

Using interactive methods to develop project management skills in an engineering programme: Drawing on German expertise

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Abstract: - In order to address the need for project management in an engineering curriculum, the author presented interactive project management workshops to a cohort of forty electrical engineering project design students in an electrical engineering programme. The author is affiliated to a South African university and he collaborated with a Germany-based company, Training Development Consulting (TDC). Interactive campus-based training workshops were conducted by the author and Andrea von Gleichenstein of TDC at the beginning of 2015 in order to enhance essential soft skills required for project management. Subsequent to the training, the students were provided with opportunities to apply these skills in realizing a renewable energy project in a local community. The aim of the workshops was to empower students with project management skills through interactive hands-on training sessions. The focus of this study is an assessment of the extent to which students were able to apply project management skills to the design and building of an engineering artefact within the required time frame. The author supervised all the students registered for the course. The findings of the research showed that students who attended the workshops gained project management knowledge and skills and were able to transfer the knowledge and skills learned to a real world project. This paper elaborates on the effectiveness of interactive methods. The author argues that interactive training should be taught to students in project-based engineering subjects, to develop their project management skills.

Key-Words: - Essential soft skills, Interactive training, Project management, Project-based subjects, Coordination plan

1 Introduction

Many start-up companies fail within a relative short period of time, due to a lack of project management skills. A number of studies suggest that project management abilities can be developed in higher education, given the appropriate curricular and pedagogical arrangements and support. Engineering programmes have a role to play in the provision of project management and other workplace 'soft' skills. Project management plays a vital role in achieving project success.

1.1 The need for Project Management

Project management is the discipline of achieving targets and is the body of knowledge concerned with principles, techniques, and tools used in planning, control, monitoring, and review of projects [1]. Many entrepreneurs and start-up companies fail long before they can become established, due to the lack of appropriate project management skills [2]. At the 22nd AMEU Technical convention it was

noted that "our present workforce is uneducated, ill trained and poorly skilled" [3]. Salome Liebenberg, a project co-ordinator and consultant revealed that many emerging black-owned companies do not have the infrastructure and resources to market themselves and complete projects without external assistance [4]. This paper explores the influence of interactive project management training that was presented to forty electrical engineering project design students in the first semester of 2015.

1.2 Cooperation with Germany-based companies to train project management skills

First year under-graduate engineering students, receive formal soft skills training at the university. However, these under-graduate engineering students, especially electrical engineering diploma students perform poorly in project-based subjects such as Projects 2, since they lack project management and presentation skills.

A need arose to teach students in engineering programmes project management skills. This led to the establishment of a MoA between our university and two Germany based companies towards the end of 2014. One of the Germany based companies conducted the first interactive soft skills workshop, to enhance project management skills to our students. The content was integrated in the coursework, with the aim to apply it in future industry projects. Another aim was to see whether hands-on project management training improves student performance, such as meeting deadlines and achieving desired outputs. These outputs were assessed through group artefacts, project documentation, presentations, teamwork and whether a predetermined deadline was met.

1.3 The role of education in addressing the need for project management

Students struggle to deliver project outcomes on time. Project management has been considered as an academic field for planning-oriented techniques and often an application of engineering science and optimization theory. Much research has also been devoted to the search for the generic factors of project success. One of them is proper planning. Söderlund claims that the father of modern project management is Henry Gantt, who invented the Gantt chart to assist with planning [5].

Offering a purely technical education for engineers, without any project management and entrepreneurial skills in order to survive in business is not sufficient anymore. Engineers who want to start their own companies need project management and entrepreneurship education to succeed [6]. Students entering the corporate world would also be better prepared to become effective team members and managers in industry. Engineers have broader opportunities for their technology and research and need formal project management training. Stanford University and the National Collegiate Inventors and Innovators Alliance (NCIIA), Epicenter was established in 2011 to include project management and entrepreneurship into undergraduate engineering education [7]. Project management training and entrepreneurship education empowers engineering students with the knowledge and tools required to identify opportunities, realize them and meet deadlines. A recent study in reports like “The Engineer of 2020” reveals that an engineer’s education would benefit from instruction in a

broader range of career-based skills, especially if they enter the world of business. Important career-based skills are entrepreneurship and project management, since it will be required that engineering graduates develop and deliver unique goods and services to the market [8].

2 Project management and interactive training

The focus of this study is an assessment of the extent to which students were able to apply project management skills to the design and building of an engineering artefact within the required time frame. Interactive training methods were used to develop the engineering student’s project management skills.

2.1 Literature related to project management

What J. Maynard Keynes is to economics or W. Edwards Deming is to quality, Drucker is to management. He was the first to assert that workers should be treated as assets, not as liabilities [9]. Three strategies in the implementation phase of projects are associated; the project mission, management support and the project action plan [10].

