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ELSE: A Novel Framework for Academically Weak Students in STEM Courses

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ABSTRACT

This research introduces the Extra Learning Support for Excellence (ELSE) framework, designed to address the learning gaps experienced by students struggling in STEM courses. Conducted in two phases (2019 and 2021), the study explored targeted interventions to improve academic performance. Phase I implemented a four-week pilot program for first and second-year computer science and engineering students, featuring additional subject-specific study sessions led by experts. Notably, students attending over 80% of these sessions demonstrated significant improvement (average increase of 18.83%, 16.33%, and 18.15%). Building on this success, Phase II incorporated project-based learning, assigning academically challenged students as project leads to foster collaboration and practical skills. This shift yielded encouraging results, with students recording an average growth of 17.49%, 23.08%, 15.87%, 12.19%, and 14.3% in five key STEM courses. The research further proposes enriching the ELSE framework by integrating industry-based projects and inviting industry professionals to lead sessions. This collaboration aims to expose students to real-world challenges, develop key competencies, and prepare them for the dynamic demands of the professional STEM landscape. In conclusion, the ELSE framework, through its phased approach and focus on project-based and industry-oriented learning, emerges as a promising strategy to bridge educational gaps and cultivate well-rounded, competent STEM professionals.

Keywords: *Remedial Classes; Tertiary Education; STEM Course; Higher Education; ELSE.*

1.0 Introduction

The rate of growth of students enrolling in tertiary education degrees in India has increased very rapidly in last decade.

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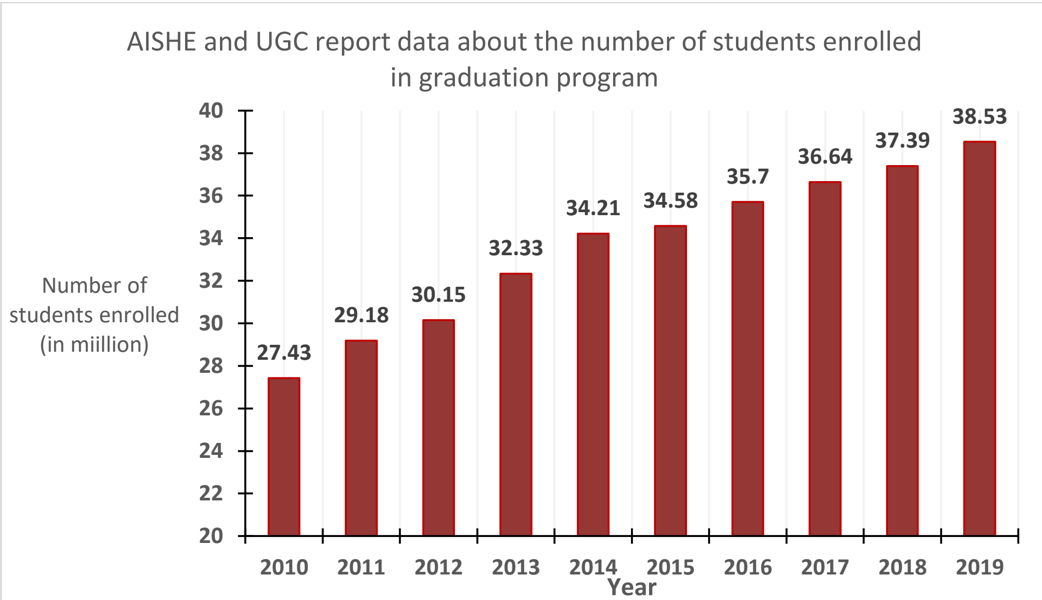
This has been shown in Figure 1 by data collected from the AISHE and UGC report [1, 2]. This phenomenal expansion has been fuelled by the ever-increasing intricacy of technology and organisation.

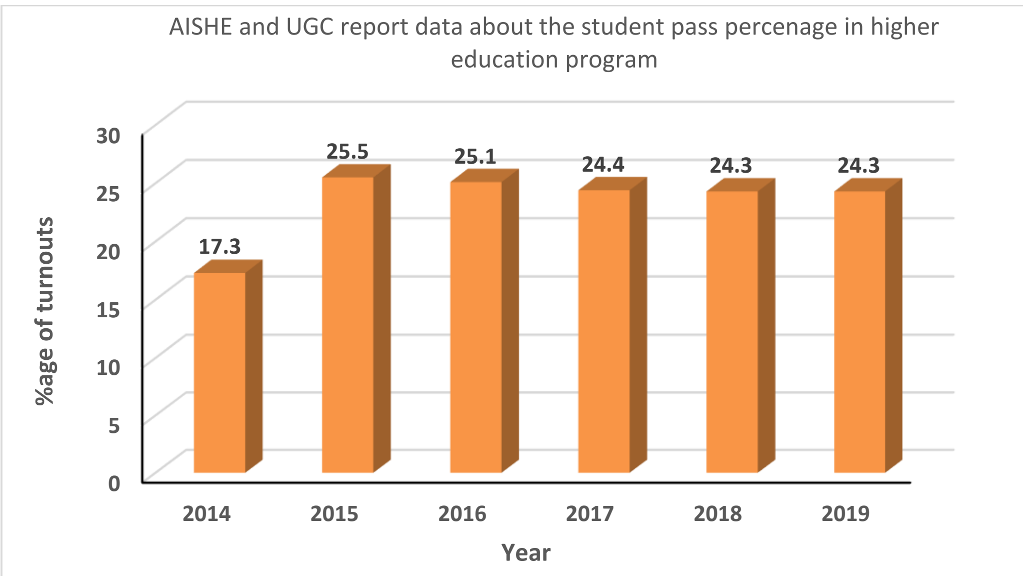
Figure 1: Detail of Student Enrolled in Graduate Programme in Last 10 Years [1, 2]



In recent years, the fast development of postsecondary education has resulted in the emergence of new challenges without resolving existing ones. The total rise in undergraduates did not always compensate for the horizontal demand-supply imbalance. Academicians have raised the concern about the falls in the number of students completing their graduation timely. These are more frightening in science technology, engineering, and mathematics (STEM) courses [3]. Data collected from the report of UGC and the All India Survey on Higher Education (AISHE) is shown in Figure 2.

Furthermore, as higher education became massifier, it resulted in a greater diversity of higher education institutions as well as a greater heterogeneity in students' talents, prior knowledge, and interests. Higher disparities in the quality of tertiary education suppliers and recipients have at least two notable implications. First, institutions must balance the requirement for more standardized processes in order to give more focused and accurate information to students and prospective employers with the demand for customized solutions to meet the needs of a diverse student population. Second, more variation in graduates' human capital reduces the signalling value of academic diplomas and increases information gaps and coordination costs between learners and universities, as well as between graduating students and employers [4]. The rapid growth in tertiary education has forced universities to adopt new teaching methodologies for diversified students in multiple domains for the professionally long career of students in a dynamically changing environment [5].

