Introducing Research-based Instructional Strategies in a Rural Engineering College in India

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Introduction

Promoting broader use of research-based instructional strategies (RBIS) is a critical challenge in undergraduate engineering education [1]. Marzano et al. [2] quote work of Sanders and colleagues that analyzed more than 100,000 students across 1,000 schools to conclude that teachers are the principal factors in students' learning and also found that teachers can improve their effectiveness by using proven instructional strategies. In the recent times, many educators and researchers have proven utility of such proven strategies i.e. research-based instructional strategies (RBIS) [3, 4].

A good educational institution, therefore, must focus on the use of research-based instructional strategies (RBIS). Brent and Felder have designed the Southeastern University and College Coalition for Engineering Education (SUCCEED) model that focuses on faculty's instructional skills [5]. They have been also conducting faculty development workshops under the auspices of 'The National Effective Teaching Institute' (NETI), which have proved to be hugely successful [6]. Such development efforts need to intensify across the globe, especially because the engineering education researchers have been developing a host of instructional strategies and educators have been significantly lagging in using them[1]. In fact, Henderson and Dancy [7] argue that the improvement in engineering education lies not in finding more effective instructional strategies but in using the proven strategies.

This paper describes our attempt to introduce a few RBIS in a rural Indian engineering college. We introduced simple strategies such as using audio-visuals, think-pair-share, formative feedback, problem-based learning in lab sessions, and project-based learning in design courses in a one-day workshop. Eighty faculty members, in two batches, attended the workshop, which itself used many of the above RBIS. The participating faculty members reflected on the strategies in groups and developed their implementation plans for the subsequent semester. The first author mentored the workshop participants over the Skype calls, WhatsApp groups, and emails; while other authors conducted in-person review sessions.

At the end of the semester, we administered a survey to the faculty members, who had submitted their implementation plans, to understand their perception of the success of the plan. The institute administrators interviewed them to validate the success stories. For the faculty members, whose success stories were validated and who had taught the same course in the earlier year, we compared the SETs (Student evaluation of teachings) of the current (post-workshop) and earlier years (pre-workshop), and found statistically significant improvement. The paper discusses the workshop design and results' analysis in the next sections, and ends with concluding remarks.

Workshop Design

A discussion between the first author (an external educator) and other authors (the administrator, his deputy, and a senior professor of the institute) led to the decision of conducting an interactive workshop on the use of research-based instructional strategies for faculty members of the

institute. The institute is in a tier-3 city (a small town), is affiliated to a regional university, and is doing extremely well in academics. It has been capturing most of the top university ranks and reporting the highest percentage of passing among all the engineering colleges of the university. It employs 127 faculty members, admits around 600 students every year, and offers various courses such as Mechanical Engineering, Electronics & Telecommunication Engineering, Computer Engineering, Information Technology, Civil Engineering, and Electrical Engineering. More than 50% of the students are first-generation college learners and more than 80% students belong to farmers or laborer family i.e. have lower socio-economic background. Further, most of the students' K-12 medium of instruction is their native language and at the college, it is English.

The workshop objective was to influence teaching practices of the college faculty and the outcomes were, participating faculty should be able to explain the current engineering education scenario and the critical need of RBIS, be able to explain the RBIS covered in the workshop, and be able to apply them to create better learning experience for their students. The first author identified the strategies to be covered and designed the workshop (Figure 1).