2.1.1 What is Project Management?

Project management is the discipline of achieving targets by optimizing the use of resources such as time, money, material, energy, space, etc. The project manager strives to maintain the progress and productive interaction of the various parties involved by executing all or some of five project stages – initiation, planning, execution or production, monitoring or control and completion. He or she should have three main objectives namely, performance, effectiveness and cost. Constant problems of dealing with the different parties involved the project such as the customer, the project team, the public, various forums and committees and management, requires a special type of individual. The project manager is required to identify and solve any problem as soon as possible. If these problems are not resolved timeously, deviations to the project plan will result, with the consequences of late deadlines, over budgeting, penalties, etc. Jack Welch, CEO of General Electric for more than 20 years, invested heavily in his project managers, equipping them with the skills and the drive to follow suit with their own teams. In

every potential leader he looked for his “E to the fourth power” namely enormous personal energy, ability to motivate and energize others, having a competitive edge, and the skill to execute on those attributes [9].

2.1.2 Obstacles to Project Management in emerging companies

South Africa is faced with different challenges regarding project management than developed countries. The project manager faces challenges such as the diversity of team members, culture and training. One of the biggest obstacles in project management in emerging companies is non execution of the five project management steps, such as a lack of planning. An expert in organizational behaviour and leadership, Lize Booysen’s response to what she considers to be her greatest strength as a businessperson was as follows: “I have exceptional planning skills” [4]. Planning is vital to meet project deadlines. Without a clear beginning, project planning and progress can easily go astray, thus a project launch meeting is well worth the effort. Emerging companies seldom have enough resources to become sustainable and without applying proper project management skills, they seldom complete projects on time.

2.1.3 Challenges students face in project-based subjects

Students face different problems in project-based subjects than in conventional subjects. It is a challenge to students to dedicate productive time and to work jointly on their project in between other classes. When working in teams it is vital that students hold regular meetings. Not for the sake of having a meeting, but to get feedback and reflection and communicate important information such as problems, delivery times and planning risk mitigation etc. The outcome of regular meetings should always aim for the technical scope to be established, areas of performance responsibility accepted, schedules and budgets defined and a risk management plan reviewed [10]. Student team members seldom plan properly and rarely have regular team meetings. At the beginning phase of a project they either work in isolation or not at all.

2.2 Literature related to Interactive training

Jerome Bruner, an advocate of social

constructivism, promoted the fact that there are many ways to learn and many ways of encouraging different forms of learning with different ends in view, as far back as in the eighties. Interactive training is one method of achieving learning. The basic tenet of interactive training is that learning takes place by students taking responsibility of undertaking an activity to achieve an end result. With interactive project management training, students can now relate to real world project management practices such as planning and monitoring or control. Many students in higher education think course-work might be meaningless and according to them, there is no need to know everything that is being taught, particularly when no relevance is associated with a particular unit of coursework. By empowering students through meaningful activities, lecturers are able to facilitate deep learning and understanding of concepts, while at the same time enhancing their abilities in broader cross-field outcomes such as project management, entrepreneurship and innovation. One of these meaningful activities in higher education would be interactive training methods. Active learning methods modify the role of the teacher from the transmitter of information to the organizer and coordinator of the educational process. It also makes it possible to form complex competences in future professional specialties through student activities that manifest as closely as possible the content of professional work [11]. One way of applying meaningful technology use in the classroom, would be implementation of hands-on, interactive project management skills training. Interactive simulation training, for example, is recognized as an efficient and effective way for teaching and learning project management in systems for engineering and business curricula [12].

2.3 Interactive training to enhance project management skills: a conceptual framework

Experiments prove to students that what they have been taught in project management can be found in the real world. Students learn by mostly listening in theoretical courses. However, learning is more effective through listening, seeing and doing. This is also the case with interactive project management training. Students retain 25% of what they listen, 45% of what they listen and see and 70% if they use the "learning by doing" methodology. The graph in Fig.1 displays the percentages of how students learn [13].

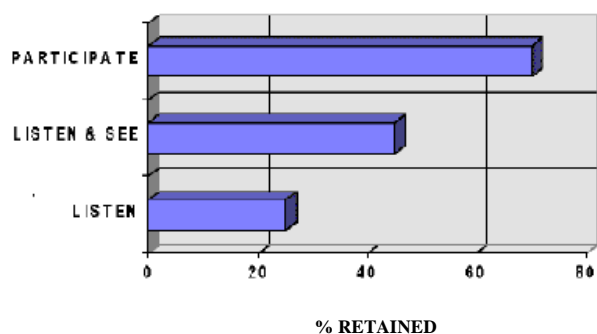


Fig.1 Retaining after what students listen to, see and participate in.