Figure 2: Pass Percentage of Student [1, 2]



Overall, data in Figure 2 has moulded universities and colleges to change their strategy to handle the dropout rates, particularly in STEM [6]. Remedial classes can play a prominent role in equalizing starting knowledge levels by imparting competencies and knowledge to weak students [7]. Based on the result of the initial tests, the tutor decides about the participation of a student in the remedial classes. A final test is frequently included in remedial courses to help students analyse their performance and identify any extra learning needs. Proof of the effects of remedial courses on indicators like student retention, achievement of higher education credentials, credits obtained, or semester exam success can be found in the literature reports [8-10].

A novel approach named Extra Learning Support for Excellence (ELSE) proposed in this paper for academically weak students in STEM courses shows the impact of remedial classes. Remaining sections of the manuscript are organised as follows: The impact of remedial classes along with the different methodologies of implementation of remedial classes are explored in section 2. Details of the proposed novel framework named ELSE have been given in section 3. The effectiveness of the ELSE has been given in section 4 named Result and Analysis. The conclusive remarks and future scope are described in section 5.

2.0 Review of Existing Approaches for Implementation of Remedial Classes in STEM

In this section, the authors have explored the different methodologies for early improvement of weak students in STEM and tried to uncover the embedded key points in their framework. Their detail are as follows:

Regression-based discontinuity model is used in [8] to quantify the impacts of remedial classes in colleges of Tennessee State, USA. The authors found low impact in case of students whose score was just below the cut-off mark on the admittance test. They also found that students who were not able to clear the admission test by a large margin have a significant impact. These findings highlight the necessity of not limiting the analysis to students who got marks around the cut-off point on the entry test, because the outcome of remedial courses may vary depending on the level of starting preparedness. The significance of domain-related prior knowledge in STEM courses has been discussed in [9] and concluded that it plays a significant role in the better course and programme outcomes.

The author has considered the case of a German college where student's participation in the remedial classes was not mandatory and marks of test conducted at entry level was the basis of their participation in the remedial classes. A severe regression-based discontinuity design has been used in [10] to evaluate the math remedial course impact on the students in an Italian university's economics department who failed the admission test. The remedial course had twenty-one hours of face-to-face instruction. Because of the circumstances under investigation, strict exit criteria from treatment were there. Students were given a formal assessment at the end of the remedial course, and their failure affected their academic path by preventing them from registering for important first-year tests. The significance of the right target setting and course outcome for each course in the starting has been discussed in [11]. The author has advised preparing the plan in advance for the achievement of the target and outcome. [12] has discussed about the effectiveness of remedial classes. To prove his points about the effectiveness of remedial classes, the author had picked the data of undergraduate students enrolled in mathematics course in the industrial engineering programme in Northern Italy from 2012 to 2016.

In his methodology of remedial classes, the author has implemented a bridge course for new entrants to fill up the knowledge gap and bring all students to the same level. An exit test was conducted at the end, and students who successfully cleat that exit test are allowed to continue the course and unsuccessful students were blocked. Implementation of this requires many resources and results in the cancellation of student admission. Through empirical analysis, the author has found that this has improved the on-time course completion percentage. A remedial course approach have been proposed in which participation was not mandatory [13]. The authors had applied their approach of remedial courses to a group of students in an Italian university. The participation criterion was the entry test in the course. The authors also discovered that increasing the level of remedial course participation reduces dropout rates and increases the credit score obtained during 1st academic year.

However, the proposed approach is not ideal for the evaluation of remedial courses for students who fall into the lowest part of the score distribution of the entrance test and are thus excluded from their analysis. [14] has highlighted the significance of remedial classes particularly in the case of underprepared graduating students. For his analysis, the author has picked a group of weak students in a US-based big private state university. The mathematics-based remedial work in the case of community college students has been discussed in [15] and done the comparative attainment analysis of remedial classes. The author has considered the sample of weak students from several community colleges in California. Both [14] and [15] concluded that remedial courses allow academically weak students to catch up with well-prepared students and resulted in insignificant disparities in dropout and graduation rates. One negative point that has been found is that most of the students registered in remedial course had left the course during remedial classes [15].

Discovering and illuminating the reasons why a student performs in a particular way: why some overachieve, underachieve, or withdraw from their higher education can provide a great deal of information to understand the issue closely and even develop plans to mitigate the retraction. The most influential factor among all would be the quality of teaching in addition to student-teacher interaction. Teachers play a crucial role in part of any student’s life, may it be academic, cultural, or psychological. In another study [16], it was concluded that quality of teaching, student-teacher relations, policies, and facilities are identified as the key drivers that affect the quality of education. The article is backed by statistical analysis using various tools and techniques like hypothesis testing, t-test, and the Analytic Hierarchy Process (AHP). Similar to this ideology, [17-19] highlights the issues of perceived stress, coping, emotional dysregulation, psychological adjustments to university, multiple intrinsic and extrinsic factors involved in the same and the overall wellbeing of a student. They emphasize all those latent and neglected problems, which constantly have been playing a critical role in students' engagement, scholastic, co-scholastic performances, and interests in retaining their higher education. Indian education system ranks third for its size and diversity, leading after China and United States. Although it ranks first position for having the highest number of educational institutions [20]. Unfortunately, even after holding top positions in statistics, the quality of Indian education has a long way ahead. There are multiple challenges faced by the Indian Higher education system such as Gap between the supply and demand, Lack of Quality Research work, Poor quality of the curriculum, and Shortage of Faculty and High student-faculty ratio [21-22].

The above-discussed review of the literature has highlighted the wide range of remedial courses available to academically challenged students in STEM courses. Assignment guidelines, content, organization, severity, and exit rules may vary between remedial courses. Furthermore, researchers' empirical methodologies differ in how they account for variation in the pre-treatment variables distribution that affect the academic performance of students enrolled in remedial courses, as well as how they choose which observations to include in the empirical analysis. As a result, definitive evidence of remedial course effectiveness is still missing. This has inspired authors for the proposed novel framework named ELSE for weak students, particularly in STEM courses. The framework proposed in section 3 contributes to the discussion on the most appropriate tools to upgrade students' academic performance by giving more evidence on the effectiveness of the remedial courses for the academically weak students in the school of computer science of a state university named the UPES in India during 2019 to 2021.

3.0 Methodology

The objective of the study is to provide additional help to the students who, for one reason or another, have fallen behind the rest of the class. By adapting school curricula and teaching strategies, various learning activities and practical experiences are imparted to students according to their abilities and needs. This programme will help students develop their generic skills, problem-solving, self-learning, and independent thinking. Such initiatives motivate students to develop positive attitudes and prepare them for future studies. The study is conducted for two years at a university located in the northern region of India. The academic flow of the assessments conducted in UPES, where the study is conducted in mentioned in Table 1.

