Software Project Management as Team Building Intervention

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Abstract: The courses of software project management (SPM) and Software engineering (SE) are regularly taught at undergraduate degree program in computer science. Students of these programs also have to undertake projects as part of various courses during their degree program. The purpose of this research is to assess whether the software engineering or the software project management course had enhanced the cohesion among team members while undertaking a six month or a year-long project. The teaching of these two courses is considered as a team building intervention in this research. A total of 167 students returned a modified version of Group Environment Questionnaire distributed to 200 students. Off these, 81 were those who had taken the SE course and subsequently did a project before they had taken SPM course. The rest of the students (85) consisted of those who had taken SPM and had undertaken final project. The results of this paper indicates that the SPM as compared to SE as a team building intervention had a better effect on team cohesion. The paper has successfully identified a single course that can enhance the performance of students as a team in contrast to proposing all the courses taught at the undergraduate computer science degree program as intervention for better team building and team work as proposed by Hogan & Thomas, 2005.

Keywords: Software project management, software engineering, final project, group environment questionnaire, team building intervention.

INTRODUCTION

Computer Science students are trained for evocative skills that they use once they are in the field after their graduation. A useful intervention to inculcate in them these skills is a semester or a year based project which introduce these students to the experience of team working for achieving a common goal. This is normally called Project Based Learning [1, 2]. These projects demand that a student must have not only the knowledge of project's development methodologies but also the knowledge related to the management of a project. Whereas software engineering course focuses on software development, management of process models, requirement gathering, analysis, design, and testing, it does not address the issues such as management of product, project and people in such a way so as to strengthen the ability of students to achieve high mutual cohesiveness to actually complete a project with its all objectives achieved. Team cohesion is necessary for ensuring completion of any group task [3-7].

Da Silva [8] noted that a team assembled to develop a software is much like a software company that is governed by the supervisor, and managed by a team's leader; the team discusses with the supervisor the goals of the project, timelines, and deliverables [9]. Sometimes an outside company is involved [10] and the students undertake the project for them directly hence have their deadlines, list of deliverables and project's quality standards dictated by them. As for the team leader, the design of student software projects is such that one of the students leads it informally; these leaders can either be democratically selected by the students of the group or selected for them by the supervisor as imposed leader. This is useful on one hand and on the other hand it also complicates the situation which may lead to the split of the team. Even in those cases, where management related responsibilities are assigned by the supervisors after ascertaining the outlooks of the students or based on what roles they prefer [11, 12], the prevalence of lack of management skills without training in software project management are evident. Imposed leaders face the disapproval of natural leaders in the team therefore the leaders are often selected by the group such that the all roles are assigned to everyone in turn for a short period [13-15]. A leader selected by the students democratically may also find opposition quickly in case of even small misunderstandings. An inexperienced student without knowledge of management of the three basic requirement of a project i.e. the skills of software development, skills of project development and skills of management of personal [16, 17] finds it generally difficult to fulfill tasks such as assigning management and coordination roles to fellow students involved in projects and in building a cohesive team.

This paper intends to prove this very assumption – the knowledge of software, project, and management [16] strengthens the cohesiveness in a group of students. Students do not understands completely the

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complication of management of projects and the different types of responsibilities in a project until they have not gone through a prescribed training in these skills. *Formally, the purpose of the current study is to determine whether the SPM course or SE course as team-building intervention increases perceptions of cohesion.* To this end we will study the experience of those that have attended a course in software engineering and those who have attended a course in software project management and subsequently did a project as a team. The aim will be to judge whether those students who had developed a project after taking software engineering course built a more cohesive team that achieved the aims of the project or those who had developed a project after taking the software project management course. The training on these two courses will now be referred to as team building intervention for enhancing team cohesion. This is an indirect approach for team building training where coaches/facilitator work with the potential team members to design a team and its strategies to improve cohesion [18]. The progression of evolving or augmenting cohesion can be accomplished through team building, which is a method to "promote an increased sense of unity and cohesiveness and enable the team to function together more smoothly and effectively" [19]. Teambuilding interventions are intended to upsurge the group's effectiveness by improving group cohesiveness [18, 20-22].