From the literature, a conceptual framework emerges that can assist in the evaluation of a project management intervention. The key criteria against which the effectiveness of interactive training for project manager should be measured include:

- Providing forums for student feedback,
- Allowing decision-making power in an area of the curriculum,
- Encouraging meaningful technology use in the classroom, and
- Involving students in "Real" Issues [14].

3 Research methodology

Practical training through a "learning by doing" paradigm is absolutely essential to educate good professionals, especially in scientific and technological fields [13]. Students attended a two day project management skills training course presented by Ms. Andrea von Gleichenstein of Training Development Consulting (TDC), seen in action in Fig.2. An interactive training method was used to cover the project management skills theory.



Fig.2 The German trainer interacting with students

The interactive training method was used in order

to enhance their competence in the area of project management and to make the course-work meaningful. The interactive workshop covered the fundamentals of project management. Topics included; the definition of a project, the characteristics of projects, the importance of communication during the different phases of a project, the compilation of coordination plans, project meetings and teamwork. The main goal was to empower students through project-based learning. An interactive hands-on training method was used in the workshops with the students to empower them with project management skills.

Another aim was that students gain knowledge on how to use cultural diversity to their advantage in teamwork in realizing a real world project. The artefact, documentation, teamwork and whether the students met the deadline would be some of the evaluation criteria. The hands-on team building exercises were thoroughly enjoyed by the students, when teams had to compete to solve a project related problem within the fastest time. See different squares, rectangles and triangles the students had to utilize in the "learning by doing" problem solving exercise in Fig.3. The methodology applied firstly used student feedback and then applied the four concepts of Adora Svitak's effectiveness of interactive training as the conceptual framework to evaluate the intervention [14].



Fig.3 Initiation of a "learning by doing" problem solving exercise

A pivotal question that had to be addressed with compelling evidence was: "How well did students learn project management?" The grades of students were compared to those of their predecessors of previous years. Feedback questionnaires completed by the students were also analysed.

4 Results

It was revealed that students who undergone the

interactive training completed their projects about a month earlier than those in the previous year. Proper planning played a pivotal role. This resulted in an increase of course grades from a 45% pass rate to 60%. The results were acquired according to the key criteria of the conceptual framework against which interactive training should be measured, namely; providing forums for student feedback, allowing decision-making power in an area of the curriculum, encouraging meaningful technology use in the classroom, and involving students in "Real" Issues.

4.1 Providing forums for student feedback

Feedback from student reflection questionnaires or course evaluations is supposed to improve lecturers' teaching [15]. With interactive training both students and lecturers get immediate feedback. The students valued the opportunities to provide feedback to the course facilitator. Such feedback ensured that the course addressed their needs. For example, some students wrote in the survey that:

"The learning workshop was the best and motivating"
 "Interactive training makes the topics interesting"
 "I found it interesting and it is useful"

This type of feedback suggests that learning took place, that students became more motivated and that the assimilation of course material is more interesting through interactive training. All, besides one of the 34 students requested a follow up workshop. This confirmed that students would like to have interactive training sessions more often. A future forum for student feedback will be part of a follow-up workshop, in order for students to give reflection of the applied theoretical steps of project management in their projects. The outcome of the survey data revealed that:

- a hundred percent of the students valued the interactive training method;
- sixty percent of the students wanted time management to be covered in the coursework;
- the interactive activities mostly enjoyed were about SMART objectives, teamwork and the project cycle; and
- students enjoyed the interaction with the German facilitator.

As part of the course curriculum the students are placed in industry for a period of twelve months, and they as well as their supervisors at work need to

give feedback in the form of logbooks, reports and questionnaires. This will then be followed up with another workshop where they reflect their experiences over that specific work integrated learning period.

4.2 Allowing decision making power in an area of the curriculum

The success of interactive training for project managers can be measured through the decision making power of students. By allowing students to manipulate, control, and modify they feel empowered and embrace their tasks [13]. Dialogue between students and teachers about teaching and learning methods in class has been recognized to be constructive at many institutions. Acknowledgement has been given to some student learning preferences that suite them [16]. The German facilitator enabled decision making power to students, by generating a questionnaire where they could choose follow-up topics for the next course, as follows:

"Which additional topics would you like to be covered in order to enhance your project management skills?"

Twenty eight students opted for "Time management" and twenty five for "Presentation skills" as topics in the follow-up project management workshop. These two topics will therefore be covered in the coursework and in the next workshop as subject matter for the students, to allow decision making power in part of the curriculum.

