Parallel learning reinforcement

-A Case Study.

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***Abstract*— Even though Mathematics, the queen of all sciences, is necessary for the engineers to master, their basic knowledge in mathematics, before taking the first year course is crucial. There is an urgent need for strengthening the students' fundamentals in mathematics, especially that of the fresh entrants into the engineering course. A novel methodology consisting of identifying those students with poor comprehension, coaching them during extra hours along with the regular course, improving their caliber and evaluating their performance to quantify the success of the process was carried out successfully in the department of mathematics, BMS College of Engineering. The result of the student's survey is discussed in this paper.**

***Index Terms*—parallel learning, diagnostic test, remedial class**

I. Introduction

Mathematics as a subject is indispensable in the development of any nation with respect to science and technology. According to National Education Policy 1986 in India [1], mathematics should be visualized as the vehicle to train a student to think, reason, analyze and articulate logically.

Our college attracts quality students with heterogeneous background from India and overseas, no doubt, but their skill sets can be described, at best as non-uniform, wide and varied. Their basic knowledge of subjects, problem solving skill, application and aptitude to mathematics and allied engineering fields are different. A typical classroom consisting of sixty students has half of the population as brilliant and motivated lot, but the same does not hold good for the other half. These students are less focused and less endowed with mathematical skills. Attending college, especially an engineering school, requires considerable personal adjustment for many students.

Even though the students of same branch have been grouped to form a section, it becomes a challenge for any teacher to address every one of them and it is also possible to claim that a large number of unprepared students may demoralize faculty [2]. The nagging doubt in every teacher's mind is regarding whom to cater to, the brightest, the average or the weakest of the lot. It is imperative that weaker students are identified at the beginning of the term and measures be taken to strengthen their foundation. Remediation is an opportunity to provide additional support to these students who still do not understand key concepts in spite of classroom support.

This paper details the pedagogical approach that engages slow learners towards desirable outcomes.

II. Methodology

There are about one thousand two hundred students taking up the introductory engineering mathematics course in the first semester. The challenge at hand is to

- Catch the slow learners early,
- Let them be aware of their shortcomings,
- Motivate and coach them to score better,
- Assess their learning outcome.

The pilot project on remediation was designed based on the above factors. As soon as the term started, the diagnostic test was given. The fundamental knowledge they require in trigonometry, differential equation, differential and integral calculus was envisaged and the question paper was set.

The under performers in every section were counseled to enroll in remedial class. A team of dedicated faculty was put in charge of the remediation. One faculty for every 25 to 30 students enthusiastically imparted skills to the students in the remedial class. Ten remedial classes were run in parallel to the regular classes in the first month. The students understood the acute need of strengthening their basics and enthusiastically took the remedial classes.

After the conduction of remedial program, the students were assessed once again and their improvement gauged. A survey too was conducted by random sampling technique and the outcome of the remediation was deduced.

A. Diagonstic Test

Mathematics diagnostic test enables the teachers to learn about the students' mathematical skills and areas of strength and weakness. The test attempts to "diagnose" and not just "report." The test probes students' mathematical skills

such as algebraic expressions and fractions, manipulating roots and exponents, factoring and expanding polynomials in trigonometry, differential equations, differential calculus and integral calculus. Eight different sets of question papers with the same difficulty level were given to students of every section to maintain fairness. Duration of the test was sixty minutes.

Each section was assigned a faculty who valued the papers. Out of 988 students who took the diagnostic test, the number of students who scored less than forty percent was identified as 220 and the percentage of failure stood at 22%. Every teacher evaluated the students' understanding level and measured the prerequisites which the student has to master before his entry into the graduation course. The test provided teachers with additional information on how to help an individual student.

B. Remediation

The purpose of remedial course is to provide academically under-prepared students with the skills they need to succeed in their graduation. Students struggling in the class room may also experience an attached stigma of not being as "smart" or "college-ready" as their peers, potentially leading to lower self-esteem, higher frustration, and higher drop-out rates. The aim is to bridge any gaps between students' knowledge and requirements for their graduation course. One can argue that unprepared students should not have allowed having access to further their course, but these students have traditional entry qualifications. There is a wide literature available on the effective impact [3, 4] and the non-effectiveness of remedial classes [5], but these remedial classes will yield definite student outcomes with the class room community developed by the efficient faculty who are professionally trained to change their teaching methods in response to the diagnostic test results.

