The Proposal of a Qualification Based Approach to Teach Software Engineering Course

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Abstract: *Software engineering students are facing many difficulties and challenging tasks when they approaching to industry. They suffer from inadequate experiences that are lacking in them to be skilled software engineers. This paper proposes a new approach to teach and train the students of software engineering course. The qualification approach (proposed in this paper) concentrates to establish a separate centre to provide a facility for students to understand real time environment similar to one in the industry. Furthermore, it focuses to live availability of real customers during software development. The approach also proposes to test each student using one of the personality tests. This will support to focus to develop a student's skills in one area, which is related to their personality preference.*

Keywords: *Software engineering education, teaching, centre, personality test.*

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1. Introduction

Software engineering course is one of the important courses that must be taught in an effective and efficient way. It is a type of course that contains many skills that each student must get into them. The skills are various from solving problems, dealing with different requirements, working in teams and communication skills. Besides core skills which are programming and analytic skills.

The goal of educational institutions is to improve education process and enhance student's skills in all fields. Otherwise, outcomes of quality education don't reflect any sign of improvement [8]. From this point, roles of researches and academics appear to investigate and propose new approaches of teaching software engineering to cover the gap between education goals and their outcomes.

The software engineering courses in most of the universities are not preparing the students well to face the real time challenging industry environment [1]. The current way of teaching and learning software engineering from many universities are showing a major gap to the real-world applications of software engineering. Most of the universities are being concentrated only in theoretical part of software engineering and giving less attention to build hands on practice skills to students to become professionals in future.

Building software and going through entire life cycle of software isn't an easy task and which needs expertise in hands on practice. Most of software companies are searching for professional software engineers but the present academic system doesn't make the fresh graduate students are better choice for them.

To make students fully skilled graduates and professionals, universities and researchers must try to follow and propose renovated and effective teaching approaches. The approaches are toward build skills of students to become expert in the world of software engineering. The approaches have to simulate about the activities that are actually practiced in software companies. The aims of new learning approaches are facilitating to get real time experiences for students. This expertise from university can make a student a better professional for his future career.

Rest of the paper is organized as follows: Section 2 covers related work. Section 3 describes the research problem. Section 4 proposes a new qualification approach model to teach software engineering course. Section 5 presents validation of the proposed qualification approach model.

2. Related Work

The main challenge for universities during the last several years is how to teach software engineering course that students can be equipped well to face situations in their professional careers. Nowadays, software engineering fresh graduates are facing a lot of difficulties when they are approaching to the software industry. The graduated students of software engineering courses are suffering from inadequate experiences in real time scenarios. This problem arises during last several years when software development has become an industry like manufacturing industry. The instructors and researchers proposed many approaches to enhance the student's outcomes of the software engineering course. These approaches renovate teaching methods to develop student's

expertise to become a real software development professional.

A number of approaches [1, 2, 4, 7] have been introduced to deal with this problem like divide students into teams to work on a semester project. The team approach will give students a feeling to understand that what are going on in software companies to develop software projects. Blake [1] suggests offering two courses in software engineering. The two courses of software engineering will be offered to cover the basics of software engineering concepts in the first course and second one is offered to develop a software project for the whole semester. In [2, 7], both provide approach of simulating real company environment where large teams of students need to work together on the software engineering projects. Each company has a project manager, team leads and team members. Furthermore, an idea of competition also advised between different companies to encourage the student to produce the best result.

Many proposals have been introduced to improve teaching methods according to [3, 9]. Both are based on idea of working a group of 6-8 students in a major software project. The aim of this is to prepare them for large team in industry. In [9] the approach depends on incremental development and delivery after every two weeks. Also, an instructor falls into multiple roles even also simulated customers like amazon company. In addition, student's knowledge built from previous and present one that will be gained in doing their projects [3]. Then, the final project will be analyzed using Key Performance Areas (KPAs).

Karunasekera and Bedse [6], the developed approach focusing on many skills such as managerial, engineering, team working and personal skills. Software engineering student must have adequate different skills rather than engineering skills. Students have to choose at least two skills from the managerial, three skills from engineering and students must be achieved all personal skills.

Rusu and Swenson [10] present a new idea to a graduate student by appointing two instructor supervisors for the software engineering project. One of the instructors will be a full time facility time and other is part time industry time. This will give the student a combination of skills from both sectors.

Hadjerrouit [5] introduces a new approach is learner-centered Web-based instruction. This approach is based on three ideas. First, the software engineering education must become more realistic, which mean provide more real examples. Second, software engineering education moves closer to the learner. Third, learning process has to be more to web technology.