4.3 Encouraging meaningful technology use in the classroom

Teacher beliefs are classified as either traditional or constructivist. Traditional teaching approaches emphasize teacher explanations and repetitive practice. Constructivist approaches emphasize the construction of student knowledge through experiences with realistic problems. Lecturers with constructivist approaches encourage meaningful technology use in the classroom. Lecturers with more constructivist beliefs use technology more frequently in class. Likewise lecturers who readily integrate technology have more constructivist beliefs. If lecturers perceive that technology addresses important instructional and learning needs, they will use it more often. Lecturers who cannot see an alignment between the purpose of

technology and its goal in the classroom will not use the technology at all or rarely use it and if they do it then support traditional activities. These lecturers do not want to move outside their comfort zone [17].

Using meaningful technology in classrooms is encouraged by many universities to enhance active learning [18]. Students are much keener than teachers to use digital technology, to support their efforts as researchers, designers, and problem solvers. The integration process of allowing students to use digital devices to facilitate their collaboration with local and distant peers to solve problems has been proved to be successful [17]. When lecturers review and analyse video material taken while they were lecturing there were positive changes over time in what the teachers noticed and in how they interpreted these events [19][20]. During the duration of the workshop some of the student activities were videotaped. These activities were then replayed to students with feedback discussions afterwards for reflection. Students were also encouraged to create "WhatsApp" groups per team to communicate project status and progress to each other.

4.4 Involving Students in "Real" Issues

When students collaborate with lecturers who put themselves in the "sandbox", in the form of interactive training, student are then eager to work on their own and reinforce course concepts are then being reinforced [14]. Students enthusiastic when they experience lecturers work alongside them. Bringing the real world into the classroom is one of the most effective active learning and industry collaboration. For example, Central Washington University have struggled to successfully implement Building Information Modeling (BIM) into the curriculum. The faculty and the industry partner created an active learning BIM workshop, and provided the students with the knowledge and skills to manipulate an existing BIM. The active learning opportunities had an outcome of a BIM implementation (Martin, 2015). Afterwards students could reflect on their respective approaches.

Likewise, students attending the German coordinated project management workshop were involved with real practical issues that were relevant to their project, as mentioned in the student feedback questionnaire:

"She was practical and her games were very useful"
 "The workshop was very helpful and relevant to my project and I feel there is a lot we could learn"

At the end of the course, students were also given the opportunity to publicly present their artefacts to a broader audience, such as, peers, adjudicators, representatives of community, industry, business, and government organizations. This normally takes place at course presentation days, innovation days or exhibits at conferences.

It is also worth mentioning that although the students mentioned that the course facilitator applied "German strictness" they enjoyed interacting with her and embraced the collaboration, involvement and the feedback she gave. This is evident in the following student responses:

"I liked the way she makes her lessons fun and exciting and teaches how students should work in groups"
 "The trainer is really good on her job because she makes it easy to understand and makes learning fun"
 "She was very helpful and experienced in her field and very social with young people"
 "She was a nice person, knowing and understand what she was talking about"
 "She also made the workshop exciting and worth the while"
 "I liked the way she makes her lessons fun and exciting"
 "She made the training interesting and enjoyable"
 "interactive training makes the topics interesting"
 "She made it interesting and fun"

5 Conclusion

The aim of the workshops was met, namely to prepare students for the semester-long project and to equip them with project management skills to apply at university and later in industry. Interactive activities enhanced student's competencies in project management. This is substantiated by the outcome of the survey and the fact that for the first time all participants met the prescribed project deadline. The value of the highly skilled and professionally trained German presenter also contributed to the success of the intervention. The literature research confirmed successful interactive training to support software project management, whereas this paper's findings and data analysis confirm successful interactive learning in project management in engineering. This interactive project management teaching method certainly developed some of the student's project management abilities. This is confirmed by the evaluation of the four concepts of the intervention framework. This endorses that engineering programmes have a role to play in the facilitation of interactive project management skills training. The conceptual

framework suggested by Svitak assisted enormously in the evaluation of the project management intervention. It was rewarding to be able to draw on the German expertise, using interactive methods to develop students' project management skills.

The author's contribution in this paper is to show how students can be empowered through interactive project management training in project based subjects in electrical engineering in order to prepare them to apply appropriate project management methods while studying and to use the acquired skills when placed in industry. The contribution of the Germany based company in the hands-on project management training was invaluable. It improved the performance of this specific group of students, such as meeting deadlines and achieving desired outputs, compared to that of students of previous semesters. The students were able to apply newly acquired project management skills to the design and building of their engineering artefact within the required time frame. This indicates the success of the intervention and that transfer of knowledge and skills learned in interactive project management training took place. The focus of this paper was on an instructional strategy to help students learn project management. The strategy was successful to teach students project management, due to the fact that they completed their projects on time and the increase in their course grades compared to those in previous years.

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