

A Systematic Literature Review on The Role of Usability in Software Engineering Education

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Abstract. Human-Computer Interaction is the study of interaction between human and computer and one of the key aspects of the study is usability. Usability is important because it determines whether the user will remain using the software or not. When it has been emphasized correctly, it reduces cost and increases the level of maintainability. This study aims to determine how usability has been emphasized in Software Engineering education and proposes further research in the future. We have employed systematic literature review by employing manual search and filtering through selected database. Usability in Software Engineering education has been proven that it is a research topic that is being studied on. Moreover, there were efforts made in integrating it into the software development life cycle. The results of the study suggest that Usability in Software Engineering Education is limited but there could be potentials for including it into the education level.

Keywords: Human-Computer Interaction, Usability, Software Engineering, Curriculum, Computer Science, Education.

1. Introduction

One of the major topics in HCI is usability. According to Chao [1], usability that is part of the HCI aspects can be defined as “*overall rating of the degree of use in human computer interaction*”. In Malaysia, Dr. Halimahtun Mohd. Khalid started coining the term usability in the 90s although it has been introduced for quite some time in other world regions [2]. To ensure that Malaysian Software Engineers understands how the user-centred design works, it is recommended to make the existing HCI curriculum that emphasizes on usability available [3].

This paper focuses on the study of usability from the Software Engineering (SE) education perspective in order to learn how usability could be injected into the Software engineering curriculum especially in Malaysia. What makes this paper different from previous papers is it investigates on Usability and SE education through systematic literature review (SLR) [4].

The objectives of this paper are:

- 1) *To identify relevant publications in regard to the research title.*
- 2) *To identify and review efforts made to introduce usability in the undergraduate SE education.*

2. Review Process

2.1. Research Questions

Table I shows the criteria and scope of the research question structure which are Population, Intervention, Comparison, Outcomes, and Context (PICOC) structure.

Table I: Summary of PICOC.

<i>Criteria</i>	<i>Scope</i>
Population	Papers proposing model or framework for SE education
Intervention	Usability
Comparison	None
Outcomes	Suggest how usability can be injected into SE education
Context	Usability in SE education

Based on the Table 1, the research questions are:

[Q1] Did any framework or model was proposed for the SE Curriculum?

[Q2] How has Usability been integrated in SE Education?

[Q3] How are we going to measure the effectiveness of the usability integration after the study?

2.2. Strategy

The complete search string based on Salleh et al. [5] keyed into IEEE Xplore is as followed:

(Software Engineering OR SE) AND (Education OR Curriculum OR Syllabus).

2.3. Qualitative Analysis

To fasten up the data extraction process, a form has been designed to gather papers related to the research questions and as the study's qualitative measurement. Table II shows the questions asked while analyzing the papers chosen according to the search string.

Table II: Qualitative Analysis Questions

<i>Question</i>	<i>Answer</i>
Q1. Was the article about undergraduate SE curricula?	Yes/No
Q2. Was usability or HCI mentioned in the paper?	Yes/No
Q3. Did the paper mentioned include quantitative measurement the study's effectiveness?	Yes/No/Partially
Q4. Will the paper contribute to the research conducted?	Yes/No/Partially

3. FINDINGS

Table III shows results of the search procedure. Initially, we identified 59 papers but after going through the Qualitative Analysis, we have managed to identify only 24 papers relevant to the study. Table III shows the list of selected papers with answers to the questions asked in the Qualitative Analysis.

Table III: Systematic Reviews on SE Education

ID	Author	Year	Title	Type	Q1	Q2	Q3	Q4
S1	Barzilay et al.	2009	A Multidimensional Software Engineering Course	Journal	Yes	Yes	Yes	Partially
S2	Bourque et al.	2002	Guide to the Software Engineering Body of Knowledge (SWEBOK) and the Software Engineering Education Knowledge (SEEK) - a preliminary mapping	Conference	Yes	No	No	Yes
S3	Ding at al.	2011	Research and practice on software engineering undergraduate curriculum NJU-SEC2006	Conference	Yes	No	No	Yes
S4	Frezza et al.	2006	Creating an Accreditable Software Engineering Bachelor's Program	Journal	Yes	No	Partially	Yes
S5	Garg and Varma	2008	Software Engineering Education in India: Issues and Challenges	Conference	Yes	No	No	Partially
S6	Hazzan and Tomayko	2005	Reflection and abstraction in learning software engineering's human aspects	Journal	Yes	No	No	Yes
S7	Hazzan	2010	Putting Human Aspects of Software Engineering in University Curricula	Journal	Yes	No	No	Yes
S8	Katz	2010	Software Engineering Practicum Course Experience	Journal	Yes	No	No	No
S9	Lethbridge et al.	2007	Improving software practice through education: Challenges and future trends	Conference	Yes	No	No	Yes