Table 1: The Academic Flow of the Assessments Conducted in UPES

Modules	Components	Methodology
Internal assessment	Quiz, Class Test, Assignments, etc.	The course instructor is responsible to conduct the assessment based on the components defined before the commencement of mid-semester examinations.
Mid-semester exam	Covers 50% of the course syllabus	The mid-term examination covers 50% of the course syllabus. Phase I and Phase II of the proposed frameworks are designed to be implemented after the mid-term exam.
Internal Assessments	Quiz, Class Test, Assignments, etc.	The course instructor is responsible to conduct the assessment based on the components defined after the mid-term exams and before the commencement of end-semester examinations.
End-semester examination	Covers 100% of the course syllabus	The end-term examination covers 100% of the course syllabus. Mid-term and end-term examinations are part of the assessment criteria developed for academically weak students.

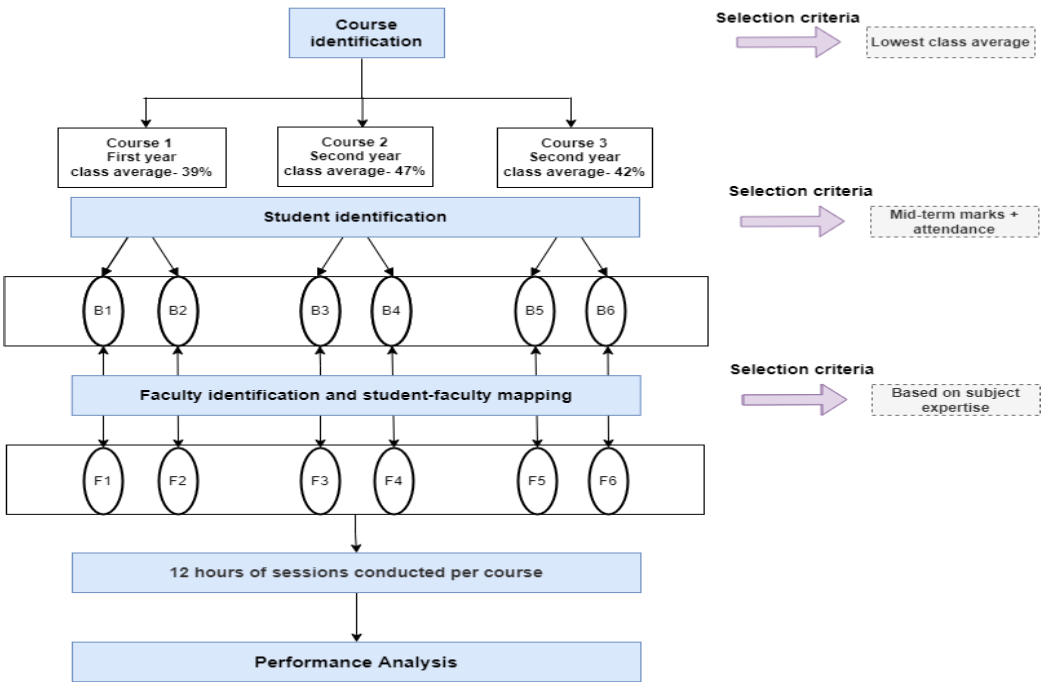
The pilot project is implemented in Phase I where the academically weak students are assessed based on their performance in mid-term and end-term examinations conducted before and after the modules designed in Phase I. The selection criteria is defined for various categories such as identifications of courses be taught, identification of academically weak students, identification of the course instructors followed by mapping of course instructors to the selected students, and performance analysis of the students.

The necessary documents are compiled post-completion of Phase I of the ELSE framework. Attendance sheets of the students are recorded for analysing their performance in the end-term examination. An interactive session is conducted for students who failed to attend the remedial classes conducted in Phase I. Their major concerns were- the majority of the sessions are lacklustre and unimaginative. When asked about similar issues to the other students in the class, they suggested employing practical execution of the topics because merely attending theory sessions were not intriguing for them. Some students were dealing with anxiety and stress, which required professional counselling from the experts. Additionally, faculty accent is sometimes an impediment for international students. Considering all the points, we have employed a Project-based learning model for encouraging the students to become independent workers, critical thinkers, and problem-solvers. The notion behind Project-based learning is to develop the capabilities of academically deficient students while working with their peers. The selected students are assigned as project leads, and other students are involved as team members considering that they are not segregated from the rest of the class. A detailed description of the proposed modules in both the phases are given in this section.

3.1 ELSE Framework implemented in Phase I

The pilot model is proposed for first and second-year Computer Science and Engineering students. The model is executed for four weeks, where 3 hours per week of the study load is assigned to the students apart from their regular classes. The ELSE framework proposed in Phase I is depicted in Figure 3.

Figure 3: ELSE Framework Proposed in Phase I



Several stages incorporated in Phase I for the development of the ELSE framework are discussed.

3.1.1 Identify courses

The primary phase of the ELSE framework focused on identifying the number of courses to be taught in Phase I. For the pilot project, we have chosen three courses, one course from the first year, and two courses from the second year. The criteria for selecting a course is the class performance in their mid-semester examination. The class performance is calculated by finding the average marks obtained by all the students in the chosen courses. The course where the class average is lowest is identified from the first year. Similarly, two courses are selected from the second year where the class average is the lowest. The formula to obtain the class average is mentioned in equation 1.

$$CA_{\ course} = \frac{1}{N}\sum_{i=1}^{N} m_i \qquad \ldots(1)$$

Where, CA is the class average, m_i is the marks obtained by i^{th} student, and N is the number of students in the class.

3.1.2 Student-faculty interaction

It is vital to understand the perception of students and course instructors before commencing the process. For that reason, an interaction of the course instructors is carried out with all the students of selected courses. This framework is designed with envisaged the progression of the students. Consequently, recording their feedback at the beginning and the end of the project is supremely essential.

The purpose of the initial communication is to analyse the difficulties faced by the instructors and students in their regular classes. Multiple issues were identified such as; the student-faculty ratio being higher, which amplifies the workload of the instructors. When this ratio is high, the instructors are unavailable to offer their services and guidance to the students. Some students are uncomfortable voicing their doubts or opinions in a larger group of students. In some cases, the accent of the international faculty becomes a barrier, which makes the course delivery incomprehensible.

3.1.3 Identify academically weak students

Identification of academically deficient students is the next step toward nurturing their abilities and talents. Firstly, the number of students for the ongoing research is to be identified. 60 students are selected in a total of which 20 and 40 students are selected from the first and second year respectively. The students are then divided into six batches consisting of 10 students each. The criteria for selecting the students are based on mid-semester marks and class attendance. The weightage of mid-term marks and attendance is kept at 70% and 30% respectively. Equation 2 is used for selecting 20 students from every course. Here, m is the marks obtained by the student out of 100, and a is the percentage of the attendance in course 1 until their mid-term examination.

$$t = m * 0.7 + a * 0.3 \ (2) \qquad \ldots(2)$$

We identify t, total marks, for an individual student per course. Next, we sort the students in increasing order of the value t, and finally, the top 20 students are selected from this sorted list. A similar approach is applied for the remaining two courses to select 40 students from the second-year.