1. The workshop started with aligning participants' expectations, and discussing objectives and outcomes of the workshop.
2. Then we covered 3H (head, heart and hand) model and the importance of RBIS. Sipos et al. have used the organizing principle of head, hands and heart [8]. Our 3H model was developed on similar lines.
3. For each RBIS, the workshop faculty provided basic information, possible configurations (changes that individuals may do while implementing the strategies), and choregraphing details (how exactly the RBIS may be used). The participants formed teams to reflect on the benefits and obstacles. This structure was based on Henderson et al.'s guide [9].
4. Reichert and Absher [10] have aptly said that it's not so much the details of what successful programs do, rather it's the care with which they do it. Therefore, we emphasized the importance of passion in deploying the RBIS.
5. We then explained the challenges in implementating any new ideas based on Rogers's work on innovation diffusion[11].
6. The particiapants chose around three strategies to use in the subsequent semester and organized department-wise discussion on the plans.
7. All the departments pressented their collective plans to the entire cohort.
8. We closed the workshop by discussing their takeaways and seeking the end-of-workshop evaluations.
9. To track progress and address roadblocks, the instituite authors followed up with the participants on a regular basis. The first author (workshop faculty) joined the discussion over the Skype calls. We also floated a whatsapp groups for faculy to discuss their expereinces. Henderson [9] has highlighted importance of such support.

The overall feedback of the workshops based on Reichheld's net promoter score concept [12] on the Likert scale was 4.5/5.

Results

Out of the eighty faculty members, who participated in two iterations of the workshop, fifty-eight (seventy-three percent) submitted plans for using RBIS (Appendix A has a sample plan). Table 1 provides the number of faculty members who chose different RBIS in their plans. Henderson et

al. [13] surveyed faculty on knowledge and use of RBIS and found that 87.1% faculty were familiar with one or more RBIS, but only 48.1% used an RBIS. Froyd et al. [1] found awareness of RBIS to be very high, but reported the use in the range of 10% to 70%, depending on characteristics of the strategy.

