

Psychographic Self-Evaluation Questionnaire for Forming Self-Managing Computer Engineering Capstone Teams*

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A Psychographic self-evaluation questionnaire is designed for assisting students in building teams for Software Engineering capstone projects. The questionnaire consists of 128 questions that are formed around the team building criteria that the author had proposed as part of his doctoral research. The items of the questionnaire are answered on a Likert type scale with varying number of choices. One hundred Computer Engineering students had participated in this research. The responses of the students on the questionnaire were recorded in specially developed software named *Psychographd*; the software had the capability to group the students into teams on the basis of the similarity of their responses to the questionnaire. After the formation of the groups, the students had worked on their capstone project for 10 months. Afterwards the cohesion among the team members was measured using the modified form of Group Environment Questionnaire. The results had shown that the student teams that were formed using Psychographic self-evaluation questionnaire (and thus the proposed criteria) had high degree of cohesion. The questionnaire together with the software (*Psychographd*) also helps tackle the orphan student problem effectively by guaranteeing at least one team for each student. The questionnaire is a result of a doctoral research. The questionnaire and the software developed on the basis of it are now in use in the department of Computer Science, Federal Urdu University of Arts, Science and Technology Karachi, Pakistan.

Keywords: psychographics; Capstone; computer engineering; team formation

1. Introduction

Small as well as large software teams are characterized by their being self-managing. Such teams are entrusted with effective and efficient performance without much disturbances and least involvement of the supervisor or manager. The software development organizations provide training to the novice software developers and computer engineers to work on self-managing teams at a high cost. The employees are normally taken in as internees or as contractual employees. Such employees are paid stipends and salaries and they get various benefits while they are only learning to practice their knowledge. Once these internees are ready to work beyond the role of an intern, they get the much rigorous tasks and high pays. However, if any software developer or computer engineer leaves the organization then it is considered a loss because of the time and money invested in him. This is the reasons why the large organizations are now focusing on team member retention; however, the smaller organizations are the worst sufferers from this employee turnover because for them, affording a team members' training is already expensive [1]. Losing a productive software developer for smaller organizations often derails them for a long period of time. Universities can play their role in providing the necessary skills to the students in not only being technically sound but also trained enough to work

as a member of self-managing teams. Capstone projects can be used to provide the students a chance to learn how to work independently as self-managing teams; too much intervention by the professors in the capstone project often end up providing less benefits to the students from what can actually be earned from this course.

Shaikh [2] proposed team building criteria for self-managing Software Engineering capstone project student teams that were pursuing Bachelor of Science in Software Engineering; 128 criterions were proposed so that the students can use them to build their capstone teams. Shaikh [2] also developed a questionnaire named Psychographic self-evaluation questionnaire that consists of 128 questions centered around the proposed criteria; each question can be answered on a Likert type scale. To automate the process of recording the answers to the questions, Shaikh [2] also developed a software named *Psychographd* that also groups the students in teams as per the similarity of the responses of the students[3]. This research investigates the effectiveness of this questionnaire (and thus the proposed criteria) – named as Psychographic self-evaluation questionnaire – in the context of Computer Engineering. The complete questionnaire can be accessed from the following URL address [4].

This current research aims to investigate if the capstone project teams of Computer Engineering (pursuing a Bachelor of Engineering degree) stu-

dents formed using the Psychographic self-evaluation questionnaire (and thus the proposed criteria [2]) will be cohesive or not. Bachelor of Science in Software Engineering is different from Bachelor of Engineering in Computer Engineering degree in the sense that “Computer Engineering” typically focuses specifically on computer hardware and software. It is an integration of computer science and electrical engineering whereas “Software Engineering/Computer Science” is an umbrella term which encompasses four major areas of computing: theory, algorithms, programming languages, and architecture [5]. An independent investigation of the effectiveness of the proposed criteria [2] and the Psychographic self-evaluation questionnaire for forming self-managing capstone teams of Computer engineering and Computer science students will be useful in quick adoption of these criteria by the students in either field.

The next section of this paper will discuss the capstone projects, modes of team selections, and self-managing teams. Later, the paper discusses the adopted methodology used for conducting this research. Data analysis, discussion of the results and the conclusion are presented too.

2. Research Background

Hoffman [6] notes that the capstone project teams are self-managing in nature because they have the complete control of their projects. They only consult about their projects with their supervisor the deadlines, evaluation of the progress of the work and the final submission. The capstone teams are characterized by several qualities. Such as:

- The capstone teams can opt to work with the industry or they may work in university without link with any external entity.
- The capstone project objectives may change in consultation with the participants.
- The capstone teams themselves set the goals of the project.
- The capstone project teams are themselves responsible for acquiring the resources for the project.
- They are also required to set clear goals of the project before starting the project. The tasks of the project are evenly distributed among the team members.