3.1.4 Faculty-student mapping

The next stage begins with the mapping of selected courses to the course instructors by finding out common free slots. The student-faculty ratio is kept at 1:10 i.e. one instructor is assigned for every group consisting of 10 students. Five-course instructors F1, F2…, and F5 are allocated to five batches B1, B2…, and B6. Identification of a common time slot by excluding their regular class timings is an arduous task, which involves analysing the timetable of both instructors and the students.

3.1.5 Performance analysis

The last stage in the journey of making underperforming students excellent performers is accessing their performance through this programme. The improvement in their performance is computed by comparing the average marks obtained by the selected students in mid-term and end-term examinations. The marks obtained by underperforming students are compared against the class average to understand how they have accomplished concerning other students in the class. Besides, we have analysed the performance of the students who had not attended remedial classes although they were eligible. The scores of such students are investigated to observe whether they have shown promising results compared to the students who have attended more than 80% of the remedial classes. The percentage improvement in the performance of the students eligible for the conducted sessions is calculated using equations 3-7. Percentage improvement in the performance of the students selected for ELSE Phase I is mentioned in Table 2 and Overall improvement in the performance of the students selected for ELSE Phase I is illustrated in Table 3.

$$PI_1 = EP_{end\_term\,average} - EP_{mid\_term\,average} \quad \ldots(3)$$

$$PI_2 = EA_{end\_term\,average} - EA_{mid_{term}}average \quad \ldots(4)$$

$$PI_3 = CA_{end\_term\,average} - CA_{mid\_te\,rm\,average} \quad \ldots(5)$$

$$PI_{EP} = PI_3 - PI_2 \quad \ldots(6)$$

$$PI_{EA} = PI_3 - PI_1 \quad \ldots(7)$$

$if\ PI_{EP} > PI_{EA}, then\ we\ conclude\ that\ there\ is\ a\ positive\ growth\ in\ the\ performace\ of\ the\ students.$

where,

P- Number of students attended more than 80% of the remedial classes
A- Number of students attended less than 80% of the remedial classes
EP (Eligible + Present students) –students eligible for remedial classes and have attended more than 80% of the classes.
EA (Eligible + Absent students) –students eligible for remedial classes and have attended less than 80% of the remedial classes.
CA – class average
PI_1- Performance improvement of EP students
PI_2- Performance improvement of EA students
PI_3- Performance improvement of the class
PI_{EP}- Performance improvement of EP students against class average
PI_{EA}- Performance improvement of EA students against class average

Table 2: Percentage Improvement in the Performance of the Students Selected for ELSE Phase I

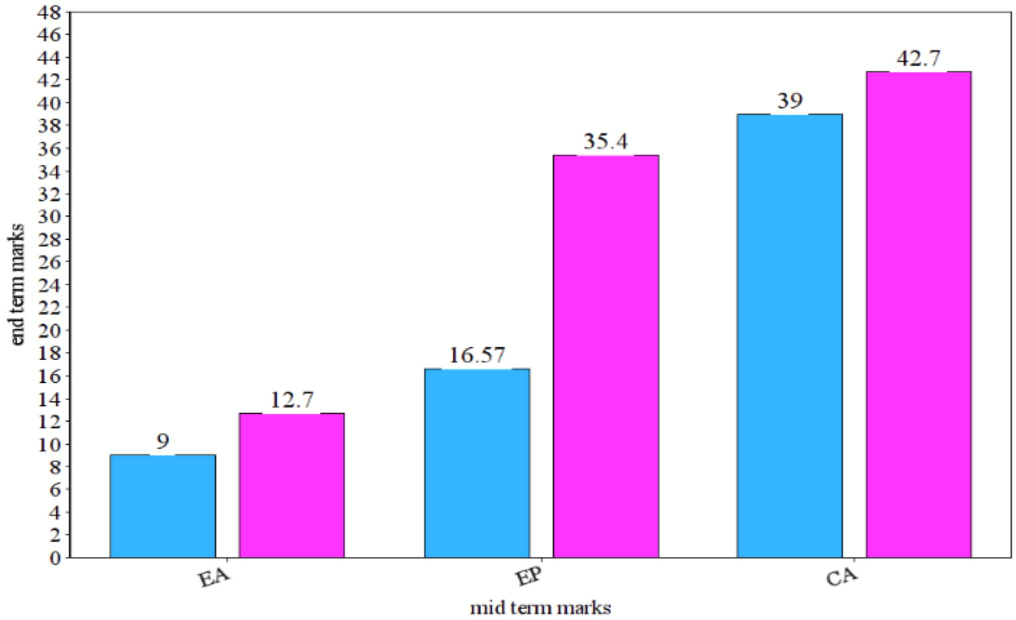
Courses	PI_1	PI_2	PI_3	PI_{EP}	PI_{EA}
PDS	18.83	3.7	8.7	10.13	-5
DCN	16.33	2.95	12.9	3.43	-9.95
DBMS	18.15	12.09	13.7	6.03	-1.61

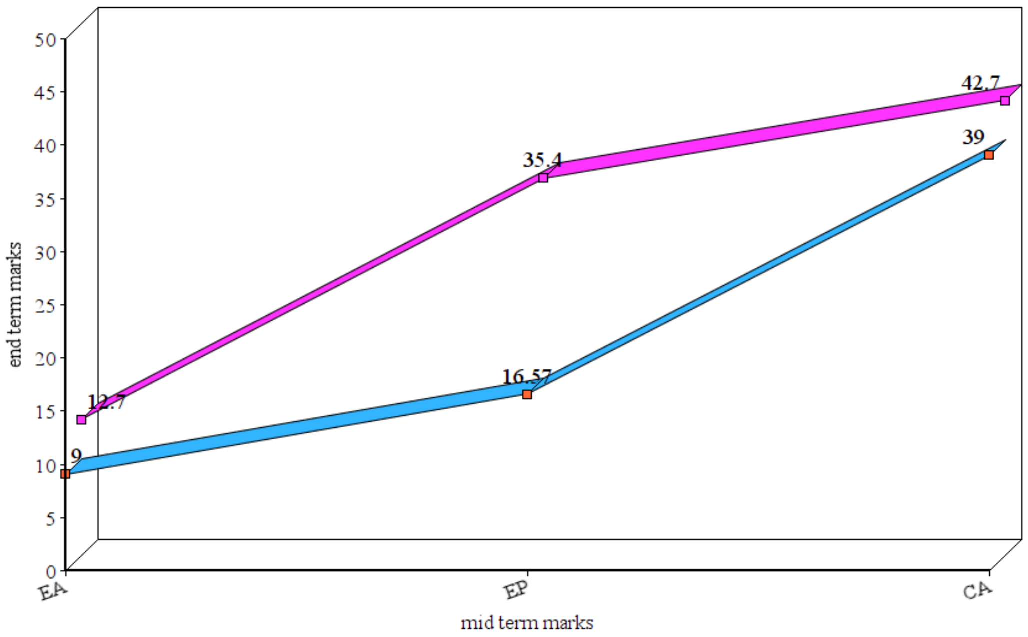
PDS- Programming and Data Structures,
DCN- Data communication network,
DBMS- database management system