According to [11], it produces an approach to the software engineering course based on the Problem-Based Learning principles (PBL). PBL centers on the problem based to make students focus in solving it. PBL has three principles. First, every week, students solve problems. Second, students work together to solve problems. Third, the role of instructor should be helping the students rather than instruct them.

All the above mentioned approaches have some limitations in their teaching methods. These limitations are displayed in Table1.

Table 1. Limitations of literature review papers.

Title	Limitation
Effective Pedagogical Principles and Practices in Teaching Software Engineering through Projects [9].	Students are less excited about use of defect tracking systems.
New Perspectives on Teaching and Learning Software Systems Development in Large Groups [3].	Instructors are playing multiple roles such as customer, instructor and manager. So students may misunderstand that which role is being played by the instructor at this time.
Large Team Projects in Software Engineering Courses [4].	Large team projects make an extra load of teaching on instructor.
Preparing Software Engineering Graduates for an Industry Career [6].	Continuous assessment model for this approach is heavy in load for both students and instructor.
The Virtual Agile Enterprise: Making the Most of a Software Engineering Course [7].	Large projects face difficulty in communication, scheduling, visions for the project, and differing levels of commitment to the project.
The Company Approach to Software Engineering Project Courses [2].	Students may get disappointed at the starting stage of the project because they do not know what to do and how to begin.
A Student-Enacted Simulation Approach to Software Engineering Education [1].	Unique grading for a project may not be suitable in case of some students they didn't work.
An Industry-Academia Team-Teaching Case Study for Software Engineering Capstone Courses [10].	Complexity of integration between first-semester and second semester projects.
Learner-Centered Web-Based Instruction in Software Engineering [5].	Prior misconception knowledge is difficult to change in this approach.
Improving Software Engineering Education through Enhanced Practical Experiences [11].	Students are more familiar with traditional classroom-based learning. So they may resist accepting this approach.

3. Problem Statement

Software engineering students are being graduated with less hands-on practice in the software-development project that can make them fit to the industry's standard. They suffer with inadequate experience to do major projects with the large group of people. They are facing many limitations and issues by implementing their familiar way of doing project. There were they had only virtual customers, difficulty in communication, scheduling between team members, assessment of student's grades, extra load to an instructor to track and supervise students works and software produced was not fully functional and less realistic to use.

4. The Proposed Solution

First of all, the proposed solution consists of enhancement of some methods was suggested in literature reviews by adding some new features and

components to improve learning process and overcome their limitations. Large team of students work in the software engineering project was shown in [1, 2, 3, 6]. Furthermore, dividing students into four groups and appointing a leader for each group are mentioned in [1]. In addition, evaluation of a student in combination of individual and group grade is shown in [6].

The new features of proposed solution are: Establish a Center for Skills Development and Training under Faculty of Computing and Information Technology in King Abdulaziz University. This center will provide working and learning environment inside university boundary. Also, for each student can test their personality using Meyers Brigger Type Indicator (MBTI) test. From the result of test, each student will be in the right position with specific job title and responsibilities. That supports to identify that student's skills in a preferred and appropriate area that can be developed from university to become a suitable professional for industry. In addition, qualification approach emphasis that customer must be real (not virtual). The customer may be inside or outside the university.

The qualification approach proposed by authors is to help software engineering students to do their projects in a very close atmosphere to real work environment. From qualification approach, students can build their expertise in building real software for real customers. To accomplish the success of qualification approach, many components must interact and cooperate effectively toward its goals. To explain the approach it is must to define its components, steps, and how it will improve the teaching methods.

4.1. Components of Approach

- Software engineering students of Faculty of Computing and Information Technology (FCIT) have to cooperate and participate to complete the project.
- Instructors of software engineering course who monitor the progress of students and advising them.
- FCIT-Center for Skills Development and Training: Is responsible to provide the real time work environment to students inside the boundary of university. It is an intermediary between real customer and students. It ensures that the final project will be delivering to customer with high quality and very minimal errors. For each project, there must be a coordinator, consultant and liaison officer. They are responsible to manage student, dividing them into subgroups, make a weekly assessment about student's performance and send report to the instructor, keep in touch with the instructor to while grading of students, solve communication gap between students or between customers and students also.
- Real customers are those who need software from FCIT center. The software may be developed to use in the same university also.