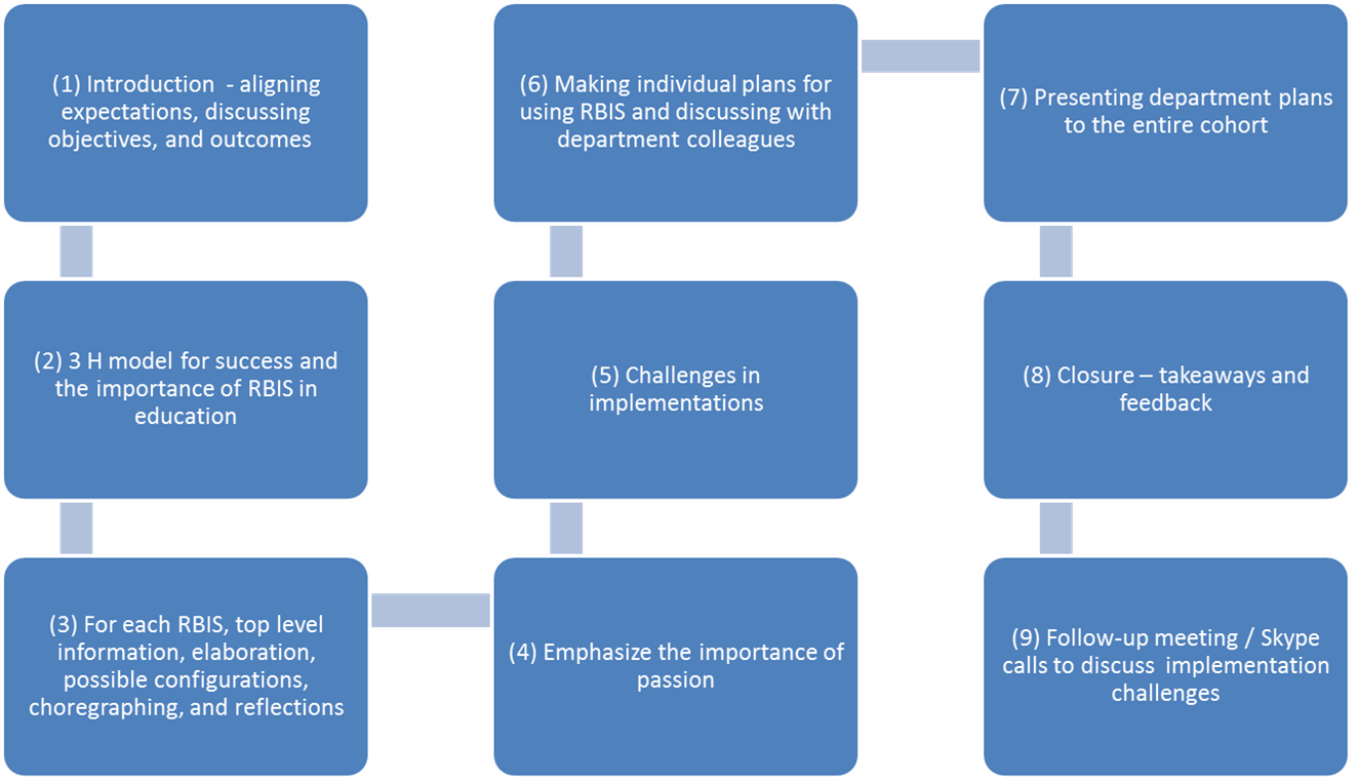

Figure 1: Workshop Design

Table 1. RBIS chosen by faculty members for implementation

RBIS	No. of Faculty who chose the RBIS	% of Faculty who chose the RBIS
Audio-Video	38	66%
Formative Feedback	26	45%
Think Pair Share	24	41%
Lab Sessions	14	24%
Project Based Learning	2	3%

Towards the end of the semester, we administered an anonymous survey to the participants who had submitted their plans, asking difficulties they faced in using their chosen RBIS, the most important thing in implementing their chosen RBIS, and their plan to implement RBIS in the next

semester. Thirty-two of the fifty-eight participants responded. The most common reported difficulty was time constraints (69%), followed by students not participating (13%), and large class-sizes (9%). The most important things in implementing RBIS were staff motivation (34%) and publicizing success stories on social media (25%). Finelli et al. have accorded the importance to faculty motivation in adopting effective teaching practices [14, 15]. All 32 faculty members, who responded to the survey were planning to implement RBIS in the next semester. We administered another survey to understand perception of faculty members on the success of implementing their plans and received responses from 41 faculty members. All of them believed that they were successful in implementing their plans.

Out of the 41 faculty members, 29 faculty members taught the same course in the earlier semester. While between the instructor and the course; the instructor has more influence on the student evaluation, the course influence cannot be ignored [16]. Therefore, we analyzed performance of only those faculty members who had taught the same course in the earlier year. The administrators interviewed the 29 faculty members and concurred with 22 faculty members' beliefs.

We compared student evaluation of teaching (SET) of those 22 faculty members with their earlier year's SETs and found statistically significant difference ($p= 0.029$). We have provided the course names, the SETs of 2015-16 and 2016-17, and the change direction (for better or worse) in table 2. We have provided scatter plot of the SETs in figure 3. While seventeen courses had better SETs, five had worse in 2016-17 as compared to 2015-16.

We used SET as the measure of the success for using the strategies. While Shvelin et al. found that student ratings do not wholly reflect actual teaching effectiveness. [17], Benton and Cashin's [18] and Richardson's [19] SET literature review indicated otherwise. Benton and Cashin concluded their review by stating that student ratings tend to be statistically reliable, valid, and relatively free from bias or the need for control, perhaps more so than any other data used for faculty evaluation. We, therefore, decided to use the SET and did not check the validity and reliability of the SET data.

Figure 2 depicts the declines in the number of faculty members from attending the workshop to the successful deployment of the RBIS. The decline from 80 attendees to 58 plans and from 58 plans to 41 self-assessments of successful deployment are not encouraging, however, are in line with the findings of other researchers as discussed earlier. The statistically significant improvement in SETs of the faculty, who had successfully deployed the learning strategies is encouraging.