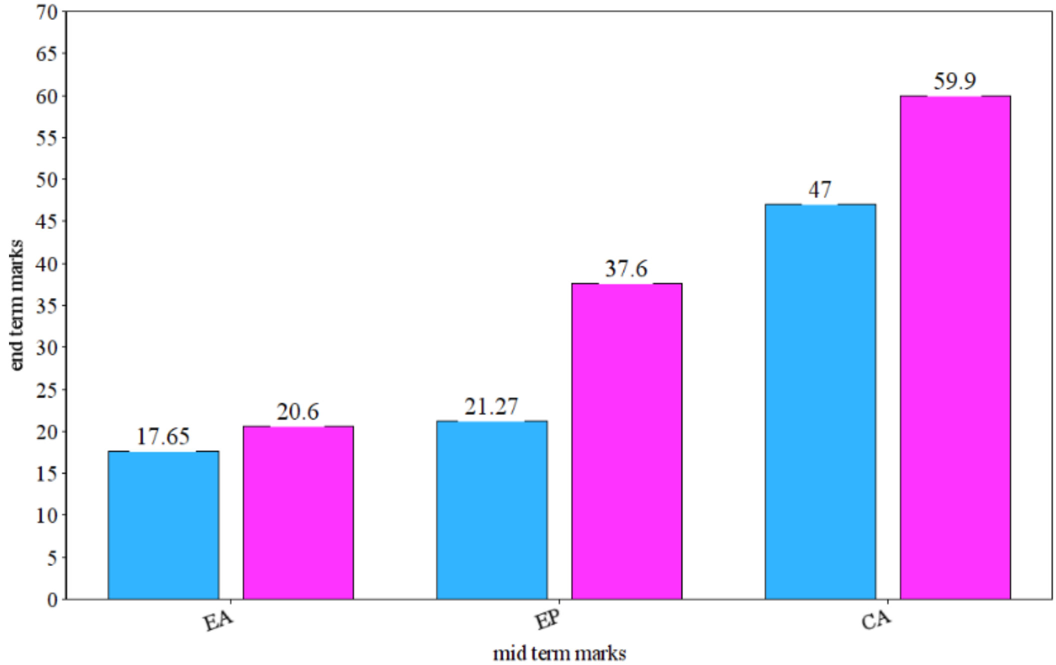
Table 3: Overall Improvement in the Performance of the Students Selected for ELSE Phase I

<table>
<tr><th colspan="5"></th><th colspan="3">Mid-term marks Average (%)</th><th colspan="3">End-term marks Average (%)</th></tr>
<tr><th>Courses</th><th>Course Faculty</th><th>Year</th><th>Eligible students</th><th>No of Students (P/A)</th><th>CA</th><th>EP</th><th>EA</th><th>CA</th><th>EP</th><th>EA</th></tr>
<tr><td rowspan="2">PDS</td><td>F 1</td><td>I</td><td rowspan="2">20</td><td rowspan="2">16/4</td><td rowspan="2">39</td><td rowspan="2">16.57</td><td rowspan="2">9</td><td rowspan="2">47.7</td><td rowspan="2">35.4</td><td rowspan="2">12.7</td></tr>
<tr><td>F 2</td><td>I</td></tr>
<tr><td rowspan="2">DCN</td><td>F 3</td><td>II</td><td rowspan="2">20</td><td rowspan="2">12/8</td><td rowspan="2">47</td><td rowspan="2">21.27</td><td rowspan="2">17.65</td><td rowspan="2">59.9</td><td rowspan="2">37.6</td><td rowspan="2">20.6</td></tr>
<tr><td>F 4</td><td>II</td></tr>
<tr><td rowspan="2">DBMS</td><td>F 5</td><td>II</td><td rowspan="2">20</td><td rowspan="2">14/6</td><td rowspan="2">42</td><td rowspan="2">24.65</td><td rowspan="2">15.21</td><td rowspan="2">55.7</td><td rowspan="2">42.8</td><td rowspan="2">27.3</td></tr>
<tr><td>F 6</td><td>II</td></tr>
</table>