4.2. Steps of Qualification Approach

The qualification approach passes to three main stages as follows:

1. *Preparation*: In this step, the FCIT-center makes a MBIT. MBIT is a type of a personality test that helps a person to identify the best career position based on the result of the test. FCIT-center divides students into subgroups based on the MBTI test results. These groups are analysis group, design group, development group and database group. For each group there will be a team leader. The main responsibility of the team leader is to facilitate the communication within the same group, between different groups, with instructor and FCIT-center members. In addition, in this stage, real customers like companies, various socio-economical organizations, educational institutions, hospitals and etc., communicate with FCIT center by enquiring software. There must be a facility to make direct communication between customer and students to increase the overall understanding of the project. The customer may be any other counterpart of the university even.
2. *Execution*: This is a critical stage of the qualification approach. All the components must cooperate to deliver the project with high quality and reliability. The responsibilities of FCIT-center members must monitor the progress of students in the project, advise them to the best ways in doing particular thing, assess their performance, solve any certain pop up problems, ensure that the students doing things in right way and coordinate with real customers. For Every week, students make a weekly report and presentation to the instructor to keep up date with the progress of the project. In addition, FCIT-center must send a weekly assessment report about student's performance. Furthermore, in a weekly manner or alternative weeks a meeting should be conducted with students, FCIT-center members, customers and instructor. This meeting would ensure that what students are doing is meeting customer requirements. It may include prototype of software also.
3. *Ending*: The software should be delivered to customer at the ending of the project. The software must be tested and documented before delivering it. This phase is very important in software development and most of the students are ignoring it. Also, the FCIT-center should participate with the instructor to give student's final grade. The grade should be based on a combination of group grade and individual grade according to the contribution and performance of each student.

Figure 1 shows the complete sequences of qualification approach.

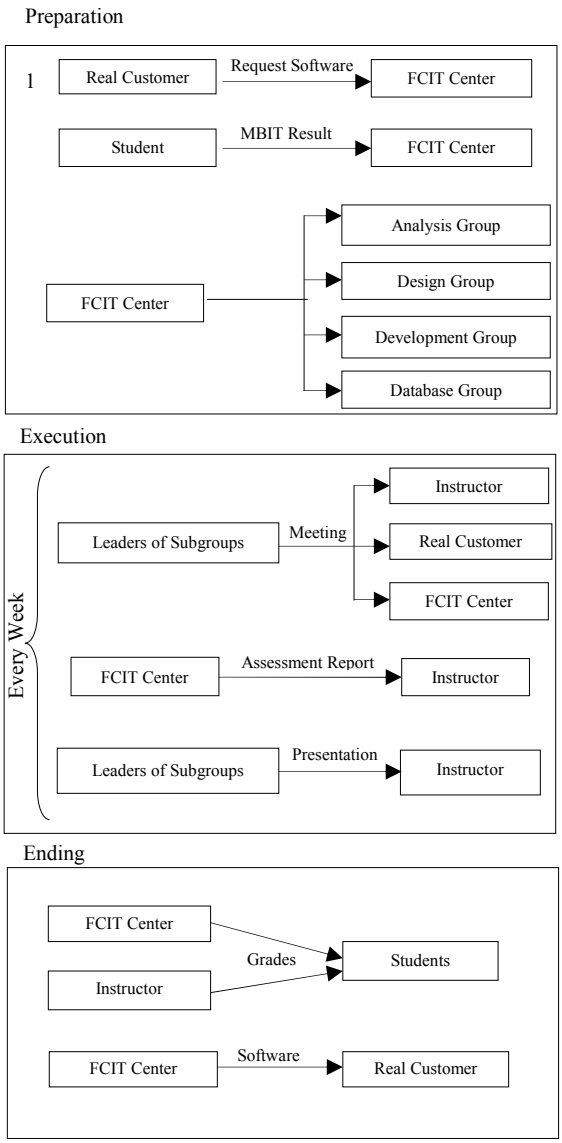

Figure 1. Steps of qualification approach: Preparation, Execution and Ending

4.3. Benefits of Qualification Approach

- Provides a very close atmosphere to real time work environment for the software engineering students.
- Make the students are experts in software projects by providing hands on practice.
- Better understanding of requirements can be achieved with the direct communication and involvement of the real customers.
- Ensures that each student has given an appropriate role and position in the group.
- Ensure that the developed software has been tested in a standardized way before delivered to customer.
- Emphasize that each student will get the grade that he/ she deserves.
- Minimize the issues of communication gap during the entire life cycle of the project.
- Reduce the overload and complexity of teaching method for the instructor.
- Well performed students may be offered with an attractive job position by the reputed companies.

5. Validation

The proposed solution mentioned early must be validated. The first technique used to validate it is the questionnaire. The second one is to compare it with some approaches already mentioned in literature review.

