THE ABILITY TO PROVIDE WELL QUALIFIED SOFTWARE ENGINEERING GRADUATES TO THE SOFTWARE INDUSTRY CASE STUDY: JORDANIAN UNIVERSITIES

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Abstract:

The new trend in software engineering research is how to provide software engineering industry with well qualified software engineering graduates; this trend has been appeared because there is an obvious difference between the industry needs and the actual supply from software engineering departments.

This paper will introduce briefly software engineering and software development process then it will mention the main properties of software engineering, A brief discussion about software engineering graduates and educators will be presented in this paper after that it will determines whether there are well qualified software engineering graduates in the Jordanian universities. Finally it will discuss a proposed model designed by the researcher to increase software engineering graduates' quality, qualification and productivity in Jordanian universities.

The result of the study (76) respondents of academic staff of software engineering department indicated that unfortunately, there are no well qualified software engineering graduates in the Jordanian universities. Another indication was that the designed model would have a significant impact to increase the quality, qualification and productivity of software engineering graduates in Jordanian universities.

Key words: Software engineering; Software engineering education; Software engineering graduates.

1. Introduction

Software development is very different from other types of product development. Software is an intangible product where other engineering disciplines produce tangible products such as buildings and bridges; Software is a relatively new engineering discipline. Because it is intangible, principles used in other engineering disciplines to produce a product free from failure do not apply. No two software development projects are alike [1, 2, 3].

Software engineering is concern about all phases that the development process passes through [5]. The developments process is divided into numbers of processes each process has its main mission and related to number of stakeholders each one of them has his own objectives and interests, the development process of the software system aims to build a system that help in solving real world problems [6, 7, 8].

Since the product is intangible, tracking the building process is an integral portion of software engineering. Unlike the building of a bridge, the production manager cannot look at the product to determine its progress. Software engineering is a methodological process of developing software in a repeatable manner on time within budget such that the software has the following attributes: conforms to specifications, maintainable, dependable, efficient, and usable [9, 10].

There were many changes happened to the software systems in the past causing many challenging in the characteristics and expectations of that systems [10, 11].

Based on the investigation of software industry, the universities failed to prepare students for real world because there are many skills that are ignored [12]. Thus, universities should pay more attention to the software engineering departments in order to provide software companies with well-educated and qualified software engineering graduates with high competence in software engineering field [12].

The researcher is attempting to answer: are there well qualified and educated software engineering graduates in the Jordanian universities and how we can increase the quality, qualification and productivity for those graduates.

2. Problem Statement

This paper investigates the ability to provide well qualified software engineering graduates to the software industry in Jordan.

These questions can better help clarifying the problem identified in this paper:

1. Is there software reverse engineering awareness in Jordanian universities?
2. What are the main significant factors that affect software engineering graduates' quality and qualification in Jordanian universities?

3. Statement of the Research Objectives

The study's objectives are to develop and test a proposed model that generates well qualified software engineering graduates in Jordanian universities. The proposed model will increase the quality of software engineering graduates in Jordanian universities based on three factors that were outlined in the suggested model.

4. Research Hypotheses

The researcher has set three hypotheses:

H01: There are no well qualified software engineering graduates in Jordanian universities toward solid courses and resources availability.

H02: There are no well qualified software engineering graduates in Jordanian universities toward academic staff capabilities and properties.

H03: There are no well qualified software engineering graduates in Jordanian universities toward well-equipped laboratories and adequate tools.

5. Suggested Model

Based on some previous studies in software engineering education [4, 13, 14, 15] the researcher proposed the following research model which consists of two types of variables: the independent one which includes solid courses and resources availability, academic staff capabilities and properties, and well-equipped laboratories and adequate tools. The dependent variable that is well qualified software engineering graduates in Jordanian universities. As shown in "fig 1" below.