Figure 4: Performance Improvement Charts of EP, EA Students against CA



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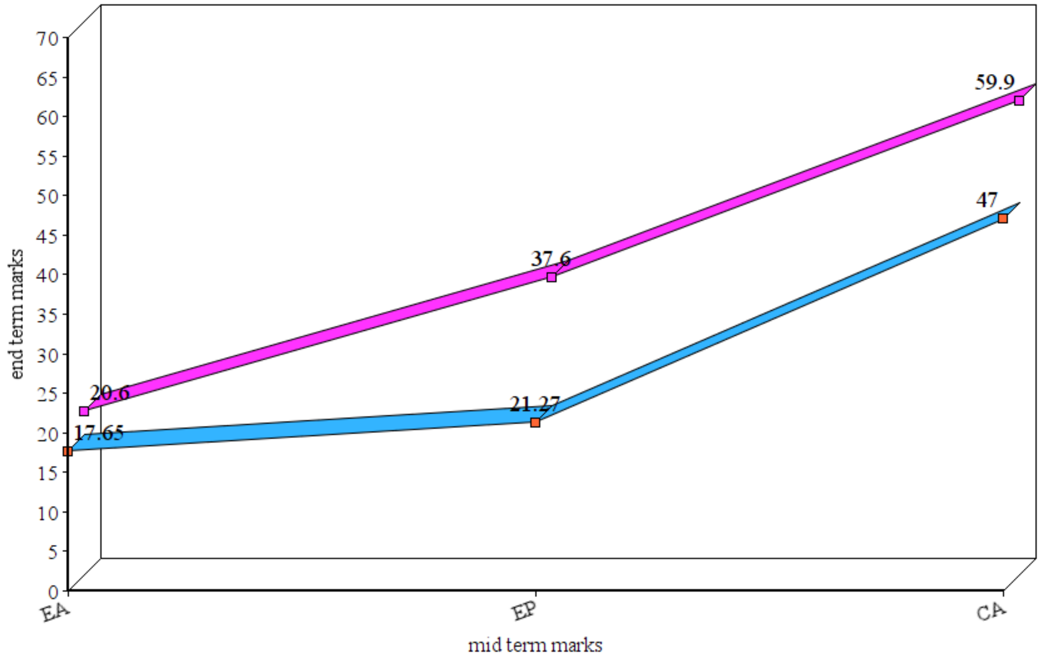
mid term marks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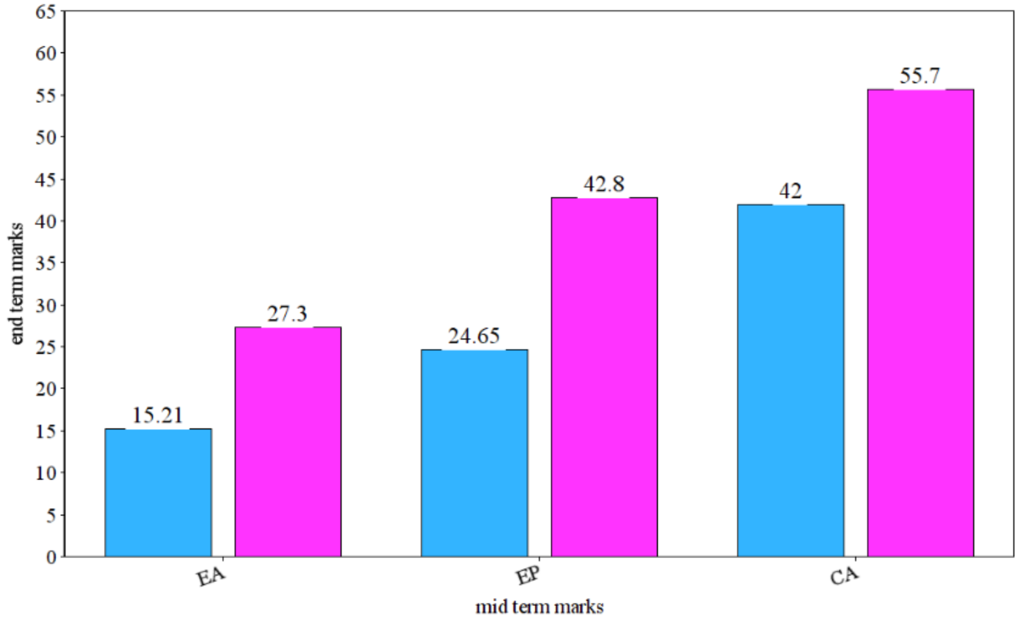
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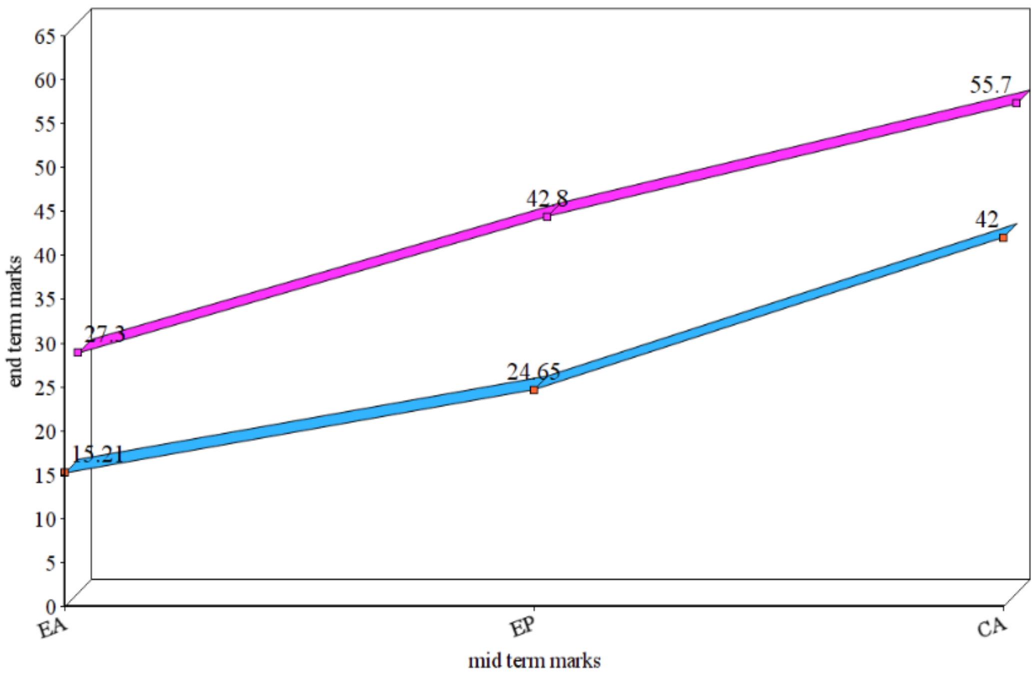
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EA
EP
CA
mid term marks

3.1.6 Performance analysis for course 1

An average growth of 18.83%, 16.33%, and 18.15% is recorded by the students on the selected courses after attending more than 80% of the remedial classes (Figure 4). Additionally, we wanted to analyse the fruitfulness of the ELSE framework by understanding how students selected for the programme are performing by not attending the remedial classes. Similarly, a growth of 3.7%, 2.95%, and 12.09% is recorded for students who have not attended 80% of the remedial classes. Although there is a positive growth in both cases, the effectiveness of the ELSE programme can better computed by comparing the performance of the students (present or absent) against the class average. It is observed in all the courses that students who have attended the remedial classes have performed better against the class average as opposed to the students who have attended only a few sessions.

3.2 Model adopted for phase II

The model adopted in Phase II, emphasizes Project-based learning instead of conducting a 4-week programme, which involves 12 hours of classes exercised per course. The notion behind Project-based learning is to develop the capabilities of an academically deficient student while working with his/her peers. Every student in the class can demonstrate his/her competencies by working on real-world problems as opposed to merely learning facts and concepts. Starting from course selection to performance evaluation, multiple factors were discovered based on the feedback received from students and faculties interaction from Phase I. The motivation behind preferring Project-based learning to theoretical sessions adopted in Phase II is listed down in Table 4.

The project-based learning is implemented for multiple courses in Phase II. The pilot project was carried out for only three courses (one from the first year and two from the second year). However, we can consider as many courses as we want in this phase. The course is first selected based on the class average, similar to Phase I. There are two courses identified from the first year and three courses identified from the second year. Secondly, the academically weak students are identified in every course ensuring they are not segregated from the rest of the class. The course faculty is responsible to identify the underperforming students based on their performance in the mid-semester examination and other internal assessments (Quizzes, class tests, assignments, etc.) conducted before mid-term exams.

The notion behind Project-based learning is to develop the capabilities of academically deficient students while working with their peers. The selected students are assigned as project leads, and other students are involved as team members.