The expectations of this research were that the students at the end of the final project who have taken SPM course will have higher acuities of cohesion than the students who did a project after SE course. Assumption is that SPM as a team building intervention in Computer Science graduate program is an effective team-building intervention for influencing cohesiveness in student teams in comparison to Software Engineering course.

A similar effort in this regard is that of Hogan & Thomas [23]. They used all the courses taught at the undergraduate degree program as intervention for team building training. They argued that "student experiences across the subjects reflect a gradual development of communication and time management skills, and an ability to work cohesively within a team – although this too is more pronounced with progression through the degree". However a major difference between their work and ours is the comparison of only two courses and checking the contribution of them towards team building and enhancement of cohesion. Comparisons often make results more expressive and

understandable [24]. In the next section we will introduce the course of Software Project Management, Cohesion and Software Engineering in the next sections before giving the methodology of the research.

Software Engineering Course

The SE course is a compulsory course of the undergraduate program in Computer Science. The aim of this course is to enhance the students' professional expertise needed to work in the software industry. The pre-requisite for this course are data structures and algorithms. Higher Education Commission Pakistan (HEC) proposes that "the objectives of this course are to study various software development models and phases of software development life cycle. The concepts of project management, change control, process management, software development and testing are introduced through hands-on Team Projects."

The topics that are ought to be covered in this course are: "Introduction to Computer-based System Engineering; Project Management; Software Specification; Requirements Engineering, System Modelling; Requirements Specifications; Software Prototyping; Software Design: Architectural Design, Object-Oriented Design, UML modelling, Function-Oriented Design, User Interface Design; Quality Assurance; Processes & Configuration Management; Introduction to advanced issues: Reusability, Patterns; Assignments and projects on various stages and deliverables of SDLC."

Once the course is complete, students are normally able to use software engineering concepts, use them while working with other software engineers and stakeholders in a software project, or undertake technical roles in software development industry and be able to document all phases of the software development process.

Software Project Management Course

This is an elective course in the undergraduate and postgraduate degree program in Computer Science. The main goal of the course is to familiarize with the main conceptions of software project management quality management and training obtained from experience of best practices. The course focuses on following topics: "it begins with the job description of a software manager and then addresses those topics germane to successful software development

management, including organizing the software development team; interfacing with other engineering organizations (systems engineering, quality assurance, configuration management, and test engineering); assessing development standards; selecting the best approach and tailoring the process model; estimating software cost and schedule; planning and documenting the plan; staffing the effort; managing software cost and schedule during development; risk engineering; and continuous process improvement. Personnel management topics, including performance evaluations, merit planning, skills building, and team building, are also covered."

Students will also be able to plan and control the quality of both products and processes within a software project. Some prerequisites are to have good knowledge of software development processes, requirement elicitations and analysis, software design, testing and UML.

Cohesion

The aim of this research is to conclude whether teaching SPM – a course, as a team-building intervention increases the perceptions of cohesion. Cohesion is normally defined as "the total field of forces which act on members to remain in a group" [25]. The definition emphasizes on the individual's attractiveness to the group. Conversely other definitions of cohesion terms it as a group's resistance to disruptive forces [26]. Newer definitions of this by researchers like Carron [6] suggests that cohesion though previously centered only on attraction to the group fails to explain cohesiveness in groups with respect to interpersonal attraction. The definition of cohesion has evolved to include aspects of individual attraction and the group's aims and purposes. Cohesion is now defined as "a dynamic process which is reflected in the tendency for a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs" [27]. Researchers have identified four main characteristics of cohesion from this definition which are multidimensionality (meaning that there are numerous factors that influence group unity), secondly, instability/dynamism (Cohesion can change over time), thirdly, it's being instrumental in keeping group united, fourthly, it induces satisfaction and positive social relationships between members [28].