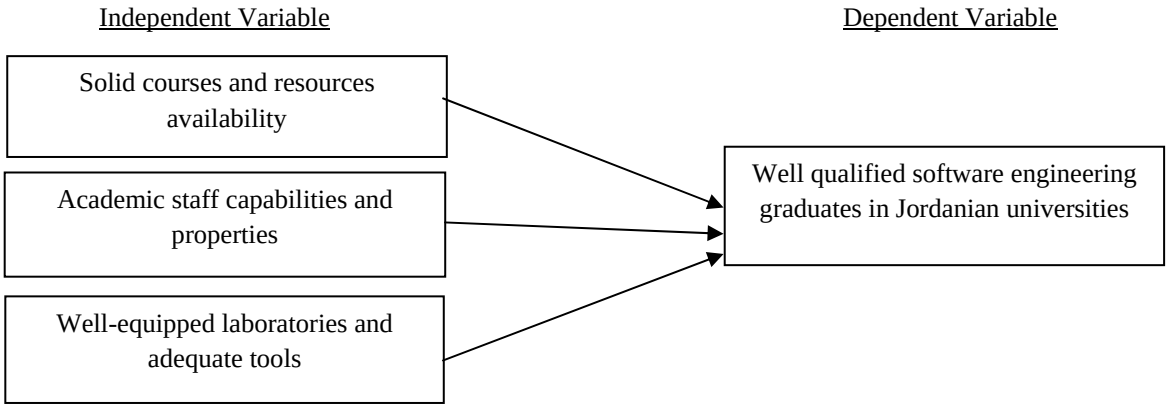

Fig 1: Research Model

6. Study Population

To conduct this study a population of academic staff in software engineering departments in Jordanian universities was identified in order to answer the survey's questions.

The researcher has made a survey for all academic staff in software engineering departments in Jordanian universities for both public and private universities, 100 questionnaires were distributed to academic staff in software engineering departments, 84 questionnaires were returned and 76 were valid responses.

7. Reliability of the Instrument

The researcher used the 19th version of SPSS to analyze the he collected to conclude the proper result [16].

The researcher used Cronbach alpha to test the internal reliability of the measurement instrument. In this study 60 % or higher is acceptable [17].

As shown in Table 1 the Cronbach Alpha values that ranged from .878 to .912, so it is noticed that all values are higher than 60 %. This shows that all the scales are highly correlated and consistent.

Table 1. Cronbach's alpha for each scale

No.	Variables	Cronbach alpha
1.	Well qualified software engineering graduates in Jordanian universities	.901
2.	Solid courses and resources availability	.903
3.	Academic staff capabilities and properties	.878
4.	Well-equipped laboratories and adequate tools	.912

8. Literature Review

Software engineering means the application of an organized, quantifiable, disciplined approach to the requirement gathering, analysis, design, implementation, and maintenance of software [18].

The main characteristics of software systems have altered rapidly recently, so many challenges of software engineering filed have shown up. First many of the software systems became concurrent and distributed in a way that interact with each component in the network. Second, software systems are now entities that cannot work, sustain, or stop in a traditional way. Third, software systems tend to be open in a dynamic operating environment [18, 20].

8.1. Software engineering education

If we want to define the software engineering education from the point of view of software engineering industry we can define it as the following: teaching the students how to deal with projects in real life and give them enough knowledge about all new techniques and tools that are actually used in software engineering industry, and to make students able to deal with teams by sharpening their communication and interpersonal skills [20, 21, 22].

This definition considered as the requirements that industry needs from software engineering departments, in other words software engineering graduates must have these requirements in order to enter software engineering industry real life in a smooth way [20]. That means instructors at universities must take into account while teaching the courses not to teach the theoretical knowledge only, they must allocate number of lectures to cover some topics related to software engineering industry [12, 20, 23].

This new trend in teaching software engineering will increase the effort needed by the instructors on one hand, on the other hand it will make the students more familiar with software engineering industry in real life [19, 24]. One of the main objectives of software engineering education at universities is to generate well qualified software engineering graduates who have the ability to deal with real life projects [10, 12], this objective requires a channel that matches the academic institutions with industry, this channel will facilitate the communication between these two parties, in order to make the needed requirements from software engineering graduates more clear to universities.

Software engineering departments after that can modify its curriculum upon the needed requirements which they take from the industry [23, 24].

8.2. Software engineering graduates and educators

The fresh graduates of software engineering faces many difficulties at the industry they work in because they find many differences between what they have learned at universities and what they face at work and they find the projects that they deal with is larger than the projects they used to deal with at universities with a different scale also, so it is very important to teach the students at their universities how to deal with projects that have the same conditions of the actual projects they will be dealing with in real life regarding software engineering industry [25, 26].

This issue can be conquered by modifying the syllabuses of the projects that the students must complete in the graduation year; this modification of the projects must take in account that the nature of that project must be very similar to the nature of real life projects. The main problem that many of software engineering instructors fall in is that they give students projects to complete with a certain requirements and specific time, during that time the instructors don't follow their students in each phase of the software engineering development process, all they do is that they just evaluate their students at the end of the time of the projects, and the grades they give to students rely on the presentations.

This trend that many instructors use doesn't offer the needed concern about software engineering development process. There are many universities that allow their software engineering students to train on actual projects in software engineering industry, sometimes the training takes six months up to two years, this trend in training the students gives them the opportunity to have the experiment of the real project in software engineering industry that they never face or deal with in their academic life, also this practice will show the students the importance of each phase of software engineering process closely, and let them know the importance of each phase practically [27, 28, 29].