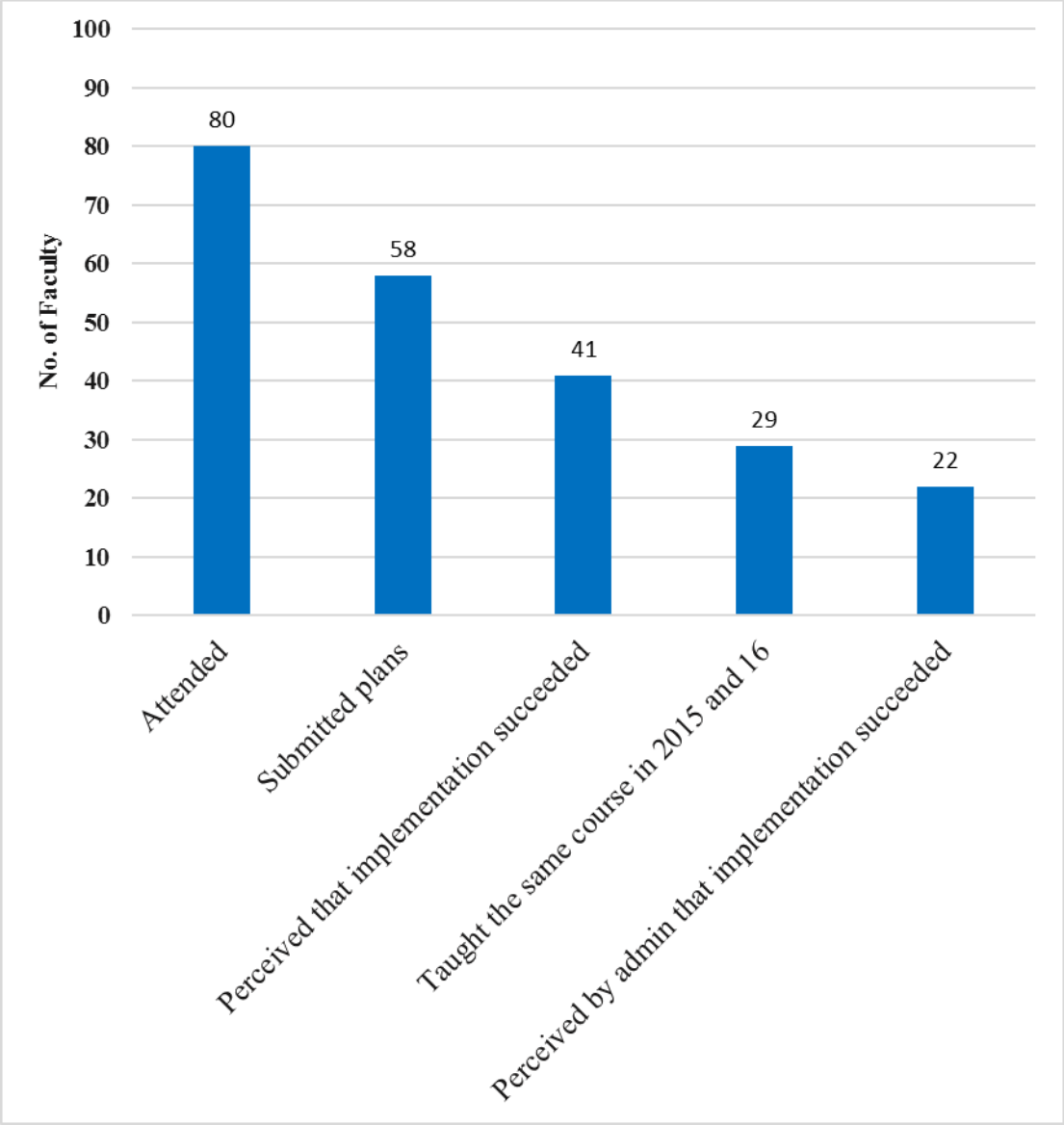

Figure 2 Participation in the workshop to successful implementations

Table 2. SET Analysis for 2015-16 and 2016-17

Course	2015-16	2016-17	SET Change
Android Programming - Computer	9.16	8.76	Worse
Android Programming - IT	8.44	9.09	Better
Communication System	7.83	9.34	Better
Component Devices & Instrumentation Technology	8.63	9.49	Better
Computer Communication	8.29	9.45	Better
Computer Network	8.18	7.76	Worse
Discrete Structure and Graph Theory	8.62	9.27	Better
Electrical Circuit and Machine	8.77	9.50	Better
Electromagnetic Engineering	9.27	9.42	Better
Electronic Circuit Design	9.15	9.23	Better
Engineering Thermodynamics	8.90	9.15	Better
Fiber Optics Communication	7.03	8.25	Better