Not surprisingly, teachers/mentors/coaches (or any other such roles) are concerned about augmenting the cohesion among the students working in a team because increased cohesion enhances performance and the chances of team's success [29, 30]. Cohesion and performance are interlinked as discovered by several researchers – Carron *et al*. [31] found that there is "a significant circular relationship between cohesion and performance". Others such as Slater and Sewell [32] and Gould, Guinan, Greenleaf [33] concluded the presence of same "circular relationship between cohesion and performance".

METHODOLOGY

The current study uses the course instructors as the facilitator of the intervention. The justification for this is based on analogical example from business and industry settings. There the interventionist characteristically works with the team members [34, 35] and stresses the enablement of the team members, and they are provided with greater understanding of the company's work. It is believed that the training from the facilitator or interventionist essentially motivates the team and increases their competence and self-determination [36].

Most studies on team-building did not use comparison to understand the appropriateness of one intervention which has been a matter of objection. Without the inclusion of a comparison it is hard to identify the influence of one factor or course or strategy as a "team-building intervention". The use of a comparison subject reduces the number of rival assumptions and investigation itself strengthens the investigated phenomenon. Hogan and Thomas [23] though proved that gradually students learn to communicate well and eventually learn to develop teams that lasts longer however their research didn't had any comparative subject that can highlight the veracity of their claim.

One may also raise concerns about the duration of the projects. In some universities from where the data is gathered for this research, the final project was of six months and in other universities it was of one year whereas all course-based projects were of six months. It should be noted that unit of analysis in this research is not the project itself but the course that is applied as a team-building intervention. Both software project management as well as software engineering is taught in a course of 16 weeks each. Therefore the length of the project didn't affected this research. This research is conducted at that time when the students have already gone through the interventional courses (SE

and SPM) and have already completed subsequent projects.

Building project teams while receiving the interventional training was not deemed effective since students would not have understood the effects of the intervention on every aspect of their project. Therefore those students are selected for this research who have already attended these courses in the past and did a project in the very next semester either as part of another course or as a final project.

Other researchers such as Hogan and Thomas [23] instead opted for a rather elaborate method which can be attributed as ethnography. Such methods required years to fully implement it.

To understand the impact of each of these courses on cohesion of student project's teams, we have used a modified version of Group Environment Questionnaire (GEQ) [37]. The GEQ is a general measure of cohesiveness instrument that measures "Individual attraction to group – social", "group integration – social", "individual attraction to group – task" and "group integration – task". The student projects were in the areas such as web-site development, database development, new software development, research based project, etc. The questions were:

1. I don't enjoy being a part of the social activities of this team.

2. I am not happy with the amount of time I got for working on the project itself.

3. I am not going to miss the members of this team when the project ends.

4. I am unhappy with my team's desire to finish the project.

5. Some of my best friends are on this team.

6. This team does not give me enough opportunities to improve my personal performance.

7. I enjoy other parties rather than team parties.

8. I do not like the style of work on this team.

9. For me this team is one of the most important social groups to which I belong.

10. Our team is united in trying to reach its goal for performance.

11. Members of our team would rather go out on their own than get together as a team.

12. We all take responsibility for any loss or poor performance of our team.

13. Our team rarely party together.

14. Our team members have conflicting aspirations for team's performance.

15. Our team would like to spend time together in the off season.

16. If members of our team have problems in practice everyone wants to help them so we can get back together again.

17. Members of our team do not stick together outside of project.

18. Our team members do not communicate freely about each member's responsibilities during the project.

Corren arranged these questions in a group of four; each category signifies a different aspect of cohesion among team members. These categories are: Individual attraction to the group - social (ATGS): 1, 3, 5, 7, 9, Individual Attraction to the Group - task (ATGT): 2, 4, 6, 8, Group Integration - Social (GIS): 11, 13, 15, 17, Group Integration - Task (GIT): 10, 12, 14, 16, 18.A total of 100 questionnaires for each SPM and SE course (200 in all) were given to the students of computer science in several major universities of Karachi. Out of the 100 for SPM 85 questionnaires were received. Out of the 100 for SE 81 questionnaires were received. The responses to the questions are shown in the Tables **1** and **2** at a glance. The data is analyzed through descriptive data statistics and qualitative analysis of each group of questions for both courses.