5.1. Questionnaire Validation

Questionnaire contains 16 questions that cover many goals of proposed solution. Goal 1 is to ascertain the readiness and willingness of students to establish FCIT center. Goal 2 is to measure the effectiveness of live availability of real customer in software engineering project of the students. Goal 3 is to measure the effectiveness of MBTI test. Goal 4 measures the capability of students to work in a large group. Finally, goal 5 is to ascertain the fairness of the way of project evaluation. The questions should be answered in likert scale of five. The responders are 32 students.

Table 2. Likert scale.

5	Strongly Agreed
4	Agreed
3	Neither Agreed Nor Disagreed
2	Disagreed
1	Strongly Disagreed

- *Goal 1. Ascertain the Readiness and Willingness of Students to Establish FCIT Center*: The questions in this goal measure how many students have willingness and getting excited to establish FCIT center. As shown in Table 3, 43% are agreed to establish FCIT center whereas 29% are strongly agreed. Furthermore, 16% are neither agreed nor disagreed. However, 8% are disagreed while other 3% were strongly disagreed.

Table 3. Cumulative analysis of goal 1.

Q. No	Strongly Disagree	Disagree	Neutral	Agreed	Strongly Agreed
1	0	4	3	13	12
2	1	0	2	16	13
3	2	2	6	14	8
4	2	4	9	15	2
5	0	3	6	11	12
Total	5	13	26	69	47
Avg.	3.1	8.1	16.3	43.1	29.4

Figure 2 depicts the cumulative results of goal 1.

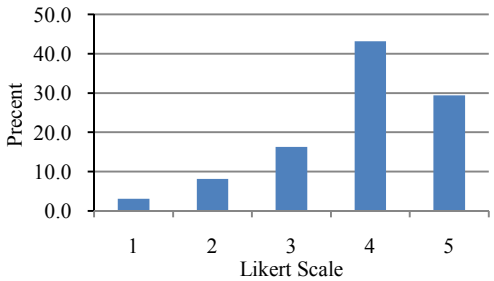

Figure 2. Cumulative analysis of goal 1.

- *Goal 2. Effectiveness of live availability of Real Customer in Software Engineering Student's Projects*: The questions in this goal measure that how much affective the live availability of real customers in the quality of software project. As shown in Table 4, 64% of students have declared that the customer is a main key in the success of software development. In another hand, 28% are responding neutral. However, 7% of responders are disagreed.

Table 4. Cumulative analysis of goal 2.

Q. No	Strongly Disagree	Disagree	Neutral	Agreed	Strongly Agreed
1	0	1	10	14	7
2	0	1	9	10	12
3	0	5	8	11	8
Total	0	7	27	35	27
Avg.	0	7.3	28.1	36.5	28.1

Figure 3 illustrates the cumulative results of goal 2.

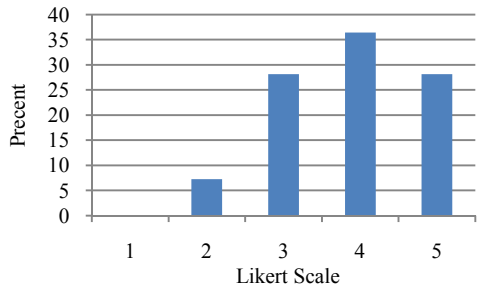

Figure 3. Cumulative analysis of goal 2.

- *Goal 3. Measure the Effectiveness of MBTI Test*: The questions asked in this goal are that if the students agree with the personality test can correctly specify right career to them based on their characteristics. Based on Table 5, 64% of students said that they agreed. Also, 20% are neither agreed nor disagree. On the other hand, 15% of the responders are disagreed.

Table 5. Cumulative analysis of goal 3.

Q. No	Strongly Disagree	Disagree	Neutral	Agreed	Strongly Agreed
1	0	5	6	12	9
2	0	5	7	12	8
Total	0	10	13	24	17
Avg.	0.0	15.6	20.3	37.5	26.6

The graph in Figure 4 demonstrates cumulative results for goal 3.

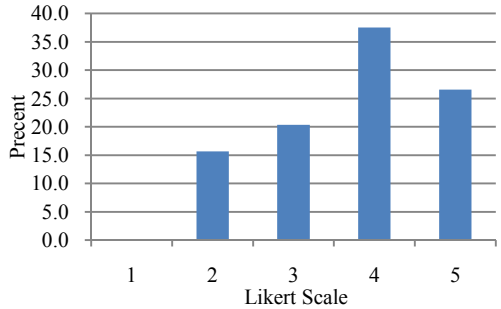

Figure 4. Cumulative analysis of goal 3.