Heat Transfer	9.04	9.35	Better
Manufacturing Engineering - I	7.50	7.75	Better
Material Science and Metallurgy	8.70	8.55	Worse
Power Electronics - Division 1	9.00	8.99	Worse
Power Electronics - Division 2	9.25	9.4	Better
Solid State Devices & Circuits-I	9.15	9.46	Better
Structure Design I – Division 1	8.47	8.87	Better
Structure Design I – Division 2	8.42	8.97	Better
Theory Machines-II	8.48	8.25	Worse
Very Large Scale Integration Design	8.20	8.72	Better
Average	**8.57**	**8.96**	

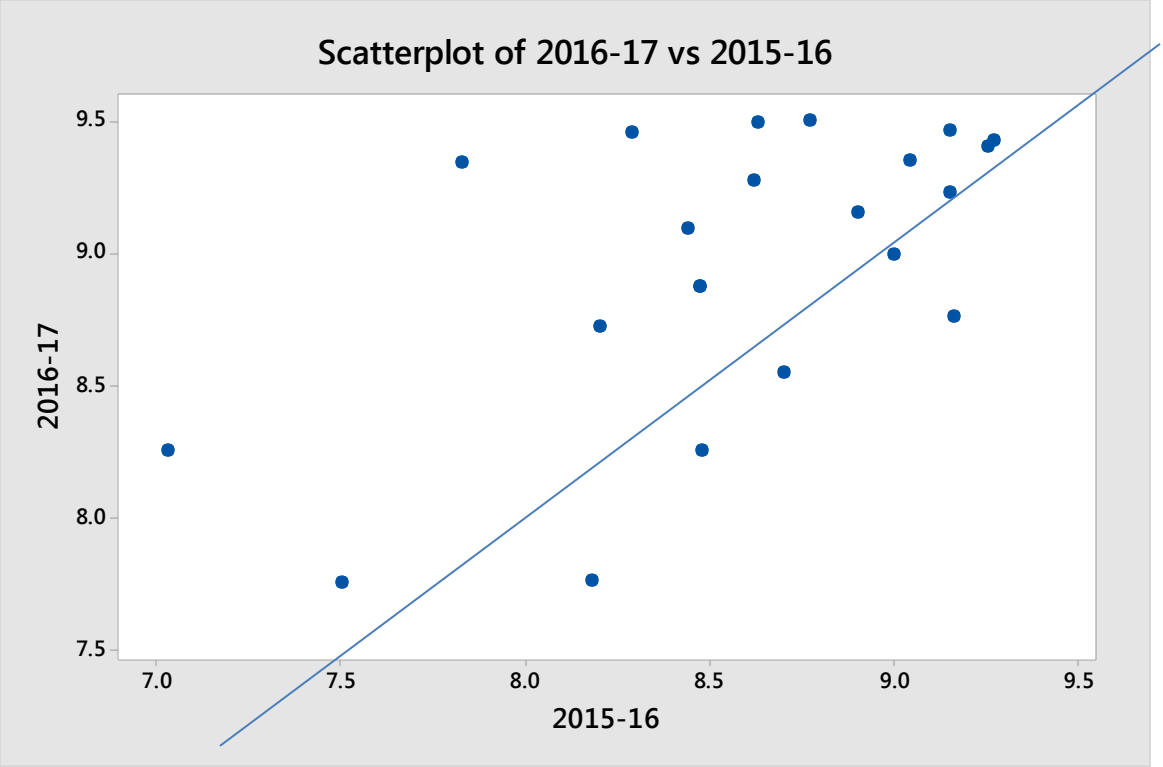

Figure 3: Scatter plot of the SET of 2015-16 and 2016-17

(The line is a no change line – the points above the line indicate positive changes and the ones below indicate negative changes)