DESCRIPTIVE DATA ANALYSIS

Students were asked to answer to each question mentioned in the previous section by selecting one of the 9 available options (see Figure **1**). The options were: Strongly disagree, Quite a bit disagree, Moderately disagree, A little disagree, No opinion, A little agree, Moderately agree, Quite a bit agree, Strongly agree. Anyone who selected any form of "agree" is considered as agreeing with the question. Anyone who selected any form of "disagree" is considered as disagreeing with the question. Tables represents the descriptive statistics at a glance.

Table 1:   Summary – Post Software Engineering Data

	Attraction to Group – Social					Attraction to Group – Team				Group Integration – Social				Group Integration – Team				
	Q1	Q3	Q5	Q7	Q9	Q2	Q4	Q6	Q8	Q11	Q13	Q15	Q17	Q10	Q12	Q14	Q16	Q18
Strongly Disagree	0	1	2	1	16	1	4	1	0	1	0	13	3	14	17	4	15	3
Quite a Bit Disagree	1	3	3	5	12	2	2	2	5	4	7	12	2	17	18	5	20	2
Moderately Disagree	4	4	4	2	21	2	1	4	3	5	4	19	4	26	18	3	19	3
A Little Disagree	1	2	1	1	12	4	4	2	1	1	1	18	0	11	10	0	13	0
No Opinion	12	12	10	13	12	6	8	7	7	10	6	7	2	2	5	6	3	5
A Little agree	14	14	15	15	0	21	15	19	20	20	17	3	12	0	0	15	2	17
Moderately agree	17	19	12	13	3	16	14	15	16	10	20	2	22	4	5	19	3	18
Quite a Bit agree	12	11	16	16	3	19	15	16	13	17	13	5	14	2	3	16	5	12
Strongly agree	20	15	18	15	2	10	18	15	16	13	13	2	22	5	5	13	1	21

Table 2:   Summary – Post Software Project Management Data

	Attraction to Group - Social					Attraction to Group – Team				Group Integration – Social				Group Integration – Team				
	Q1	Q3	Q5	Q7	Q9	Q2	Q4	Q6	Q8	Q11	Q13	Q15	Q17	Q10	Q12	Q14	Q16	Q18
Strongly Disagree	35	35	6	31	7	15	20	31	20	22	14	13	29	0	3	19	3	30
Quite a Bit Disagree	7	9	0	19	8	16	19	23	30	38	19	0	23	0	0	23	0	15
Moderately Disagree	13	12	3	12	3	22	19	12	15	17	18	11	17	0	0	0	0	30
A Little Disagree	15	8	2	3	4	13	10	2	11	0	29	0	0	0	0	12	0	6
No Opinion	6	7	3	10	12	7	8	5	6	4	5	0	0	4	4	10	0	0
A Little agree	1	2	5	4	6	6	2	6	1	0	0	6	0	10	0	0	10	0
Moderately agree	5	3	12	4	19	1	2	4	1	0	0	0	12	6	18	4	9	0
Quite a Bit agree	1	1	13	1	11	3	1	2	0	0	0	33	0	36	33	5	36	4
Strongly agree	2	8	41	1	15	2	4	0	1	4	0	22	4	29	27	12	27	0

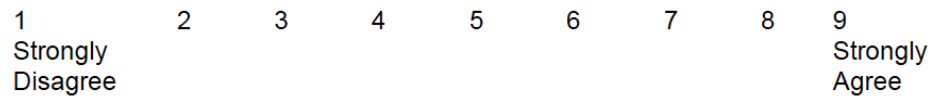| 1	2	3	4	5	6	7	8	9
Strongly Disagree								Strongly Agree

Figure 1: Available options as Likert type scale.

