

Project Clinic: An approach to project mentoring

Raghuraja Adi¹, Shraddha G. Revankar², Gopalkrishna Joshi³, Sanjeev M. Kavale⁴

^{1,2}Centre for Engineering Education Research, KLE Technological University, Hubballi

³Department of Computer Science Engineering, BVBCET, Hubballi

⁴Department of Mechanical Engineering, KLE Technological University, Hubballi

¹raghu.adi@bvb.edu, ²s.revankar@bvb.edu, ³ghjoshi@bvb.edu, ⁴sanjeev_kavale@bvb.edu

Abstract: Projects form an important part of engineering curriculum. These projects offer learning contexts that enhance student learning. However, engaging all students in this work and guaranteeing the learning through various phases of work to all of them is a challenge because of the sheer number of students and their varying motivation levels. It is also observed that significant number of students loose motivation because of lack of mentoring through various stages of project work. This paper discusses about an effort by name "Project Clinic" established with an intension of doing hand holding and mentoring through all the stages of project activity.

The uniqueness of this effort is that it is done in a course project at freshman level of undergraduate engineering program. This effort is observed to be having positive impact on student learning and has resulted in significant learning for faculty members as well.

Keywords: Project Clinic, freshman, student learning, motivation, mentoring.

1. Introduction

The goal of actively involving students in learning tasks can be achieved by adopting student-centered approaches (Richard and Rebecca., 2005). Active learning, experiential learning and project based learning are a few of the widely practiced pedagogies in Engineering Education (Karlet al., 2005; Nichola., 2014; Ruth., 2010; Alan and Robin., 2013; Anders., 2013). These pedagogic practices are widely practiced student-centered learning approaches. It is observed that projects result in better learning for students as students find a learning context and motivation (Ruth., 2010; Anders., 2013). Learning from these experiences, KLE Technological University, Hubballi has introduced experiential learning in its curriculum practiced through different types of projects from course project to capstone project. This paper shares the experience of implementing course projects in a course designed for freshman students which is titled "Engineering Exploration (15ECRP101)". This course aims at introducing first year students of Undergraduate Engineering program to essentials of engineering Profession including problem solving, design thinking and multi-disciplinary approach to problem solving. A study of course projects done during the first cycle of delivery done in odd semester of 2015-2016 revealed the following:

- 1) The projects done were at different stages of completion during the final review
- 2) The quality of projects had huge variation across teams of students.

Raghuraja Adi

Centre for Engineering Education Research,
KLE Technological University, Hubballi
raghu.adi@bvb.edu

A few of the reasons for poor quality of projects may be listed as below:

- 1) Sustaining student motivation through all the phases of project: Students at certain stages of development of project find difficult to find the solution for the problem they face by themselves, and even find hard to establish the priorities between the different subjects participating in projects (Rui., 2007). Due to lack of mentoring at different stages of project they end up compromising with the quality (Taajamaa., 2013). It is observed that most of the projects of today are multidisciplinary in nature, this emphasizes the need of multidisciplinary skills for achieving the good quality projects (Fletcher and Przirembel., 1971).
- 2) Inadequate student mentoring by faculty: Students need mentoring throughout the project period. Availability of faculty members of mentoring beyond the class hours is one of the reasons and it requires scheduling of faculty time of mentoring (Taajamaa., 2013). Further, lack of skills among individual teacher to mentor a multi-disciplinary project is another reason. This requires formation of action-oriented faculty team capable of working together for mentoring multidisciplinary projects (Jinny et al., 2014). It is also stated that lack of coordination in faculty team has become a serious problem to achieve the purpose (Julie and David., 2003; Rui et al., 2007).
- 3) Lack of skills among students demanded by the project to complete it successfully.
- 4) Large number of students to be handled, more than 500.

This paper discusses the experience of addressing these issues through an intervention called "Project Clinic". The next section of the paper discusses about effort put by academia to solve similar problems elsewhere.

There are a number of initiatives taken by academic community to address the challenges listed in the previous section. University at Buffalo, Department of electrical engineering, initiated a plan where faculty members from different disciplines shared their experiences about their field to the students to give multi-disciplinary perspectives of engineering (Taajamaa et al., 2013). Plymouth University has identified some challenges and also provided potential solutions regarding selection of

teachers for mentoring the student projects, it summarizes:

- 1) Teachers equipped with knowledge and experience in multi disciplinary work, trained teachers in project based learning should be chosen.
- 2) Time for staff to trial and evaluate and reflect project based learning supported by pedagogical experts.