With a vision to foster excellence in mathematics among the engineering students, these classes were offered free of cost to the students under the TEQIP- II program which remunerates the faculties offering the classes. Technical Education Quality Improvement Programme (TEQIP) was envisaged in 2003 as a long term programme of about 10-12 years duration to be implemented in three phases for transformation of the Technical Education System.

The remedial classes, ideally, have the following functions for the weak students:

1. enhancing understanding of mathematics concepts,
2. practicing the topic taught,
3. improving problem-solving skills,
4. preparing for test and examination,
5. assessing learning from mistakes, and
6. Extension of mathematical knowledge to engineering problems.

A simple and effective method, having the following five phases was agreed upon by the team of faculty who opted to teach the weaker students:

i) Removal of mathematical Phobia
ii) Developing a homogenous classroom community
iii) Reading and understanding problem
iv) Organizing strategy and solving problem
v) Confirmation of the answer and process

Each phase involved a different combination of the five mathematical skills and different cognitive abilities. The cognitive abilities of learning were limited to the ability to focus, to make perceptions, to use logic, to memorize and to recall. [6]

Smaller class strength paved way for giving attention to individualistic needs and better grasping of trigonometry, differential and integral calculus by these fresh entrants. Slow learners were benefitted as the learning pace was comfortable for them.

The following benefits were obviously felt by the learners with the parallel teaching approach:

Clarity: Smaller class strength paved way for giving attention to individualistic needs and better grasping of logical and problem solving skill by these fresh entrants.

Improved Pace: Learners with slow pace, having difficulty in problem solving, were given repetitive training till they could apply it with confidence. They were benefitted as the learning pace was comfortable for them. Students were encouraged with the motto," persuasion without force."

Avoidance of errors: Mistakes often made by students and the dos and don'ts are clearly spelt out in the class so that they need not have to learn the hard way.

C: Assessment

The impact of the remedial classes was assessed by a post-remediation test. Similar question paper as that of the diagnostic test with logical reasoning, problem solving, computational talent, application and formula retention was set. A random sample containing the marks scored by 20 students was analyzed.

D: Survey

A student survey is a valuable help to benchmark any teaching learning program. A case study approach was adopted in this survey.

Scope: A random sampling technique was used among twenty randomly picked students out of a population of 220 students who took the remedial class. The purpose of remedial education in most college systems is to provide under-prepared students, the skills necessary to complete and succeed in college. The questionnaire was designed to analyze not just to get their feedback about math remediation but also to find the scope of application of remedial classes for other subjects. The time chosen to conduct the survey was after the remedial classes were finished, to quantify its success.

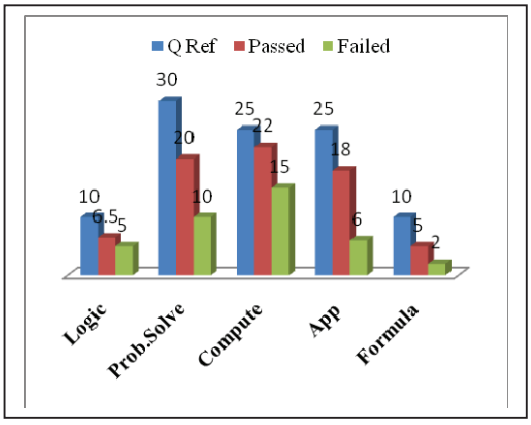
Collection of data: Their opinion about the new pedagogy was collected by means of questionnaires containing eight

questions. Their response for the following points was sought and was documented.

1. Prior knowledge of students' caliber: Marks scored in the previous year at higher secondary schools or pre- university, if known in advance, our teaching method can be tailored to suit the individuals. Determining the differences of students and their points of view about the methods of education can be useful and informative [7]. Hence, the marks acquired by students in their promotional examination at their higher secondary level were considered to gauge their fundamentals.
2. Attendance: The diagnostic test results, even though discouraging for the low scoring individual should create awareness about his lack of foundation. That would turn them as serious learners. As a motivational factor, the number of classes attended by them was enquired.
3. Usefulness: Pre test and post test marks are a measure of the usefulness of the remediation. To reinforce the fact, their opinion was sought about the revision and strengthening of their basics.
4. Aim of the institution and students: One of the most important goals for engineering educators is that their students should succeed academically. Academic accomplishment is the combined goal of the college and the student. That was a key question in our survey for which the answer was sought.
5. Quality of remedial class: **T**he relationships among students and between students and faculty. Students and faculty are interdependent hence the people's network quotient NQ is more important than intelligent quotient IQ, the measure of individual intelligence.
6. Faculty feedback: As the team of faculty wanted the feedback of slow learners about their teaching method, the survey contained a faculty feedback question.
7. Scope of remediation: If the corrective measures are to the students liking, they would like to improve in other subjects too. It was decided to find out their willingness to take up coaching in other subjects too, like in Physics, Chemistry, Computer science and biology.