The capstone team members are inexperienced in various aspects of teamwork, management of the project as well as the technology they may be using [7]. Therefore, the students of the capstone projects need to be aware of their capabilities of collaboration, conflict management, and taskwork skills etc.[8].

Often the capstone project coordinators or professors are tasked with organizing students into teams based on a handful of inconsistent criteria. Such professor-led team formation is not satisfactory for the students [9, 10]. Another way of team formation is self-selection, which essentially dictates students to form teams themselves. Yet another way of team formation is random assignment. Interestingly, the lack of formalization in either of these three ways of team formation had made all these techniques dubious and the researchers are not sure of the effectiveness of any of them [10]. Irrespective of which mode of team formation is adopted, the capstone project teams are self-managing in nature. Self-managing teams are often also called autonomous workgroups. Such groups have certain distinct features, such as they consist of fewer people sharing a task, accepting responsibility of it completely and they share the resources to accomplish that task [12, 13]. An important and recognizing capability of such groups is the high level of autonomy over decisions to accomplish the tasks along with the allocation and scheduling of these tasks etc. by the members of that group [14].

It is unfortunate that when students are asked to form the capstone project teams, they are not provided any “basis to critic and select appropriate team members” [15]. To bridge this gap, Shaikh (2018) [2] proposed 128 team building criteria for forming Software Engineering (that were pursuing a Bachelor of Science in Software Engineering degree) capstone project teams. The results show that the criteria has positive effects on the cohesion among the team members formed using the Shaikh’s [2] proposed criteria when compared with the teams that had not used those criteria. This current research aims to investigate if the capstone project teams of Bachelor of Engineering in Computer Engineering students are formed using the Psychographic self-evaluation criteria [2] than would they be more cohesive or not.

3. Methodology

This research follows a mixed methods approach (similar to Chen and Meindl [16]) with both the descriptive quantitative analysis as well as qualitative content analysis performed on the data. One hundred students of Bachelor in Computer Engineering had participated in this research. The students were from various universities including NED University of Engineering and Technology, Karachi, Usman Institute of Technology, Karachi and Sir Syed University of Engineering and Technology, all located in Karachi. The students were approached in December 2017 even before they would start their capstone projects. The students

were dispensed the Psychographic self-evaluation questionnaire as well as an access to the accompanying software i.e. *Psychographd* [3]. Those students that had filled the questionnaire on paper were asked to feed their responses to the questionnaire into the software. The students had formed their teams as per the recommendations of the software that had proposed multiple groups for each students based on the closest matches of the responses to each question of the self-evaluation questionnaire. No cross university teams were formed; each team consisted of students of only one university.

Cohesion was measured by using the modified version of the Group Environment Questionnaire [17]. The modified GEQ was dispensed to the students in October 2018. The GEQ is an 18 item questionnaire that assesses four dimensions of cohesion: Individual Attractions to Group: Social – ATG-S; and Task – ATG-T; Group Integration – Social – GI-S and Task- GI-T. Participants answered in a 9-point Likert scale, ranging from 1 (strongly disagree) to 9 (strongly agree). Thus higher scores reflect higher perceptions of cohesion.

Table 1. Means and Standard Deviation of modified GEQ Data

	Descriptive Statistics	
	Mean	Standard Deviation
ATG-T	7.65	0.89
ATG-S	7.32	0.83
GI-T	7	1.62
GI-S	7.24	1.9
N = 100		

All students were required to fill the questionnaire individually and without the consultation of their group members. The modified GEQ was also available both in hard copy as well as in electronic form as part of *Psychographd* software [3].

4. Data Analysis

The GEQ data indicated that cohesion was clearly high (table 1) in students that had used the Psychographic self-evaluation questionnaire and the accompanying software for team formation. As evident from the Table 1, means were above 5 which is the mid-point of the 9-point Likert type scale. The measurements indicated high personal involvement as well as task involvement.

When the modified GEQ was dispensed to the students, response to questions in ATGS category (Table 2), revealed that the students not only enjoyed social activities together, had affection for each other, had or made best friends on the team, liked to go out for parties together and considered the team as the most important thing for them. Similarly, in response to the questions under the category of ATGT, students (that were teamed using the proposed criteria) displayed satisfaction for the time they spend on their project, displayed tenacity to complete the project on time, considered the team as important for improving their personal performances, and were found overall satisfied with the team's approach of undertaking the project. When the students that had formed the teams using the proposed criteria were asked GIS category questions, they were of the opinion that they liked to party together, and enjoy each other's company

Table 2. Modified GEQ Dispensed to Capstone Students Teams formed using Psychographic Self-evaluation Questionnaire (in assistance with *Psychographd*)