Self-directed study is a big part of a student's responsibility and after the student has engaged in self-directed study, they must collaborate with peers and teachers in a problem resolution stage (Chandrasekaran et al., 2012). Project Based Learning is perceived to be a student centered approach to learning (Chandrasekaran et al., 2012). It is observed that, the cooperation between lecturers and students stemmed in great results obtained by students on the projects (Rui et al., 2007). To support realization of multi disciplinary capstone project from other schools, College of Engineering at Georgia Tech collaboratively launched an internal project to create an online portal, which assists the efficient communication between faculty and students (Amit and Sarvagya.,) .College of Engineering at Purdue University initiated a program called "EPICS"(Engineering Projects in Community Service) e)to accomplish the necessities of undergraduate students and society. Here they believed that by offering students context of engineering design ,a multidisciplinary team experience, personalized mentoring would ensure students involvement in engineering project experience (Edward et al., 2004).

The experiment of bringing in professional services from outside the academic system to improve the quality of mentoring senior capstone projects has resulted in students developing better appreciation of design methodology and develop expertise in engineering analysis and problem solving skills (Chaomin Luo, XindeLi et al,2015). Another experiment done at UTAM in freshman level where in mentors were chosen from different specialisations has resulted in the following benefits to students:

1. They developed problem solving strategies, research skills, and a sense of self-efficacy
2. Students appreciated the contributions of all disciplines of engineering.

- Students were excited and motivated about a career in engineering

Besides this, mentors were challenged to think creatively and guide students to do the same. And teaching freshman about engineering design forced mentors to understand it better themselves (Ms. Lacey Jane Bodnaretal.) Similar efforts of multi disciplinary team projects mentoring, drawing mentors from different faculty, at freshman level done at Engineering Learning Centre of Kansas State University has seen faculty members unable to give adequate mentoring time because of busy schedule in other works(Bradley A. Kramer.et al.,2002)

Based on these learning, a strategy to offer course project mentoring and technical services support to students beyond regular class hours by a group of faculty members was designed in the form of "Project Clinic". This clinic was made operational during the even semester of 2015-2016. Through this activity we have tried to address the following research questions:

- Whether providing support in all phases of project development enhances completion chances of projects in time and project quality?
- Whether multi-disciplinary teams of faculty members for project mentoring has positive impact on project execution?
- Whether working in multi-disciplinary teams increase faculty learning and skills?

2. Project Clinic

This section describes the process of setting up Project Clinic, operationalising it.

2.1 Project Clinic : Planning

Based on the observations and the experience of mentoring course projects the need for making faculty members available for course project mentoring was identified. Accordingly a set of objectives were identified for the Project Clinic:

- To provide project mentoring to students of Engineering Exploration course during all the phases of project from the beginning.
- To offer project mentoring to students outside the regular contact hours of class.
- To provide testing and debugging support to students

- To study the commonly encountered difficulties and build a FAQ

2.2 Project Clinic :Execution

The course projects were multidisciplinary in nature thus requiring knowledge and skills of mechanical and electronics engineering along with programming. Hence it was decided to offer mentoring support through a group of faculty members departing from conventional approach of single faculty member offering mentoring support to an individual project team. Accordingly mentoring teams consisting of members from multiple

Table.1 Schedule for Course Project

Phases		Deadline
1.a	Develop a problem statement.	10-03-2016 midnight
1.b	Develop Design Considerations or Criteria	13-03-2016 midnight
1.c	Pair wise comparison chart for prioritising design criteria.	15-03-2016 midnight
2.a	Information regarding the established problem	19-03-2016 midnight
Review	March 21–23 (Week 11.A)	
3.b	4 feasible alternate solutions.	27-03-2016 midnight
4.a	Decision Matrix.	29-03-2016 midnight
4.b	Detailed design of most feasible solution	06-04-2016 midnight
Review	April 5–7 (Week 13.A)	
5.a	Implementation.	19-04-2016 midnight
5.b	Testing	20-04-2016 midnight

disciplines meeting the needs were formed. Creating an identity for Project Clinic was perceived to be another important aspect as the freshman students are in large number and are unfamiliar with the campus facilities. Therefore, a separate place easily visible and accessible was chosen. It was equipped with required resources such as computers with supporting software required for the project activity, internet availability, hardware tools, necessary documents and essentials is facilitated.

The process is well designed such that it is easily adaptable. The process followed is maintaining a file in which discussions with students are noted down

regularly by the faculty, mainly questions asked by the students during different phases of project are noted. This helps the mentors to resolve the commonly faced problems by students during their project activity. It is observed that most of the students work on their projects after the college hours; it is the peak time when students need faculty to support them in all the aspects of issues regarding projects. Hence focusing on this aspect, it is required to schedule the operating time of clinic after college hours. Classroom announcements are the means for exposure of Project Clinic to the students and schedule for faculty are informed through e-mails and regular meetings.

