Psychographd: A Team Building Platform for Software Engineering Students*

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A new criteria-driven team building software is designed specifically for Computer Science or Software Engineering students. This research intends to find whether the cohesiveness in the student capstone project teams improves when the teams are built using the proposed courseware, named *Psychographd* as compared to when teams are built through random assignment. The criteria for the software are based on the findings of the doctoral thesis of the lead author. The teams are built on the basis of the results of criteria-centric self-evaluation questionnaire built into the software, which each student will have to answer so as to be considered a candidate for a team. Two hundred students had participated in this research; out of these 200, 100 students had used *Psychographd* for forming teams and the other 100 students had formed teams through random assignments. Cohesion is measured and compared in the teams that were formed using the *Psychographd* and those that had not used *Psychographd*; for measuring the cohesiveness in teams, modified Group Environment Questionnaire is used. A sharp increase in the cohesion among the team members is reported for the teams that were formed using the *Psychographd*. Some unique features of the *Psychographd* are (a) 128 research based criteria for team formation (b) elimination of the chances of occurrence of "orphan student" problem (c) multiple team alternatives for each student.

Keywords: CATME; team-maker; team building; criteria; software engineering

1. Introduction

Software engineering students need to learn to work in teams, which is unfortunately not always taught to them in the curriculum. Even though it is not taught to them still they are expected to work in teams; moreover, their performance evaluation is linked to their ability to work in teams. In every other course ranging from computer programming, requirement engineering to artificial intelligence, students are required to form teams, however, how they form the teams is largely left up to them [1]. Some software are available commercially that help students build teams on the basis of their teamwork skills; the most popular among them are the CATME and the Team-maker. Team-maker's central idea of forming teams is based on students' schedules, preferences, skill areas, and instructors' learning goal [2]. The preferences, skill areas and other such factors are set by the faculty. On the contrary, the Comprehensive Assessment of Team Member Effectiveness (CATME) is centered around the self- and peer-evaluation of team-member contributions to a team based on behaviors that the research has shown to be important for effective team functioning [2]. Though useful, however, both of these team building tools are general and not specific to any particular discipline. Their focus is more on teamwork skills only with task-work skills only referred to in general form.

The first author has designed the *Psychographd* as part of his doctoral thesis; this is a new platform for building Software Engineering capstone project teams. The web and non-web based courseware *Psychographd* collect self-evaluation data on a 128-item questionnaire from the students; this self-evaluation leads to team formation. Moreover, the courseware provides a mechanism for giving feed-back on the level of cohesion that the students had achieved whilst working on the system-proposed teams. This new software provides the ease of use, simplicity of data collection, and confidentiality. Table 1 shows a summary of the functionality along with the limitations of the Team-maker and the CATME and the later section discusses how the *Psychographd* is different from both. Moreover, data of 200 students is presented, out of which 100 students had used the *Psychographd* for forming teams. A comparison of cohesion between the teams that were formed using the *Psychographd* and those 100 students that had not used *Psychographd* is also presented. The cohesion is measured using modified form of Group Environment Questionnaire. The 128-item self-evaluation questionnaire is proposed by the first author as part of his doctoral thesis; it would be referred to as *Psychographic self-evaluation questionnaire* in this paper.

2. Existing team building courseware

Layton, Loughry, Ohland, and Rico [3] notes that, there is a substantial body of research available in psychology and in management that discusses the influencing factors that affect the success of teams;

however, such work only attribute teamwork skills as factors affecting the team success and not the taskwork skills (such as Stevens and Campions [4]). Such work cannot be generally applicable to Software Engineering students directly; this is mainly because software development is a task based activity. An indigenous system is utmost important that is developed and tested particularly for the Software Engineering students; such software should also be based on factors familiar to the field of Software Engineering. One can easily conclude "from existing research is, how members are assigned to teams has important implications for team-member outcomes and team effectiveness" [3].