- *Goal 4. Measure the Capability of Students to Work in a Large Group*: A large group of developers must work together to produce a fully functional software. Because of that reason, students have to work in a large group in the software engineering project. Goal of questions were asked to students about their ability of working in large group, division of students into subgroups and assign a team leader to each groups. As shown in Table 6, 69% of students are agreed with it whereas 18% of responders are disagreed. Also, 11% are neither agreed nor disagreed.

Table 6. Cumulative analysis of goal 4.

Q. No	Strongly Disagree	Disagree	Neutral	Agreed	Strongly Agreed
1	4	8	3	14	3
2	0	4	3	15	10
3	1	2	5	14	10
4	1	3	4	14	10
5	6	17	15	57	33
Total	4.7	13.3	11.7	44.5	25.8
Avg.	4	8	3	14	3

Figure 5 displays the cumulative results for goal 4.

- *Goal 5. Ascertains the Fairness Way of Project Evaluation*: For the grading of students in software projects, 'Is the proposed way of grading in qualification approach fair for their point of views'. The results are shown in Table 7. 56% of students are agreed with this grading. 23% are neither agreed nor disagree. However, 20% are disagreed.

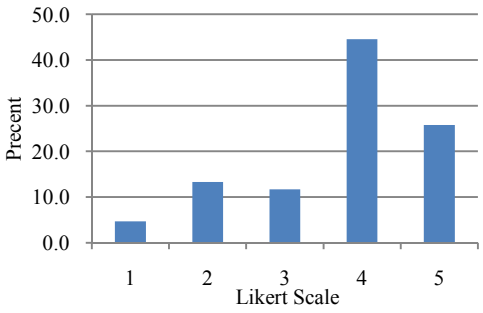

Figure 5. Cumulative analysis of goal 4.

Table 7. Cumulative analysis of goal 5.

Q. No	Strongly Disagree	Disagree	Neutral	Agreed	Strongly Agreed
1	2	5	9	12	4
2	1	5	6	13	7
Total	3	10	15	25	11
Avg.	4.7	15.6	23.4	39.1	17.2

Figure 6 presents the cumulative results for goal 5.

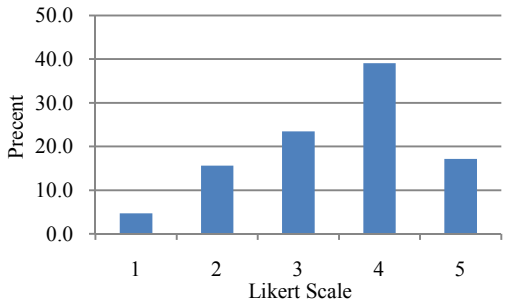

Figure 6. Cumulative analysis of goal 5.

The final cumulative results for all goals surveyed in the questionnaire are shown in Figure 7. The results show that 66% of the respondents agree with qualification approach and 20% of students are neither agreed nor disagreed. However, 14% are disagreed about this approach.

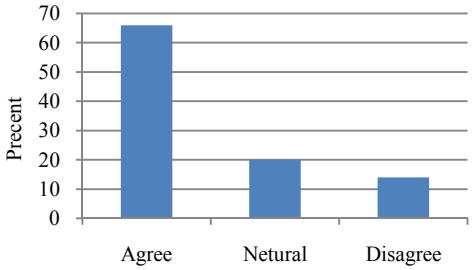

Figure 7. Cumulative analysis of all goals.

5.2. Comparing Validation

This section discusses the features of qualification approach compared to most similar previous approaches. One of them is presented in [1, 2]. As shown in Table 8, qualification approach combines most of the features and introduces its new methods. It is characterized by a special centre that links between real time customers and students. In addition, personality test appropriate classification of students based on their personality preferences.

Table 8. Comparison between Qualification approach and related work.

	Qualification Approach	Black [1]	Broman et al. [2]
Real Customer	Yes	Instructor is Customer	Yes
Special Center	Yes	No	No
Large Number of Students	Yes	Yes	Yes
Personality Test	Yes	No	No
Grading System	Individual and Group	Only Group	Individual and Group
Division Student into Subgroups	Yes	Yes	No

6. Conclusions

To make a skilled software engineering graduate as an industry fit professional is not an easy process. It requires many tasks of teaching and training students to build their expertise. The qualification approach proposed in this paper is a combination of many roles, tasks, sequence of actions, tests and special centre. All contributions in qualification approach have to communicate and collaborate to achieve its goals. With respect to the validation of the responses from the point of views of students, authors highly recommended of building FCTI center and following all sequences of tasks of qualification approach. Also as the future work, measure the effectiveness and validation of practical qualification approach.

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