Log book and project document templates formed the documentation part of Project Clinic. The purpose of maintaining log book is to monitor student traffic and record the problems faced by the students during different phases of project development. The faculty are assigned with certain tasks like troubleshooting, clearing student doubts with respect to documentation and project implementation and recording the questions or issues raised by students. This documentation is done to build the support system in the next cycle in terms of FAQ.

The clinic is designed as per the faculty perception of what students need during the project phases. To analyse it based on student's point of view feedback is a necessary tool. From the data collected through the survey any modifications to be made are considered for the upcoming semesters.

Multidisciplinary project development was implemented through Arduino environment. This required that faculty teams formed for mentoring to be having multiple skills. A team of 12 faculty members were made available to 540 students doing 132 projects. Each student team consisted of 04 students. Project Clinic was operational for four weeks from 3.b phase to 5.b phase as shown in Table.1, every day for two hours outside contact hours.

Maintaining the log book for knowledge management was a part of process. Student's difficulties were recorded in the form of questions and majority of frequently asked questions during different phases of project was one of the measures. A format for maintaining the records is as shown in the Table.2

3. How did "Project Clinic" Work?

An effort to understand the impact of Project Clinic was done through knowing how its operations were perceived by students through structured survey done using Google forms. Focus group discussions were also conducted, the two methods adopted in order to collect qualitative data.

Project Mentoring made available to students through Project Clinic, in the form of faculty members drawn from different specialisations resulted in maintaining the constant motivation levels among the

Table2: Daily Report for monitoring Student traffic and reporting FAQ's

Sl. No	Question asked by student	Recorded by
1		
2		

students during different phases of project. Failure is observed to be one of the reasons for loss of motivation. But Project Clinic offered an opportunity for students to seek mentoring, learn from their failures and proceed further. As shown in Figure.1 it is observed that most of the students have failed more than once, yet they were successful in completing the project. Further, since students found support in all the phases of their work, 96% of projects were completed as shown in the Figure.2. Here, completion refers to meeting at least 80% of the stated objectives.

Another survey was conducted to study the students' perception of Project Clinic operations and its impact on them. 91% of the students found that Project Clinic was helpful to them during their course project, as shown in Figure. 3. A study of student traffic visiting Project Clinic was done as part of this work. The number of students' teams visiting Project Clinic during different phases of their project is shown in Figure.4. Flat portions touching X- axis indicate other activities on Campus. It can be observed that there is a regular use of Project Clinic services by students during all the phases even though it is found to be high

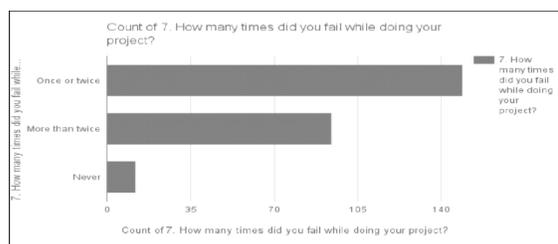


Figure. 1 Survey Result on "Motivational level"

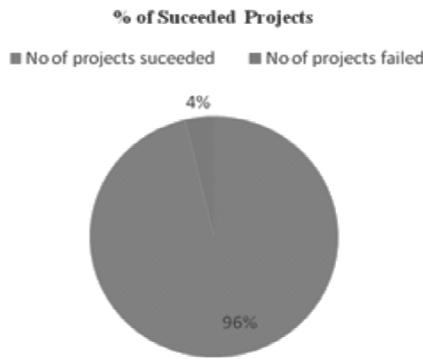


Figure. 2 Percentage of succeeded projects

during the implementation phase. It is the observation of the authors also that a planned approach doing project was followed by students instead of last minute rushing through. It is observed that the involvement of students in their project works increased as they progressed through the phases of their project. This may be related to the number of questions asked by the students during different phases of their work as shown in Figure.5.

Figure.3 Was Project Clinic Was Helpful To You?

Figure.4 Student traffic analysis

Figure. 5 Analysis of services provided in Clinic during different project phase

A focus group discussion with students was conducted. A total of 16 students randomly selected from 08 divisions were invited to participate in the discussion. 14 students participated in the discussion.

Was Project Clinic helpful to you?

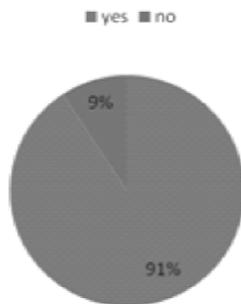


Figure. 3 Was Project Clinic Was Helpful To You?