Attraction Towards the Group's Social Life

For those students who had their software engineering course before doing a project, when asked question 5, majority of them replied that they had their some best friends on this team. However 10 had no opinion and 10 disagreed. Even though most had their best friends working with them their opinion about question 1, an overwhelming majority agreed that they don't enjoy the group's social activities. Only 12 students had no opinion in this regard and 6 disagreed. Similarly, for the question 3, except 12 students who had no opinion and 10 disagreements all others agreed that they will not miss their co-workers later. Moreover, for the question 7, except 13 with no opinion and 9 with disagreement all agreed that they enjoy other parties. Lastly, for the question 9, only 12 had no opinion and 8 agreed, rest thought that this was not their most important social group. Overall this suggests that otherwise good friends when once entered the partnership for developing a project had no "Attraction towards the Group's social life".

On the contrary, when the same questions were asked from those who had their software project management course, following were the responses. For those students who had their software engineering course before doing a project, when question 5 is asked, most replied that they had their some best friends on this team. However 3 had no opinion and 11 said they didn't. The student's opinion about question 1was that an overwhelming majority disagreed that they don't enjoy the group's social activities. Only 6 students had no opinion in this regard and 9 agreed. Similarly, for the question 3, except 7 students who had no opinion and 14 agreeing all others disagreed that they will not miss their co-workers later. Moreover, for the question 7, except 10 who had no opinion and 10 agreeing all disagreed that they enjoy other parties. Lastly, for the question 9, only 12 had no opinion and 22 disagreeing, rest thought that this was their most important social group. Overall this suggests that when these students had taken SPM and worked on a project they had high "Attraction towards the Group's social life".

Attraction to the Group - Team

Coming back to the students who had their SE course before the project, when asked question 2, only 6 had no opinion and 9 disagreeing rest were of the opinion that they didn't had enough time for working on the project themselves. These students for the question 4, had the opinion that the team had not much motivation for finishing the project. Only 8 had no opinion and 11 had disagreement in this regard. The students when question 6, showed that they were not happy as individuals as well while working on the project with only 7 having no opinion and 9 disagreed while rest agreed with the question.

The students were also not happy with the style of the work on the project as when they were asked question 8, mostly agreed with only 7 had no opinion and 9 disagreed, rest agreed. It seems that the "Attraction to the Group - Team" was also not very high.

On the contrary, when the same question was asked from those who had their software project management course, these were the responses. When asked question 2, only 7 had no opinion and 12 agreeing rest were of the opinion that they don't agree with this. These students for the question 4, had the opinion that the team had high motivation for finishing the project. Only 8 had no opinion and 9 agreed in this regard. The students when asked question 6, showed that they were happy as individuals as well while working on the project with only 5 having no opinion and 12 agreeing while rest disagreed with the question. The students were also happy with the style of the work on the project as when they were asked question 8, mostly agreed with only 6 had no opinion and 3 agreed, rest disagreed. It seems that the "Attraction to the Group - Team" was also high.

Group Integration - Social

When students who had taken SE course were asked question 11, most of them agreed whereas 10 had no opinion and 11 disagreed. For question 13, most students agreed with 6 having no opinion and 12 disagreeing. When asked question 15, most students disagreed with 7 having no opinion and 12 agreeing. Similarly, when asked question 17, most students agreed with 2 having no opinion and 9 disagreeing. It seems that the "Group Integration - Social" was also very low in students who had taken SE course.

On the contrary, when the same questions were asked from those who had their software project management course, these were the responses. When asked question 11, most of them disagreed whereas 4 had no opinion and 4 agreed in this regard. For question 13, most students disagreed with 5 having no opinion and no one agreed to this. When asked

question 15, most students agreed with no one having no opinion and 24 disagreeing. Similarly, when asked question 17, most students disagreed, no one had no opinion and 16 agreed. It seems that the "Group Integration - Social" was very high in these students.