Computer-aided team formation systems facilitates in using criteria for team assignment process. To facilitate the team formation using instructor-specified criteria, Bacon, Stewart, and Anderson [6] developed Team-maker which mainly collected demographic data and the roles in which team members like to work. Another software program in this regard was developed by Redmond [7]. Cavanaugh, Ellis, Layton, and Ardis [8] too developed a system that also use instructor-defined criteria for assigning students to teams. They also named their software "Team-maker." Henry [9] had identified many group formation systems described in the literature. According to him, the most highly used among them are the Team-maker and the CATME software. He notes that the Team-maker is a web-based system that the instructors can use to create groups; it uses the data from actual courses to evaluate the group formation process. Cavanaugh, Ellis, Layton, and Ardis [8]'s algorithm facilitates the team-assignment process through Internet-based interface.

Whereas Team-maker is based on instructor-led criteria, CATME courseware developed by Loughry, Ohland, and Moore [5] is based on a peer evaluation instrument conceived by Loughry, Ohland, and Moore [5]. The instrument consists of 87 items. A shorter version of it is also available that consists of 33 items. It is important to note that there are no generally accepted peer evaluation instruments available for teams. However the notable ones are: Rosenstein and Dickinson [10]'s 87-item instrument for measuring performance in eight areas, S. Taggar, and T. C. Brown [11]'s problem solving behavioral observation scale—the Team Developer—with 50 items, 4 area self-evaluation instrument by McGourty and Demeuse [12], Moran, Musselwhite and Zenger [13]'s work and Wheelan [14]'s 35-item effective member and a 40-item effective leader checklist.

A limitation of the above described systems is that none of them were developed for a particular discipline. In fact, the Team-maker and the CATME were chiefly developed with MBA students. Therefore the criteria are either demography centric (Team-maker) or teamwork skill centric (CATME). The taskwork component in the CATME essentially deals with this as sub-type of teamwork skill and has not recognized specific taskwork skills at all. There was a need to develop an area specific software for team formation, especially in Software Engineering. This gap is filled by the first author as part of his doctoral thesis.

The available courseware for team formation does not liberate either the teachers or the students to select the team members on researched criteria that covers all the important aspects of team building. Mihic and Završki, notes that the result is that "employers find the graduates lacking in teamwork, communication and other soft skills as well as in engineering thinking, engineering intuition and higher order thinking and problem solving skills"

Table 1. Functionality of CATME & Team-maker

Team-maker	CATME
1. The basic functionality of this software is to assign students to teams using instructor-defined criteria.	1. Teams are formed on the basis of five primary factors which are: contribution to the team's work, interacting with teammates, keeping team on track, expecting quality and having task related knowledge/skills/abilities.
2. Data is centered on demographic data.	2. These five factors are based on the work of Loughry, Ohland, and Moore [5].
3. The students are grouped on the basis of students' schedules, preferences, skill areas, and instructors' learning goals. The instructor decides which attributes of students are to be measured to put them in groups.	3. The survey consists of 67 items in total.
4. No prior list of attributes exists in the system, thus there is a chance of using entirely different attributes by different faculty members for building student teams.	4. The survey is general purpose and broad and is not applicable to any one particular field.
5. Team-maker assign students to teams by choosing weights for each criteria.	5. Students log in to fill active surveys and to view results.
6. Team-maker provides two web interfaces - one for instructors and one for students.	6. The software does not elaborate on taskwork skills. The category "Having task-related knowledge/skills/abilities" consists of general questions such as "Had the skills necessary to contribute to the team's work" [5]. In other words of the developers of CATME, they wanted the "instrument to be broad instead of applicable specifically for one area in particular" [5].
7. The students interface allows each student to complete the confidentiality survey.	7. The tool is susceptible to the emergence of "orphan student" problem.
8. The tool is susceptible to the emergence of "orphan student" problem.	

[15]. A team building software for student teams should provide an opportunity to the teachers and the students to form groups on the basis of either all the important teamwork and taskwork skills or any particular teamwork and taskwork skills of interest. This flexibility is missing from the existing team building software. Capstone projects also provide an opportunity to enhance the skill to work in multi-ethnic and multi-cultural environment. A team building software should be "sensitive to cultural differences" [16]. It is also observed that the team formation tools for student teams should be developed after a thorough investigation of the attributes of the students; attributes obtained from the literature on professionals cannot be applied to the student team building [17]. The new software proposed in this paper is based on the literature on engineering student teams. Lastly, all "the existing tools often fail to assign some students to groups creating a problem well known as orphan students" [18–20]. This problem too needs to be tackled specifically.