Students were asked to share their opinion regarding

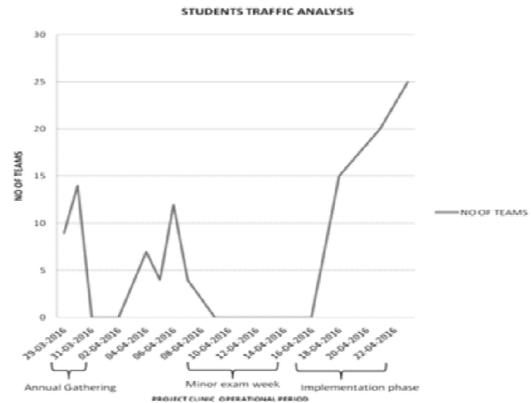


Figure. 4 Student traffic analysis



Figure. 5 Analysis of services provided in Clinic during different project phase

Project Clinic services. "Troubleshooting helped us", "teachers were always available and gave the best advices which helped us a lot", "Operating time of clinic was appropriate", "If there was no clinic we would end up copying some others project idea", "Project Clinic-Plan B", these were the points noted during discussions. The discussions summarised that Project Clinic played a vital role in completion of projects in time.

The approach of faculty members from different disciplines involving themselves in project mentoring as a team was a unique experiment for the authors to involve and observe. A study of impact of such a team effort was done through a survey conducted for the faculty members involved in Project Clinic design and implementation. The survey was conducted among the faculty team to study the enhanced learning and skills while being apart to multi disciplinary team. The survey contained five questions and there spones were to be marked on Likertscale (Strongly agree, Agree, I don't know, disagree, strongly disagree). We

can observe improvement in project mentoring capabilities among all the faculty members through their involvement in this course and Project Clinic as many of them felt they did not possess project mentoring skills before joining this activity(Figure. 6 and Figure. 7). All the faculty members feel that working in multi-disciplinary teams has helped them develop better understanding of engineering concepts (Figure 8) which was also evident in the discussions during weekly faculty meetings. This was also seen to be having its impact during session delivery all through the semester. The course on "Engineering Exploration" was designed with "Engineering Design" as its heart. And many faculty members in the team did not have adequate knowledge of "Engineering Design" except the ones from Mechanical Engineering discipline. Through the involvement in this course it is found to be improving and this is one of the major reasons form success of Project Clinic(Figure 9). This course has developed skills and practices which 75% of the faculty members are found to be using in other courses in their respective disciplines which is one of the major gains.

Count of 1. I had the knowledge and skills required for project mentoring before I joined Engineering Exploration course.

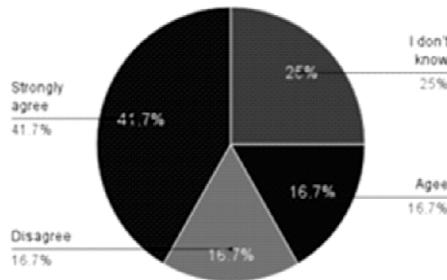


Figure. 6 I had the knowledge and skills required for project mentoring before I joined Engineering Exploration course

Count of 2. The knowledge and skills required for project mentoring has enhanced through my involvement in Engineering Exploration course.

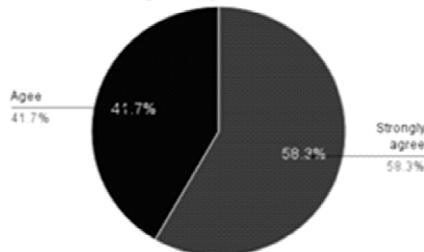


Figure. 7 The knowledge and skills required for project mentoring has enhanced through my involvement in Engineering Exploration course.

Count of 3. Working in multidisciplinary team has helped me to understand the engineering concepts and practices well

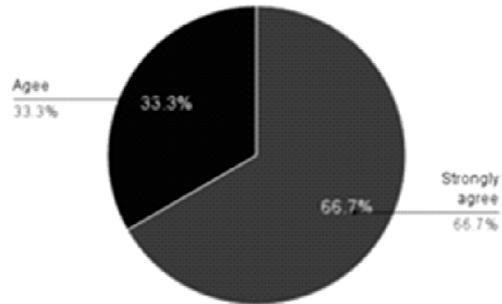


Figure. 8 Working in multidisciplinary team has helped me to understand the engineering concepts and practices well

Count of 4. My knowledge and understanding for engineering design enhanced during this course design and delivery.