Group Integration - Team

When SE students were asked question 10, most of them disagreed whereas only 2 had no opinion and 11 agreeing. For the question 12, most students disagreed with 5 having no opinion and 13 agreeing. For question 14, mostly disagreed with 6 having no opinion and 12 having disagreement. When asked question 16, mostly disagreed with 3 having no opinion and 11 having an agreement. Lastly for question 18, mostly students agreed with 5 having no opinion and 8 disagreeing. It seems that the "Group Integration - Team" was also very low.

On the contrary, when the same questions were asked from those who had their software project management course, these were the responses. When asked question 10, mostly agreed whereas only 4 had no opinion none disagreed. For the question 12, most students agreed with 4 having no opinion and 3 disagreeing. For question 14, mostly disagreed with 10 having no opinion and 21 agreeing. When asked: question 16, mostly agreed with no one having no opinion and 3 having disagreement. Lastly for question 18, mostly students disagreed with none having no opinion and 4 agreeing to this. It seems that the "Group Integration - Team" was also very high in this group.

DISCUSSION

This survey was made at the end of the projects, therefore we had the possibility to ask indirectly the questions from the student team members related to whether the course affected their expectations about the team and team task. The purpose of this study was to determine whether the software engineering course or software project management course taught as a semester-long team-building intervention increased perceptions of cohesion. Specifically, it was hypothesized that students participating in a semester-long taught SPM course would have higher perceptions of cohesion while working on a project than those that had a semester-long taught SE course and worked on a project. In general, the descriptive and qualitative analyses of data supported our hypothesis.

Those that undertook a project after going through SE course reported lack of satisfaction on all four

dimensions on GEQ. The presence of best friends on the group didn't enhanced the social attraction towards the group because the project was not going well. The amount of time spent on the project was poor which affected the attraction towards the group and also diminished the charm of social activities. The team's desire to finish the project also affected personal satisfaction in working on the project; the poor work style of the team on the project hindered uniting them in reaching the goal for performance moreover no one took responsibility for any loss or poor performance. Most importantly there was a lack of togetherness or cohesion among the team members which was evident from the lack of communication among the members about each other's responsibilities on the project.

On the contrary, those that undertook SPM showed greater level of satisfaction on all four dimensions. There was greater amount of time spent on actually doing the project and there was more attraction in attending social activities with the team. The team's desire to finish the project improved greatly which also enhanced the personal satisfaction in working on the project. The work style of the team was not greatly criticized by the members and students reported more unity in reaching the goal for performance. Students also reported the act of taking responsibility for any loss or poor performance. The SPM enhanced the sense of togetherness amongst the team members which was also evident from swift flow of communication about each member's responsibilities on the team. All of these factors have great importance while doing industrial student projects [38, 39]. After completing the training, students from SPM course perceived levels of cohesion higher than those of the SE course onall four dimensions of GEQ.

Beyond these findings, a number of aspects associated with the results should also be highlighted. The findings of the current study displayed the importance of individual courses not only so much for enhancing cohesion but as a method of, at least, maintaining it for the duration of the projects. In contrast, at the end of the project conducted after SE students had a significant decrease in perceptions of cohesion on all four dimensions (ATG-T, ATG-S, GI-S) compared to those that had taken SPM and did a project. The results of the current study suggested that both individual and group orientations of cohesion are important when student's projects are to be undertaken. Training in this regard will be effective as it is found that "often the causes of software project failure are not related to in competency among the

software developers, but inadequate skills" of the team members [40, 41].

CONCLUSION

Software Project Management is a course that is often taught as an elective whereas software engineering is always taught as a mandatory course. However this current research has shown that SPM has more capability to prepare the students for building cohesive teams and work as a cohesive team. The course of SPM can be used as a guiding tool for proposing team building criterions to achieve the formation of cohesive teams.

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