Table 4: Demonstrates the Modifications Incorporated in Phase II based on Challenges Faced in ELSE Phase I

Phase I			Phase II	
Category	**Phase I methodology**	**Challenges faced**	**Modification done**	**Phase II methodology**
Identify courses	Course selection is done based on class average	No challenges faced	Similar process is adopted for Phase II	Course selection is done based on class average
Identify underperforming students	The students are selected based on their performance in mid-term exam.	The students are chosen and segregated from the rest of the class. They felt dispirited as they are handpicked for individual sessions.	The students are identified for project-based learning, which is carried out by making groups with their classmates.	The selected students are assigned as project lead, where other students are involved as team members.
Faculty selection	Individual faculties are identified for conducting remedial classes	Extra load is allotted to the selected faculties.	No individual selection of faculties is involved.	Instead of assigning extra load to the faculties, the course faculty is responsible to assign the projects.
Student-Faculty mapping	The mapping is done by matching student and faculty's timetable.	It is a tedious task to identify a common time slot for students and faculties for conducting remedial classes	No mapping is required	The activities are conducted as part of regular sessions. Therefore, no extra time slot is allotted.
Student interaction	Theoretical sessions are conducted. It was a 4-week programme, which involves 12 hours of classes exercised per course.	Around 20% of the students find the approach uninteresting.	Project-based learning is introduced in this phase.	The notion behind Project-based learning is to develop the capabilities of academically deficient students while working with their peers
Student interaction	Students who have not attended the remedial classes are identified.	Around 3% of the students not attending the classes were dealing with anxiety and stress.	Professional counselling is provided to the students.	Before commencing phase II, student interaction is conducted, where the importance of mental health is enunciated.

The top 18% of the students having lower performance in the selected courses are allocated as project leads. For instance, in a first-year course, in a class of 40 students, seven weak students are identified to become the project lead. The number of projects assigned per course should be equal to the number of academically deficient students to effectively allot them as the leader of the projects. Equations 8, and 9 are used to identify the number of academically weal students, and the number of projects/groups allotted per course. The students of the class are then evenly distributed among the selected groups except for the last group, which includes the remaining students using equations 11, and 12.

$$N_{AD} = ceil(.18 * n) \quad \ldots (8)$$

$$N_P = N_{AD} \quad \ldots (9)$$

$$N_R = n - N_{AD} \quad \ldots (10)$$

$$N_G = ceil\left(\frac{N_R}{N_P}\right) + 1 \quad \ldots (11)$$

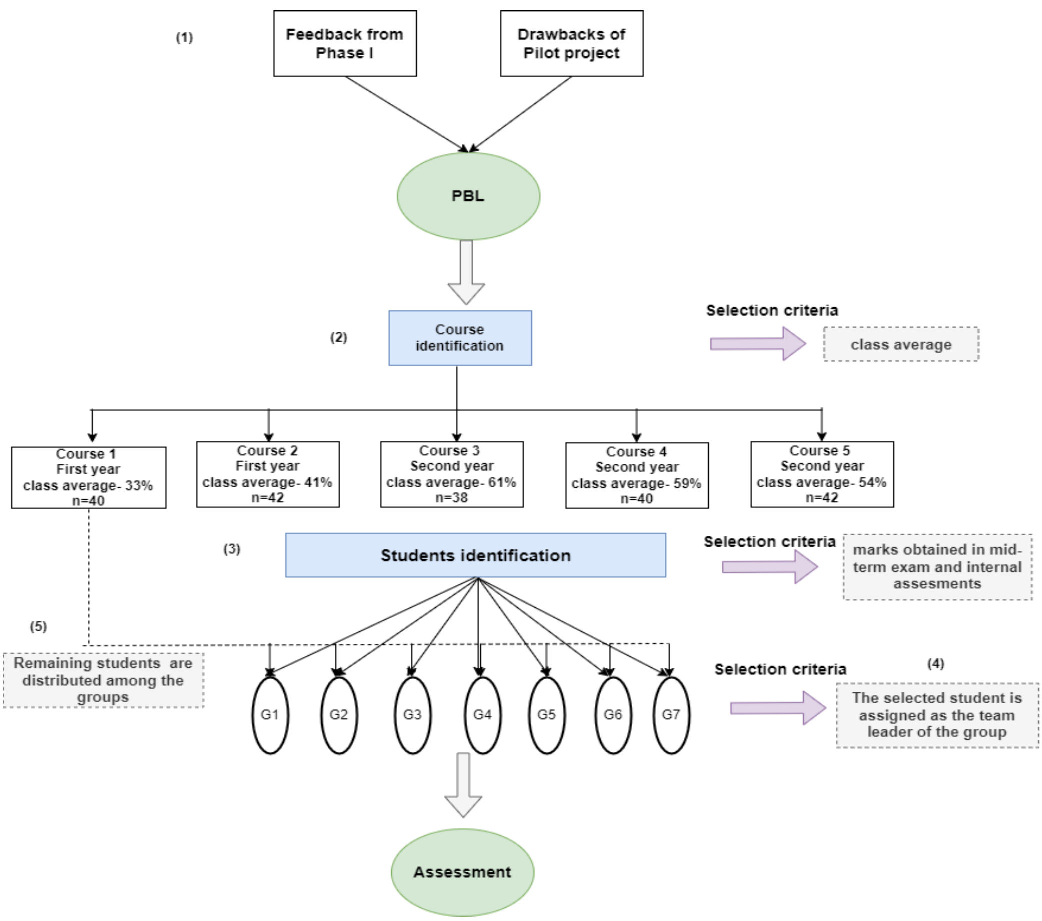
$$N_{LG} = n - (N_G * (N_P - 1)) \quad \ldots (12)$$

where, n is the total number of students in the class, N_{AD} is the number of academically deficient students selected per course, which is 18% of the class based on their performance, N_P is the number of projects/groups assigned per course, N_R is number of remaining students, N_G is the number of students in the group from 1 to N_P-1, and N_{LG} is the number of students in the last group. The distribution of students among various groups identified for Phase II is mentioned in Table 5. Figure 5 depicts the methodology adopted to implement ELSE framework in Phase II.

Table 5: Number of Students Allotted in the Identified Groups for Project-based Learning

Course/Year	N	N_{AD}=N_P	N_R	N_G	N_{LG}
Course 1, I Year	40	7	33	5 + 1=6	4
Course 2, I Year	42	8	34	4 + 1=5	7
Course 3, II Year	38	7	31	4 + 1=5	8
Course 4, II Year	40	7	33	5 + 1=6	4
Course 5, II Year	42	8	34	4 + 1=5	7

Figure 5: Methodology Adopted in Phase II Implementing ELSE Framework



3.3 Performance analysis

The selected students are assessed before conducting Project based learning based on their average marks obtained in mid-term examinations and IA (Internal Assessments). The pre-assessment performance is accessed using equation 13 for all the courses and recorded in Table 6. Project-based learning is conducted between the duration of mid-term and end-terms examinations. The group-wise assessment is conducted twice by the course instructor in the form of viva and presentations, referred to as Faculty assessment. The end-semester marks are combined with the faculty assessment records to analyse the performance of the students' post Phase II implementation.

$$PA_{ci} = \sum_{i=1}^{n}\left(\frac{mid+IA}{total\ marks\ alloted\ for\ mid-term\ and\ IA)} * 100\right) \quad \ldots(13)$$

