This reflection provides an additional perspective on student outcomes associated with the two teaching approaches. Subject-wise correlation analysis involving DBMS, Java, DSA, and TW were also included to discover the relationship between academic performance variables and placement outcomes. However, placement outcomes are inclined by multiple factors beyond the teaching-learning process, including individual competencies, recruitment requirements, employment opportunities, and external market conditions. Therefore, the placement-related findings should be interpreted as supplementary observations rather than as direct evidence of the effectiveness of the proposed framework.

Phase 3 further extended the evaluation through predictive analysis. The predictive model based on the scrum-related dataset achieved an accuracy of 72.13% and an AUC score of 0.6891, compared with an accuracy of 53.41% and an AUC score of 0.6307 for the model based on the traditional teaching dataset. Feature importance analysis additionally provided responsiveness into the relative contribution of the academic variables included in the prediction process. The dashboard also demonstrated the practical application of the predictive models by generating placement probabilities for a new student based on the provided academic performance values. In the illustrated analysis, the Scrum-based model produced a higher predicted placement probability than the traditional teaching model.

Overall, the statistically significant difference in academic performance provides the strongest empirical support for the proposed framework, while the placement and predictive analyses offer additional perspectives. The findings demonstrate the potential of a structured Scrum-based approach to support teaching and learning through iterative planning, monitoring, feedback, and continuous improvement.

8 Conclusion

This study proposed and empirically evaluated a structured scrum-based teaching learning framework for higher education. The framework systematically adapts scrum principles to the academic environment by defining appropriate roles, artifacts, and events for planning, monitoring, reviewing and improving the teaching learning process. Unlike the conventional teaching approach, the proposed framework promotes an iterative learner centred process in which academic activities are organized into structured learning cycles supported by continuous monitoring, feedback, review, and retrospective environment. The framework was implemented and evaluated using student academic performance data by comparing students taught through scrum based and traditional teaching approaches. The result demonstrated that the scrum-based group achieved a higher average academic performance score of 68.91 compared with 62.99 for the traditional teaching group. The observed difference was statistically significant ($p < 0.001$) providing empirical evidence of the potential effectiveness of the proposed framework in enhancing student academic performance. Senesterwise analysis also showed consistently higher performance for the scrum-based group, further supporting the usefulness of the structured and iterative teaching approach.

In addition to the comparative evaluation, a dashboard was developed to support systematic, comparative, supplementary, and predictive analysis of student data. Placement related and predictive analysis provided exploratory insights; however academic performance remained the primary basis for validating the proposed framework. These analytical capabilities can assist educators and academic decision makers in monitoring student progress, identifying performance patterns and supporting evidence based academic interventions.

The major contribution of this study is the development of structural approach for adapting scrum from software development to higher education through clearly defined academic roles, artifacts and events. The findings suggest that the proposed framework can support more organised, iterative, feedback oriented and learner centred teaching learning process. Although the evaluation was conducted within a specific academic setting, the framework provides a foundation for further investigation across different courses, institutions, learner groups, and educational context.

Further research may focus on validating the framework with a larger and more diverse student population, examining the effectiveness across different disciplines, and integrating advanced learning analytics and predictive models for early identification of students requiring academic support. Further studies may also investigate the long-term impact of the framework on student engagement, learning, outcomes, retention, and placement performance.

Declarations

Conflicts of Interest: The authors declare that they have no conflicts of interest.

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