3. *Psychgraphd*: new team building platform for software engineering students

The courseware described in this research is based on the doctoral thesis of the first author which resulted in identifying 128 team building criteria; those criteria are not the subject of this paper. The criteria are based on a framework proposed in Shaikh and Ahsan [21]; that framework recognizes not only the teamwork skills but the specific taskwork skills as well, as necessary factors for building Software Engineering teams. The framework consisted of 2 major categories: Soft skills (teamwork skills) and Technical skills (taskwork skills), and 9 subcategories. Following is the functionality of the proposed software i.e., the *Psychographd*.

1. The software is primarily web-based, however by installing supporting software i.e., Dot NET framework and SQL Server, the software can be used as a desktop application as well.
2. The *Psychographd* form teams on the basis of psychographic data of individuals instead of the demographic data.
3. The software is particularly developed for Software Engineering teams. Self-evaluation instrument built into this software takes into account both the teamwork skills as well as the taskwork skills – an ability which is unique and is not part of any other team building software.
4. The software can be operated by an Administrator as well as by the students, instead of individual teachers.
5. However, an administrator is the only role that can create a university, department, degree program as well as the semester and course. He may also create a student's id. Before a student may register into the system, the administrator must have had created the university, department, degree program as well as the semester and the course.
6. A student may fill in his credentials for directly registering into the software, however, a student may not create the university, department, degree program, semester and a course.
7. Once a student is registered for a course, a semester, a degree program, and a university, he shall log in to reach his control panel.
8. Each student is required to fill in two mandatory questionnaires.
    (a) One of them is the 128-item self-evaluation questionnaire which is based on the criteria that the first author has proposed as part of his doctoral thesis. The questionnaire consist of two major section and eight subsections as shown in [21] consisting of Soft skills (interpersonal/social skills, problem solving and conflict management skills, individual self-management, personality) Technical Skills (Project management skills, task work expertise, software development processes, and work reflection skills).
    (b) The second mandatory questionnaire is the Criteria Usage Questionnaire. This questionnaire provides a student an option to select only those criteria out of 128 that he might want to judge others on.
9. As soon at least two students have filled the two mandatory questionnaires, the teams will start to form based upon matching of responses to the questions in self-evaluation questionnaire.
    (a) Student will be shown teams based on (a) all the criteria on which each student is mandatorily self-evaluated on (will be referred to as *view 1*), and (b) the teams will be shown based only on those criteria that he had selected an option '1' or '2' for, while filling the second mandatory questionnaire (will be referred to as *view 2*).
    (b) Whichever view a student may like to opt, he will be shown multiple possible team members in a group of 4, including himself. Thus, the possible teams consist of those students with whom his own responses on either all criteria of the self-evaluation questionnaire or on those criteria only that he had selected while filling the second mandatory questionnaire are closets to.
10. Finally, students may choose to fill the Group

Interpersonal/social skills

Cultural conditioning: I am culturally conditioned i.e. I can work with people from own and different background?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Strongly   Strongly
Disagree   Agree

Dependable: I never give excuses for the tasks that are my responsibility.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Strongly   Strongly
Disagree   Agree

Diligent: I don't give up on tasks such as course assignments, daily preparation for exams etc. easily.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Strongly   Strongly
Disagree   Agree

Fig. 1. Preview of 128-item Psychographic Self-evaluation Questionnaire for View 1.

Interpersonal/social skills

Cultural conditioning: I am culturally conditioned i.e. I can work with people from own and different background?

| 0 | 1 | 2 |

Low   Medium   High

Dependable: I never give excuses for the tasks that are my responsibility.

| 0 | 1 | 2 |

Low   Medium   High

Diligent: I don't give up on tasks such as course assignments, daily preparation for exams etc. easily.

| 0 | 1 | 2 |

Low   Medium   High

Fig. 2. Preview of 128-item Criteria Usage Questionnaire for View 2.

Environment Questionnaire as well once they have finished their whole projects. The students as well as administrator may download the group formation and response to self-evaluation data in Excel form (Figs. 1 and 2).