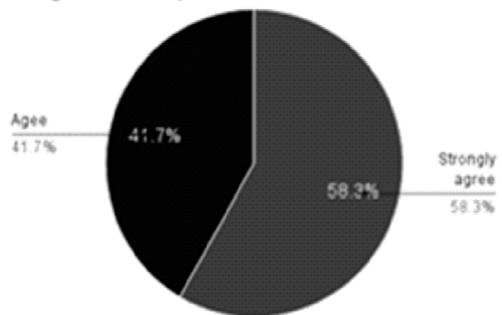


Figure.9 My knowledge and understanding for engineering design enhanced during this course design and delivery

Count of 5. I have practiced the skills gained working in multidisciplinary team while teaching other courses too.

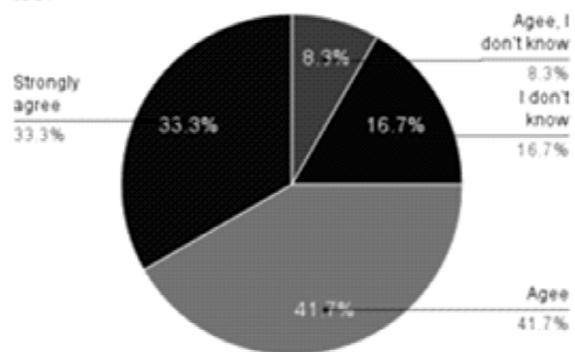


Figure.10 I have practiced the skills gained working in multidisciplinary team while teaching other courses too.

4. Conclusion

Project mentoring in multi-disciplinary teams surely increases the quality of mentoring for students there by enhancing the learning of the students. Further, it is also helping faculty members develop better understanding of certain engineering concepts through their working in multidisciplinary teams. A major gain as observed by the authors is that the learning in this course for faculty members are used in other courses thereby improving the overall quality of learning experiences created for students.

References

- Karl A. Smith, Sheri D. Sheppard, David W. Johnson, Roger T. Johnson, "Pedagogies of Engagement: Classroom-Based Practices", January 2005.
- Nichola Harmer - School of Geography, Earth and Environmental Sciences, "Project-based learning", August 2014.
- Richard M. Felder, Rebecca Brent, "Understanding Student Differences" ,Journal of Engineering Education, 94 (1), 57-72 (2005)
- S Chandrasekaran, A Stojcevski, G Littlefair, M Joordens, "Learning through Projects in Engineering Education". 2012
- Dr. Ruth Graham, "UK Approaches to Engineering Project-Based Learning", White Paper sponsored by the Bernard M. Gordon, MIT Engineering Leadership Program, 2010
- Alan Finkel, Robin King, "Innovative Approaches to Engineering Education", CAETS 2013 Budapest - June 27, 2013.
- Anders Berglund, "Two facets of Innovation in Engineering Education- The interplay of Student Learning and Curricula Design". 2013.
- L. S. Fletcher, C. E. Prziembel, "Multidisciplinary Projects: A Modern Technique in Engineering Education", Apr 1st, 8:00 AM.
- Jinny Rhee, Clifton M. Oyamoto, Leslie Speer, David W. Parent, Anuradha Basu, "A Case Study of a Co - Instructed Multidisciplinary Senior Capstone Project in Sustainability", Summer 2014.
- Julie E. Mills, David Treagust, "Engineering Education, Is Problem-Based or Project Learning the Answer", Article in Australasian Journal of Engineering Education . January 2003
- Rui M. Lima , Dinis Carvalho , Maria Assunção Flores & Natascha Van Hattum-Janssen, "A case study on project led education in engineering: students' and teachers' perceptions".
- V. Taajamaa, T. Westerlund, P. Liljeberg, T. Salakoski, "Interdisciplinary Capstone Project", 41st SEFI Conference, 16-20 September 2013, Leuven, Belgium
- Amit S. Jariwala, Sarvagya Vaish, "Design of an online portal to assist in the realization of Institute-wide Multidisciplinary Capstone Design".
- Edward J. Coyle, Leah H. Jamieson, William C. Oakes, "EPICS: Engineering Projects in Community Service", July 2004.
- Ms. Lacey Jane Bodnar, Ms. Magdalini Z. Lagoudas, Ms. Jacqueline Q. Hodge, "Ac 2012-4319: Engaging Freshman In Team Based Engineering Projects"
- Chaomin Luo, Xinde Li, Jiawen Wang, Wenbing Zhao, " Enhancement of Electrical Engineering Education by a Mentoring Scheme", 10-12 December 2015.
- Bradley A. Kramer, Jeff Tucker, Taylor Jones, Mel Beikmann, Richard Windholz, "The Engineering Learning Center: A Model For Mentored Product Innovation", November 6 - 9, 2002.