III Analysis

To master mathematics, a set of five skills comprising of logical reasoning, problem solving, computation, application and retention of formula are needed.



Fig(1): Skill set of passed versus failed students in pre test.

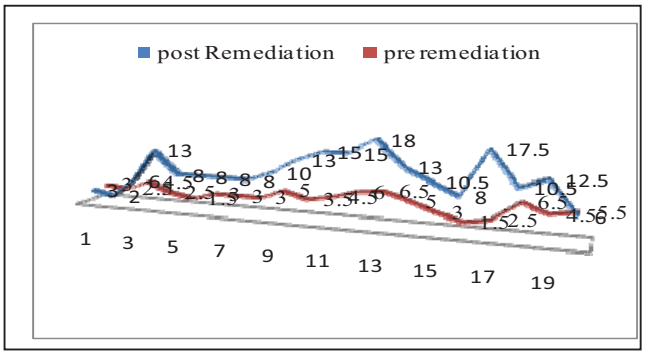
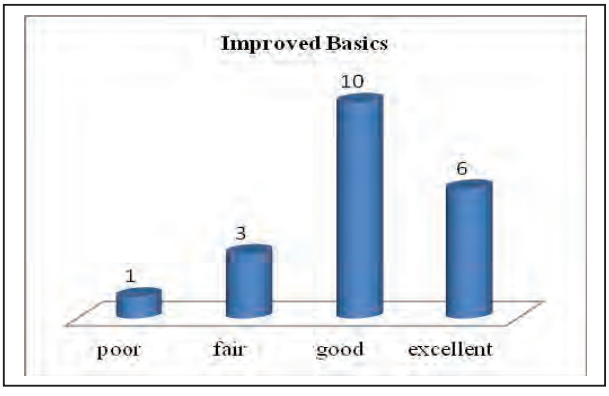


Fig.(2): Diagnostic test versus Post remediation test score.

The diagnostic test and the assessment test after the remediation contained a standard fraction of these integral parts. The skill components which the non-performers lacked are problem solving, application, and formula retention. The bar diagram in Fig. (1) depicts the skills in which the non-performers lagged behind their counterparts who passed the diagnostic test.

After the corrective action by faculty, reassessment was done to check improvement in learning and not grades. Reassessment was in a format as close to the original assessment as possible. A random sample of marks of 20 students is given as a plot above, in Fig. (2). Using their individual scores a left tailed t- test conducted on the sample test data of twenty students showed significant improvement at 64 % level, in learning skill of the students, post remediation.

Simple, lucid instruction and delivery of remedial course such as those described earlier, are the more promising trends to a favorable student outcome. From the survey, we could gather evidence for three positive effects, their enhanced fundamentals, boosted confidence levels and improved communication with the faculty. The following bar chart Fig.(3) depicts their broadened knowledge base, as felt by them.



Fig(3): Positive outcome I: Improved basics.

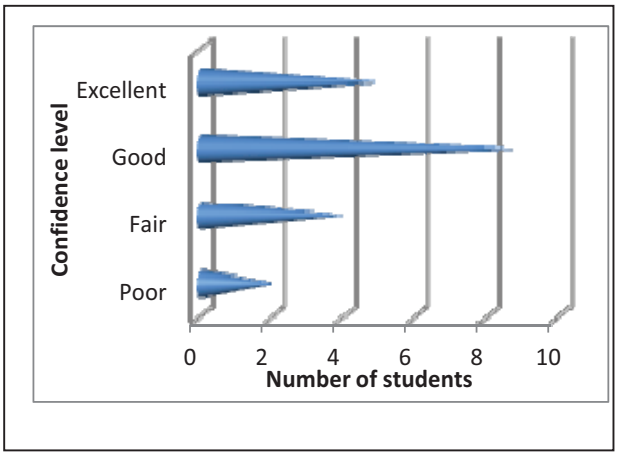


Fig.(4):Positive Outcome II: Pretty good Confidence levels.