Concluding remarks

Even though RBIS have convincingly proven their value, their adoption is far from satisfactory. This paper describes our experience of deploying RBIS at a rural but a reputable Indian engineering college. In two iterations of a daylong workshop, we introduced a few strategies to 80 faculty members. Even though most of them liked the workshop (as indicated by the overall rating of 4.5/5), only 58 out of 80 attendees (73%) submitted their plans to implement the discussed RBIS, and only 41 out of those 58 (81%) claimed successful implementations. These numbers are in the proximity of the earlier reported numbers [1, 13], and underline the challenges posed in deploying RBIS. Out of the 41, 29 faculty members had taught the same courses in the earlier year (2015 fall), with whom we discussed their implementations, and adjudged 22 implementations as successful. We compared 2015 and 2016 SETs of the 22 faculty members and found statistically significant (P=0.029) increase in the 2016 SETs.

Many faculty members perceived the use of RBIS as time consuming. Froyd et al. [1], Prince et al. [20], and Felder and Brent [3] have reported similar faculty perceptions. To save class time, Felder and Rebecca have suggested providing handouts of information-based material and not covering that in the style of traditional lectures. We implemented the technique in our workshop itself and strongly recommended participants to use it. Those solutions seemed to have only limited success.

Most of the college students are from lower socio-economic background, which hampers their communication abilities and resultant participation in classes that follow active learning strategies such as think-pair-share. We had suggested that the students with such difficulties be allowed to use their first languages. We must analyze the problem further and research better solutions.

We believe that more in-person mentoring by the workshop author could have increased the use of RBIS and the resultant teaching performance. Henderson and Dancy [21] and Henderson et al. [9] view the lack of support as a key reason for the poor use of RBIS. Brent and Felder's [5] SUCCEED model includes community of practices. We introduced a WhatsApp group for collaboration among workshop participants, but did not see enough activity on that. More efforts to stimulate the group could have been beneficial. While the institute administrators provided full support to the program, their active participation could have been another useful lever. We used the student evaluation of teaching (SET) to decide effectiveness of the use of RBIS. While the SET is regarded as the best measure of faculty's teaching performance, it cannot be the only measure [18]. We require using other measures such as peer feedback and students' learning outcomes. We plan to work on these steps in the next iteration of the experiment.

We can also analyze the result of use of different RBIS. Some strategies or some combination of strategies may be more fruitful than others. Besides, we can analyze correlation between faculty members and courses, and use of various strategies. Some faculty members' characteristics such as past performance, gender, experience in teaching the course and course characteristics such as course class size, course type (design, management, etc.), and course levels (freshmen, sophomore, etc.) may have some influence on outcomes.

We do realize the herculean task of improving the use of research-based instructional strategies among engineering faculty, in general and the Indian engineering faculty, in particular. We believe that we have made a good start that could pave the way for our success as well as help others in similar situations.

Acknowledgements

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Appendix 1:

Innovative Engineering Education

RCPIT, Shirpur, Maharashtra (India)

My RBIS Plan

Class: - SE (E & TC) Subject: - Solid State devices and circuit-I

Faculty Name and dept.	RBIS	Starting from (Probable Date)
********** (E &TC)	Use of Animation videos for explaining the working of different semiconductor devices	Aug 2016
	Lab sessions - Students will solve problems instead of doing procedure oriented experiments	Sept 2016
	Unit-wise formative feedback	Aug 2016