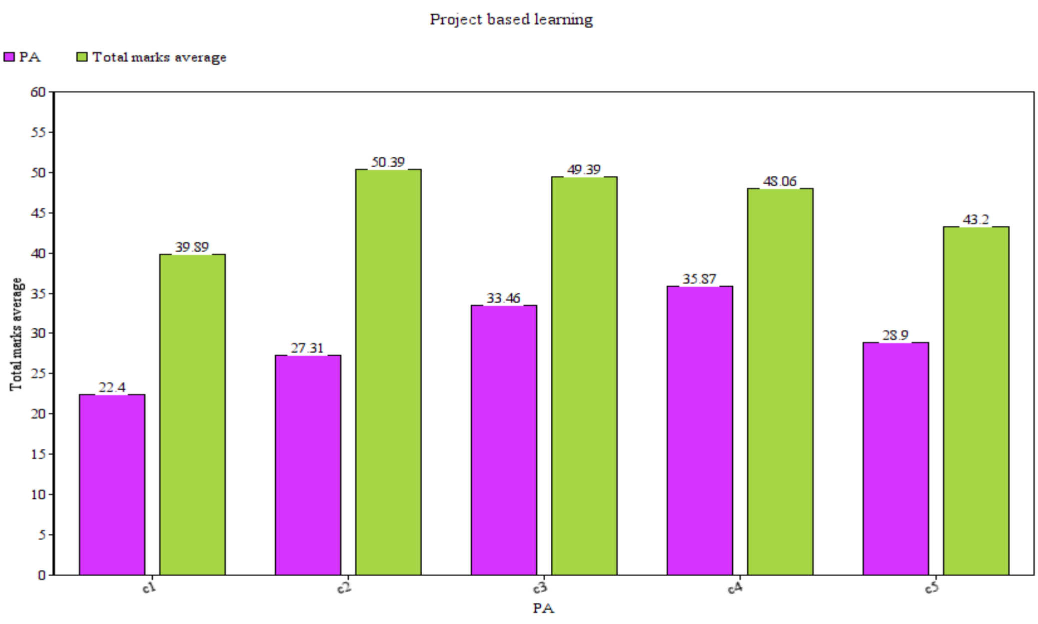
$$Total_{ci} = \frac{1}{2}(FA + ET) \quad \ldots(14)$$

$$PI_{ci} = Total_{ci} - PA_{ci} \quad \ldots(15)$$

Table 6: The Pre-assessment and PBL based Assessment for Academically Deficient Students are Recorded

		Pre- Assessment			PBL based assessment			
Course	**Year**	**Eligible students no.**	**Class Average (%)**	**PA (%)**	**Faculty assessment (%)**	**End term marks average (%)**	**Total marks average (%)**	**PI (%)**
C 1	I	7	33	22.4	55.12	24.67	39.89	**17.49**
C 2	I	8	41	27.31	67.39	33.42	50.39	**23.08**
C 3	II	7	38	33.46	61.0	37.66	49.33	**15.87**
C 4	II	7	59	35.87	57.12	39.0	48.06	**12.19**
C 5	II	8	42	28.90	54.9	31.50	43.2	**14.3**

Figure 6: The chart depicting the Performance Improvement of Academically Challenged Students Before and After Project-Based Assessments. Project Assessment (PA) scores are represented on the Y-axis for all five courses, while the X-axis corresponds to the respective courses



Where, PA is the average of pre-assessment computed using the components of mid-term marks and internal assessments conducted before the implementation of PBL-based assessments. FA is the average of the faculty assessment done using viva/quiz conducted group-wise during the PBL-based activity, ET is the end-term marks average obtained by the selected students, and PI is the improvement in the performance of the academically weak students through PBL-based learning. A significant improvement in the performance of the students is observed for all the courses, which is identified by the difference in the average of the total marks and the Pre-assessment marks using equation 15. The average growth of 17.49%, 23.08%, 15.87%, 12.19%, and 14.3% are recorded by the students in the five courses selected for implementation of the Project-based learning programme. Performance improvement chart of academically weak students before and after conducting Project-based assessments is illustrated in Figure 6.

4.0 Discussion

Education has always been one of the biggest promoters of human social interaction, culture, intelligence, and invention. It plays an essential role in the development and prosperity of a student as well as the society. Not just that, higher education associated with reputed institutions also ensures an improved standard of living and overall quality of life while simultaneously addressing major social and global problems. However, currently, seeking higher education and completing one is rather not a parallel concept. In India, as per the All India Survey on Higher Education (AISHE) report 2019-20, total enrolment in higher education has been estimated to be 38.5 million with 19.6 million males and 18.9 million females [21]. Gross Enrolment Ration (GER) in Higher Education in India is 27.1, which is calculated for the 18-23 years of age group. Out of all the Total Student Enrolment, 79.53% is acquired by undergraduate courses, and then comes Postgraduate courses with 11.19% and the rest (Ph.D., M.Phil., Diploma, PG Diploma, Certificate, and Integrated) take about remaining 9.28% [23].

The study introduces the Extra Learning Support for Excellence (ELSE) framework as a targeted solution to address learning gaps experienced by students struggling in STEM courses. Executed in two phases in 2019 and 2021, the research explores specific interventions designed to enhance academic performance. Phase I initiated a four-week pilot program for first and second-year computer science and engineering students, incorporating additional subject-specific study sessions led by experts. Remarkably, students attending over 80% of these sessions exhibited significant improvement, with an average increase of 18.83%, 16.33%, and 18.15%.

Building upon the success of Phase I, Phase II introduced project-based learning, strategically assigning academically challenged students as project leads to foster collaboration and practical skills. This shift yielded encouraging results, with students recording an average growth of 17.49%, 23.08%, 15.87%, 12.19%, and 14.3% across five key STEM courses. The study also proposes the enrichment of the ELSE framework by integrating industry-based projects and inviting industry professionals to lead sessions. This collaborative approach aims to expose students to real-world challenges, cultivate key competencies, and prepare them for the dynamic demands of the professional STEM landscape.

5.0 Conclusion

The Extra Learning Support for Excellence (ELSE) framework, introduced to assist academically challenged students in STEM, has showcased significant success in its phased implementation. Phase I, featuring additional sessions led by experts, demonstrated notable performance improvements of 18.83%, 16.33%, and 18.15% in three courses. Building on this, Phase II introduced project-based learning, with academically underperforming students as leads and peers as team members, resulting in average growth rates of 17.49%, 23.08%, 15.87%, 12.19%, and 14.3% across five courses. This research underscores the adaptability and effectiveness of ELSE, offering valuable insights for enhancing STEM education and cultivating well-rounded professionals. In conclusion, the ELSE framework, characterized by its phased approach and emphasis on project-based and industry-oriented learning, emerges as a promising strategy to effectively bridge educational gaps and cultivate well-rounded, competent STEM professionals. The study's findings underscore the potential of targeted interventions to address the challenges faced by academically struggling students in STEM education, positioning the ELSE framework as a valuable contribution to the ongoing discourse on innovative educational strategies.

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