Most engineering students are visual, sensing, inductive, and active; some of the most creative students are global; most engineering education is auditory, abstract (intuitive), deductive, passive, and sequential. These mismatches lead to poor student performance, professorial frustration and a loss to society of many potentially excellent engineers [8]. These diffident, passive learners had a dramatic transformation to self-confident, active students, which they acknowledged in their response to our confidential survey.

The motivation provided by any teacher goes a long way in improved performance of a learner. Close student-teacher interaction paved way for a better learning, it was felt. Fig. (5) is another feel good factor felt by these students. They had stayed passive without asking their doubts aloud and were diffident about voicing their weakness, in the regular class. Once the homogeneous community of remediation class was formed, they gained confidence, voiced their doubts, unaffected by classmates, showed marked improvement in their active learning.

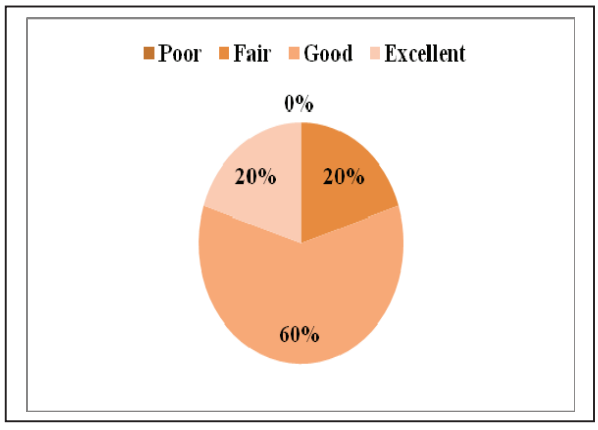


Fig. (5): Positive effect III: Improved interaction with Faculty

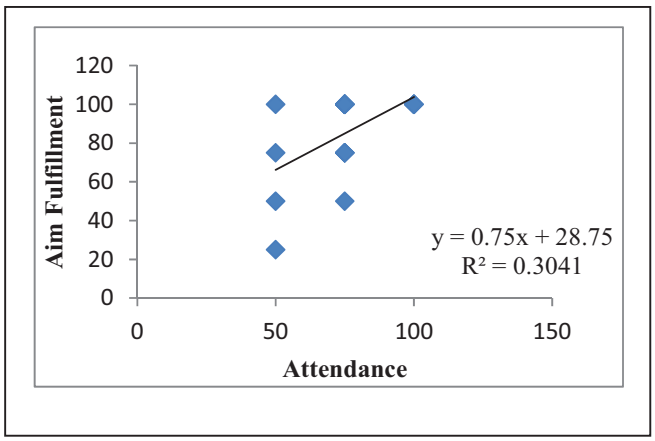


Fig. (6):Positive correlation between attendance and fulfillment

For pedagogical use, the direct positive correlation between the number of classes attended by the students and their self-efficacy was tested. There is a causative relationship between the attendance of remedial classes and their performance in the test. The attendance percentage in the remedial classes, as confessed by the students and their fulfillment on a scale of 100 was plotted and the positive correlation calculated. The coefficient of correlation is 0.55 and it can only get better when we try and mitigate the negative effects of remediation.

IV Scope

The remediation has its own negative effects as well because of which the number attending the remedial class was less than expected. We hope to improve it next time by proper counseling by involving proctors. The psychological stress due to awareness, fear of failing in course, the risk of dropping out of college and more than anything else the peer stigma of having been singled out are some issues we are yet to address. We are also enthusiastic to take remediation into greater level by integrating Physics and engineering applications into a mathematics class without loss of focus, using computer assisted models.[9]

V Conclusion

Based on the analysis of data collected, some of the positive effects, namely understanding of their weakness, choice of non-mathematics papers for electives, completion of course within 4 years, strength to overcome peer pressure are enough incentives for us to march ahead. Our fervent hope is that engaging educators and motivated learners will need to work hand in hand to stay focused and make the teaching learning process scale novel heights.

ACKNOWLEDGEMENT

We wish to thank TEQIP-II of BMSCE and the dedicated team of wonderful teachers in the department of Mathematics who made this process feasible and successful.

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