Another trend some universities use with software engineering students that they allow their students to build systems and software for other students in different departments, this practice can develop and foster the understanding of requirements phase in software engineering process [30]. So it is very important to modify the curriculum in a frequent way in order to keep it up to date with the new skills and techniques needed in software engineering industry. These modifications on the curriculum play a very important role in preparing software engineering graduates to deal with software engineering industry in a smooth way.

An important issue we must take into account when modifying the curriculum is the new technologies which are needed by organizations and industry in real life, these new technologies must be added to curriculum by adding some topics to cover these technologies in order to prepare the students with some needed skills and having the ability to deal with in their careers, while sometimes we must discard some topics by removing them from curriculum, but before that we must investigate these topics carefully before removing them especially if they are from introductory topics which affect the foundation knowledge of software engineering [30, 31]. Because of the rapid changes which happen to technologies in software, graduates have new responsibility which is remaining up to date by learning under any condition. To prepare graduates who have the ability to learn requires efforts from educators represented by new methodologies they must use in the teaching process which focus on innovations [32].

There are many new technologies raised which help educators to make the teaching process easier and add many improvements to that process [20]. In addition to the technical skills needed by software engineering industry there are another needed skills which are the communication and interpersonal skills, these skills are very important in team working which the industry rely on in the actual projects in real life [5, 30].

These skills requires more concern from software engineering educators in order to sharpen them, for example pair programming is a new concept of programming relies on team working, this new concept must be deployed by instructors in software engineering education [3, 5]. As we mentioned before, software engineering industry relies on team working in actual projects in real life, so one of the factors of the success or failure of any project depends on communication skills [1, 30].

Another important skill software engineering graduates should have is leadership; leadership is required in any project, because any team needs a manager who is responsible for assigning tasks of team members in order to achieve the mission of the project. Regarding to these skills which are needed in software engineering industry, there is a new responsibility of software engineering educators to concentrate on these skills in the education process to sharpen the required skills for software engineering graduates [20, 21, 30].

9. Data Analysis and results

9.1. Population Description

This section shows the population which is academic staff of software engineering departments in Jordanian universities through the general characteristics of the respondents in term of university's sector, gender, age, scientific qualification, academic rank, general major, specialist major, teaching experience in software engineering department, number of published researches in software engineering. As shown in table 2 below.

Table 2 population description

Variable	Category	frequency	Percent%
Sector	Public	28	36.8
	Private	48	63.2

Variable	**Category**	**frequency**	**Percent%**
Gender	Male	55	72.4
	Female	21	27.6
Variable	**Category**	**frequency**	**Percent%**
Age	Under 30	7	9.2
	31-40	35	46.1
	41-50	23	30.3
	Over 50	11	14.4
Variable	**Category**	**frequency**	**Percent%**
Scientific qualification	Master	15	19.7
	PhD	61	80.3
Variable	**Category**	**frequency**	**Percent%**
Academic rank	Master	15	19.7
	Assistant professor	48	63.2
	Associated professor	10	13.2
	Professor	3	3.9
Variable	**Category**	**frequency**	**Percent%**
General major	Software engineering	51	67.1
	Else	25	32.9
Variable	**Category**	**frequency**	**Percent%**
Specialist major	Software engineering	43	56.6
	Else	33	43.4
Variable	**Category**	**frequency**	**Percent%**
Teaching experience in software engineering department	1-3	38	50.0
	4-7	28	36.8
	More than 8	10	13.2
Variable	**Category**	**frequency**	**Percent%**
Number of published researches in software engineering	0-2	48	63.2
	3-5	20	26.3
	More than 5	8	10.5

9.2. Central Tendency Measures

Mean, median, mode, and standard deviations are the main measures of central tendency [17]. Mean and standard deviations were used to describe attitudes toward fourteen questions related to the fist variable which is: solid courses and resources availability, the participant's opinions about this variable were rated on five-point scale. Based on the responses, most of the mean ratings are less than 3 on the five-point scale, only "The software engineering courses are reviewed in order to update curriculums" is with a mean rating greater than 3.

The participants' opinions about eight statements related to the second variable which is academic staff capabilities and properties were rated on five-point scale. Based on the responses, only "The academic staff members subscribe to journals such as ACM and IEEE" is with a mean rating greater than 3. All other statements were with a mean rating less than 3.

The Participant's opinions about ten statements related to the third variable which is well-equipped laboratories and adequate tools were rated on five-point scale. Based on the responses "There are enough modern computers in laboratories which increase the effectiveness of the educational process" had the greatest mean score (3.30). The lowest mean score was (2.28) for "adequate software and special tools are used in teaching software engineering courses in laboratories".

9.3. Hypotheses testing

Hypothesis (1):

H01: There are no well qualified software engineering graduates in Jordanian universities toward solid courses and resources availability.

Ha1: There are well qualified software engineering graduates in Jordanian universities toward solid courses and resources availability.