4. *Psychographd* vs. the CATME & the team-maker

The *Psychographd* software has several advantages over the Team-maker as well as the CATME. Following are few of them:

1. The software provides a research based criteria for team formation instead of leaving the selection of criteria on the teachers. This removes the chance of arbitration in the process of team formation every successive time the need for forming a team comes up. The Team-maker does not have research based criteria whereas in the CATME, the criteria are too few and incomprehensive.
2. Neither the Team-maker nor the CATME is designed specifically for Software Engineering students. The software is developed for building self-managing teams for Computer Science/ Software Engineering discipline primarily. Both the CATME and the Team-maker are general purpose team building tools.
3. Unlike the CATME tool, the criteria on which this current software is developed takes into account both the teamwork skills as well as the specific taskwork skills.
4. The data produced through this software may be used later for data mining. The software also provides the functionality to download the accumulated data stored in the software. This

functionality is missing from both the CATME and the Team-maker.
5. The software provides more than one possible teams in which a student may adjust. It is a common observation that the other team building software such as the CATME and the Team-maker provides only one possible team to each individual; that team may not necessarily have such individuals that a student may like to work with for some reasons, even though they might be a perfect match based on the criteria. Providing multiple team possibilities reduces the chance of pushing a student towards old method of team formation which is based on relational biases.
6. The software also provides an opportunity to the students to select only few criteria (using Criterion Usage Questionnaire) that they might be personally interested in while seeking team members. Since the team formation is either based on all criteria or on the selected few criteria, the students may selectively enhance the effect of few particular criteria (such as only documentation skills, Java programming skills instead of all the criteria) in their teams. This is a unique feature.
7. This new software guarantees a possible team for each and every student thus eliminating the possibility of occurrence of "orphan student" problem.
8. Unlike the CATME and the Team-maker, the student's responses to the survey questions can be viewed and downloaded as Excel file. This shall be useful for producing data for Big Data analysis.

5. Methodology

The research is carried out through mixed methodology. A total of 200 (including both male and

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

Student ID	Group with	Similar Responses
Std_1	Std_12	11
	Std_13	10
	Std_14	10
Std_1	Std_17	10
	Std_21	10
	Std_4	9
Std_1	Std_7	9
	Std_8	9
	Std_9	9

(a)　　　　　　　　　　　　　　　　(b)

Fig. 3. (a) Multiple Possible Groups for Student 1 per View 1 (b) (a) Multiple Possible Groups for Student 1 per View 2.

female) final year project students participated in the research. Out of these, 100 students were those that had formed the teams for final year projects without using the *Psychographd*. The students that had not formed the teams using the *Psychographd* had formed teams randomly. Relation bias plays an important role in such team formation. These students were passing out in December 2016, and that's when they filled the modified Group Environment Questionnaire [22] on the request of the first author. In January 2017, 100 students that had entered into their final year were asked to form groups using the *Psychographd*. These students were later asked to fill the modified Group Environment Questionnaire in November 2017. The descriptive statistics of the data obtained from both the set of students is shown in tables 2 and 3. Modified Group Environment Questionnaire is a modified form of widely used cohesion testing instrument, i.e., Group Environment Questionnaire [23]. It has been modified for different researches in the past as well [22, 24]. Through assessing the cohesion among the students, the authors want to investigate whether the use of the *Psychographd* courseware has affected the level of cohesion in

students or not. The students reside and study in Federal Urdu University Pakistan's Computer Science department and are undergraduate degree program students. The students knew each other beforehand. The students were not allowed to discuss the answers to the questions of the questionnaire. Qualitative assessment of the data backed by quantitative descriptive analysis has established the inference obtained in this research.

6. Data analysis

The teams of students for this research were formed using the software named the *Psychographd*. This software proposes multiple possible teams for each students. The students that had participated in this research had selected a possible team from multiple alternatives presented to them (see Fig. 3). Only 4 teams chose to disband their earlier selected team in which they had already started working and chose the next possible team two months after the start of the project. Their GEQ data is not treated differently, however. The data given below is organized in four groups as per the practice described by Carron, Widmeyer, and Brawley [23].