Modified GEQ Dispensed to Capstone Student Teams Formed Using the Psychographic Self-evaluation Questionnaire (in assistance with <i>Psychographd</i>)																		
	Individual Attraction to Group – Social					Individual 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
SD	20	39	20	53	0	36	34	26	30	25	43	0	22	1	3	21	0	30
QABD	42	33	39	26	3	37	47	47	33	39	46	5	57	0	0	35	3	44
MD	23	15	22	8	8	10	10	8	23	27	0	1	7	3	0	31	0	6
LD	0	8	0	2	0	7	2	2	11	1	0	6	0	0	0	2	0	15
NO	6	0	0	3	3	7	3	5	0	4	3	0	7	0	4	3	2	1
LA	1	0	0	2	5	0	0	6	1	0	0	11	0	0	8	0	0	0
MA	5	3	4	4	0	0	0	6	2	0	6	13	0	8	10	1	12	0
QABA	1	0	3	1	44	3	2	0	0	4	1	31	7	37	38	6	60	4
SA	2	2	12	1	37	0	2	0	0	0	1	33	0	51	37	1	23	0

1 = Strongly disagree, 2 = Quite a bit disagree, 3 = Moderately disagree, 4 = A little disagree, 5 = No opinion, 6 = A little agree, 7 = Moderately agree, 8 = Quite a bit agree, 9 = Strongly agree.

Student ID	Group with	Similar Responses
Std_1	Std_2	50
	Std_3	50
	Std_9	47
Std_1	Std_7	46
	Std_12	46
	Std_13	46
Std_1	Std_17	46
	Std_5	44
	Std_18	44

Fig. 1. Screen shot of the *Psychographd* while Proposing Multiple Possible Groups for a Student.

even during the off-season or when they are on various other courses. Moreover they were found to be organized in terms of completing their tasks, had a sense of mutual responsibility, liked to help each other on individual tasks, and had a very frequent communication among each other thus signifying that the students that were formed into teams using the proposed criteria were integrated on task activities (GIT) as well.

5. Discussion

Capstone projects are meant to provide an environment in which a group of students can practice to operate as if operating in a real organization. They must be made independent enough not only in choosing the aim and objectives of their project but also in selecting the members of their team for the project. In this regard, the literature on capstone projects for Software Engineering, and Computer Engineering field were poor enough to have no researched criteria for building self-managing teams. As evident from the previous section, the Psychographic self-evaluation questionnaire and the proposed criteria had resulted in the formation of highly cohesive teams.

Another benefit of Psychographic self-evaluation questionnaire is the control of orphan student's issue [3]. The software's algorithm has ensured that the responses of each student on the questionnaire shall result in the proposition of one or more groups recommended for all students (thus leaving no orphans). *Psychographd* is equipped with an algorithm to compare the responses of all students on the questionnaire at once; those students that have the highest number of similar responses are placed in a group. Finally multiple groups with

varying degree of similarity of student responses are proposed for each student (Fig. 1).

This research has shown that the Psychographic self-evaluation questionnaire (and thus the 128 team building criteria [2]) can be used not only in Software Engineering degree program but in Computer Engineering degree program as well without change.

6. Conclusion

Cohesion in teams is related to how satisfactorily a team is formed. For years, researchers have been studying the level of satisfaction of students when they form capstone teams using the various alternatives such as through professor advice, and relational ties. However, no serious attempt is made to identify the criteria that may assist them in building self-managed capstone teams especially in the field of Computer Engineering and Software Engineering. One may conclude that the capstone student teams are the least studied teams when it comes to team formation theories. The result is the dearth of team building criteria, KSAO frameworks or team building software for Computer and Software Engineering student teams. This current research is an effort in this regard specially for the Computer Engineering students. A Psychographic self-evaluation questionnaire is designed as part of this research that is based on 128 team building criteria that were proposed by Shaikh (2018), which has successfully assisted the Computer Engineering students in forming cohesive self-managed capstone teams. A software is also designed to automate the process of Psychographic self-evaluation by the students, the formation of teams and recording the responses of students to the questions of the ques-

tionnaire for long term data mining purposes. The results have shown that those students that had formed their capstone teams using the Psychographic self-evaluation questionnaire were more cohesive and satisfied as compared to those students that were formed using various other alternatives such as professor advised or relational ties. Another benefit of Psychographic self-evaluation questionnaire and *Psychographd* is that the use of it success-

fully controlled the orphan student problem. The current research is conducted only with the students of Computer Engineering program offered at the NED University, Sir Syed University and Usman Institute of Technology situated in Karachi. In the future, this limitation of administering the proposed questionnaire only to the university students of one city shall be addressed.

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