Table 3: test of hypothesis (ho1)

T calculated	T tabulated	T Sig.	Result of Ho1
- 1.284	2.925	.204	Accept

Referred to table 3, one sample T-test used at .05 significant level to test the hypothesis and it was found that (calculated T = -1.284) is less than tabulated T, and Sig. T value is greater than 0.05. According to the decision rule: Accept Ho if calculated value is less than tabulated value and reject Ho if calculated value is greater than tabulated value. Therefore, Ho1 is accepted and Ha1 is rejected. This indicates that there are no well qualified software engineering graduates in Jordanian universities toward solid courses and resources availability.

Hypothesis (2):

H02: There are no well qualified software engineering graduates in Jordanian universities toward academic staff capabilities and properties.

Ha2: There are well qualified software engineering graduates in Jordanian universities toward academic staff capabilities and properties.

Table 4: test of hypothesis (ho2)

T calculated	T tabulated	T Sig.	Result of Ho1
- 0.353	2.925	0.726	Accept

According to table 4, one sample T-test used at .05 significant level to test the hypothesis and it was found that (calculated T = - 0.353) is less than tabulated T, and Sig. T value is greater than 0.05. Therefore, Ho2 is accepted and Ha2 is rejected. This indicates that there are no well qualified software engineering graduates in Jordanian universities toward academic staff capabilities and properties

Hypothesis (3):

H03: There are no well qualified software engineering graduates in Jordanian universities toward well-equipped laboratories and adequate tools.

Ha3: There are well qualified software engineering graduates in Jordanian universities toward well-equipped laboratories and adequate tools.

Table 5: test of hypothesis (ho3)

T calculated	T tabulated	T Sig.	Result of Ho1
-0 .894	2.925	0.375	Accept

Referred to table 5, one sample T-test used at .05 significant level to test the hypothesis and it was found that (calculated T = -0 .894) is less than tabulated T, and Sig. T value is greater than 0.05. Therefore, Ho3 is accepted and Ha3 is rejected. This indicates there are no well qualified software engineering graduates in Jordanian universities toward well-equipped laboratories and adequate tools.

10. Conclusions & recommendations

10.1. Conclusions

As shown in this study there are no well qualified software engineering graduates in Jordanian universities, based on the following results:

- There are no well qualified software engineering graduates in Jordanian universities toward solid courses and resources availability because there is no encouragement for the students in graduate Project courses and the practical training courses to work on software engineering area. There is a lack of financial management, communication skills, project management, programming languages and systems analysis and design courses that software engineering department offers. There is a lack of software engineering courses that taught in laboratories.
- There are no well qualified software engineering graduates in Jordanian universities toward academic staff capabilities and properties, since there is no enough academic staff in software engineering departments having a good experience and enough knowledge about specialized topics in software engineering and its applications and importance in industry. In addition software engineering department's academic staff does not organize seminars and group working about research topics in software engineering area.
- There are no well qualified software engineering graduates in Jordanian universities toward well-equipped laboratories and adequate tools because the lack of laboratories numbers that are specialized for software engineering departments, and the lack of modern computers in these laboratories. There is a lack of new software packages and specialized tools and in software engineering which are very important to the graduates when they start working in software industry.

10.2. Recommendations

Depending on the research findings that there is no well qualified software engineering graduates in Jordanian universities, in order to increase software engineering graduates' quality, qualification and productivity in Jordanian universities to provide them to the software industries the researcher recommends the followings:

- Software engineering department should offer its course with the software engineering fundamentals provide the core technical knowledge and process skills and tools to create, manage, and maintain software and documentation and deal with complexity and human error. These include software process discipline, life-cycle models, software metrics and economics, architecture, design methods and skills, design inspections, testing, configuration management, and standards.
- Software engineering department must encourage the academic staff members to get good enough experience in software engineering, motivate them to make researches and papers in the hottest topics in software engineering.
- Software engineering department must provide their laboratories with the newest software engineering packages and with specialized tools in software engineering that are effective to the students, and teach them how to use these tools. Teach the students how they could seek, find, evaluate, and use information depending on themselves.
- Finally there must be coordination between software engineering industry and software engineering departments, so software engineering industry can inform software engineering department about the actual needed requirements from software engineering graduates as a first step , and the second step is implemented by software engineering departments by deploying the needed requirements and skills in the curriculum and the subjects taught to their students, this action will minimize the differences between the actual needs of software engineering industry and the real supply from software engineering departments. On one hand Software engineering industry faces a problem in finding adequate software engineering graduates. On the other hand universities facing a problem in the balancing process between what are needed by industry and what must be taught at software engineering departments. When software engineering departments take the decision of

modifying or changing the curriculum, the goal of that changing is to serve both software engineering graduates and software engineering industry.

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