Table 2. Modified GEQ Dispensed to FYP Student Teams Formed Without Using the *Psychographd*

Modified GEQ Dispensed to FYP Students Teams Formed Without Using the *Psychographd*

	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	3	2	10	1	21	1	4	1	0	1	1	31	1	24	37	4	23	1
QABD	2	3	5	5	29	2	2	2	5	5	0	23	0	37	28	0	27	2
MD	5	4	0	2	23	2	1	4	3	2	1	23	1	25	21	3	23	2
LD	1	2	0	1	11	4	4	2	1	1	2	11	2	1	0	0	0	4
NO	2	2	0	3	0	0	0	0	0	3	2	0	2	2	1	6	3	0
LA	14	10	15	15	0	10	15	10	6	8	10	0	10	0	0	9	2	10
MA	17	27	12	5	0	25	20	15	22	17	17	0	16	4	5	9	11	25
QABA	27	35	20	35	6	37	26	30	33	22	34	2	27	2	3	36	2	27
SA	29	15	38	33	10	19	28	36	30	41	33	10	41	5	5	33	9	29

Table 3. Modified GEQ Dispensed to FYP Students Teams Formed Using the *Psychographd*

Modified GEQ Dispensed to FYP Students Teams Formed Using the *Psychographd*

	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	27	29	30	43	0	26	44	36	30	35	43	5	32	1	3	41	3	44
QABD	42	43	29	36	3	47	37	37	43	39	36	0	47	0	0	35	0	30
MD	16	15	22	10	8	17	12	8	13	17	10	1	7	3	0	11	0	15
LD	0	8	0	0	0	0	0	2	11	1	0	6	0	0	0	2	0	6
NO	6	0	0	3	3	7	3	5	0	4	3	0	7	0	4	3	0	1
LA	1	0	0	2	5	0	0	6	1	0	2	11	0	0	0	0	2	0
MA	5	3	4	4	10	0	0	4	1	0	4	13	0	18	18	1	12	0
QABA	1	0	3	1	34	3	1	2	0	0	1	41	3	37	28	1	40	4
SA	2	2	12	1	37	0	3	0	1	4	1	23	4	41	47	6	43	0

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.

Fig. 4. Modified Group Environment Questionnaire Items.

Whereas students that had formed teams themselves, were less satisfied with the team performance in all four categories, the students that had formed teams using the *Psychographd* reported themselves to be more satisfied. The students that had not formed teams using the proposed courseware were of the opinion that they were not satisfied in terms of social activities, fulfillment of responsibilities, association with the members, desire to perform well, biasedness towards having only friends on the team, opportunities to improve self-performance, working style, and overall cohesiveness of the team. However the teams that were formed using the courseware showed remarkable improvements on all factors of the modified GEQ.

7. Discussion

The Group Environment Questionnaire assesses the cohesiveness among team members on four dimensions: Individual Attractions to the Group-Social, Individual Attractions to the Group-Task, Group Integration-Social, and Group Integration-Task. The questions that were asked are shown in the Fig. 4. The questions are arranged 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): questions 1, 3, 5, 7, 9, Individual Attraction to the Group—task (ATGT): questions 2, 4, 6, 8, Group Integration—Social (GIS): questions 11, 13, 15, 17, and Group Integration—Task (GIT): questions 10, 12, 14, 16, 18. The questions are shown in the table 3.3. Each student is required to rate his response on a Likert-type scale with values mostly from 1 (Strongly Disagree) to 9 (Strongly Agree).

The students that had formed their teams using the *Psychographd* were found more cohesive on all four dimensions. Whereas the teams that were formed through random assignment were found considerably less cohesive on all four dimensions.

8. Conclusions

A software is developed for forming Computer Science/Software Engineering capstone project teams. The software is named as the *Psychographd*. The working prototype software is based on a 128-item based self-evaluation questionnaire which is developed as part of the doctoral thesis of the first author. The software is unique in several ways. Unlike the Team-maker and the CATME, this software takes into account both the teamwork as well as the taskwork skills. It also presents multiple team alternatives to each individual student as opposed to the more popular alternatives such as the Team-maker and the CATME. The software is based on 128 research based criteria several times more than the criteria available in the CATME. Unlike other team building tools, the *Psychographd* guarantees a team for each and every student, thus eliminating the chances of occurrence of "orphan student" problem. This ability is so far unique to only the *Psychographd*.

This research has shown that the students that had formed their teams using the *Psychographd* showed the higher level of cohesion when compared to those students that had not used this courseware and instead had randomly assigned students to teams. Students of only the department of Computer Science, Federal Urdu University, Karachi Pakistan had participated in this research.

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