S10	Lethbridge et al.	2006	SE2004: Recommendations for Undergraduate Software Engineering Curricula	Journal	Yes	Yes	No	Yes
S11	Mead	2008	Software Engineering Education: How Far We've Come and How Far We Have to Go	Journal	Yes	No	No	No
S12	Milewski	2004	Software engineers and HCI practitioners learning to work together: a preliminary look at expectations	Conference	Yes	Yes	No	Yes
S13	Parnas	1999	Software engineering programs are not computer science programs	Journal	Yes	Yes	No	Yes
S14	Polack-Wahl	2004	Teaching HCI in software engineering	Conference	Yes	Yes	No	Yes
S15	Pow-Sang et al.	2009	Applying the Chilean Educational Experience in HCI to Peruvian Undergraduate and Graduate Programs	Conference	No	Yes	Yes	Yes
S16	Pyla et al.	2004	What we should teach, but don't: proposal for a cross pollinated HCI-SE curriculum	Conference	Yes	Yes	No	Yes
S17	Rusu et al.	2008	Usability Practice: The Appealing Way to HCI	Conference	No	Yes	Yes	Partially
S18	Shao et al.	2011	An introductory software engineering course for software engineering program	Conference	Yes	No	Yes	Partially
S19	Sun	2011	The challenge and practice of creating Software Engineering curriculum	Conference	Yes	No	No	Yes
S20	Thompson and Reed	2005	Undergraduate Software Engineering Education: The Mark of a Discipline	Journal	Yes	No	No	No
S21	Tucker	2002	On the balance between theory and practice [software engineering curriculum]	Journal	Yes	No	No	Partially
S22	van der Veer and van Vliet	2001	The human-computer interface is the system; a plea for a poor man's HCI component in software engineering curricula	Conference	Yes	Yes	No	Partially
S23	van Vilet	2006	Reflections on software engineering education	Journal	Yes	Yes	No	Yes
S24	Zeid	2007	Lessons Learned from Establishing a Software Engineering Academic Programme in Developing Countries	Conference	Yes	Yes	No	Yes

3.1. Published Year

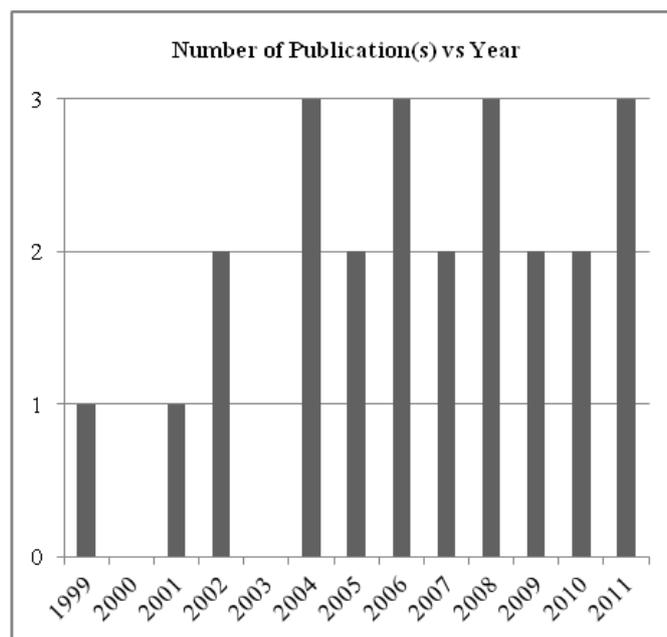


Fig. 1: Number of Publications vs Year.

Based on Fig 1, the papers selected laid in between the year 1999 and 2011. There were no papers selected for the year 2000 and 2003. One paper was selected in the year 1999 and 2001. Two papers from the year 2002, 2005, 2007, 2009 and 2010 while 2004, 2006, 2008 and 2011 had three papers from each of the year. The mode for number of publications according to Fig 1 is two papers. On average, 1.85 papers were found per year.

3.2 Relevant Conference or Journal

Table IV shows the relevant conference or journal to the study based on Table III. The main source of the papers comes from CSEET since nine publications came from it although conference year varied. IEEE Software has the second highest number of publications by having seven of the papers being listed under it. Out of eight of the sources, three of them were listed under journal type while the rest of it was proceedings. Since this is a Software Engineering curriculum study, it was expected that CSEET to have the highest number of publications.

Table IV: Relevant Journals and Conferences

Source	Acronym	Type	Number of Publications
Computer	Computer	Journal	1
IEEE Software	Software	Journal	7
IEEE Transactions on Education	ITEDU	Journal	1
Conference on Software Engineering Education and Training	CSEET	Proceeding	9
Frontiers in Education	FIE	Proceeding	2
Future of Software Engineering	FOSE	Proceeding	1
IEEE International Magnetics Conference	INTERMAG	Proceeding	1
International Conference on Advances in Computer-Human Interaction	ACHI	Proceeding	2

4. DISCUSSION

In this section, we discuss the answers to the proposed research questions for this study.

[Q1] *Did any frameworks or model was proposed for the SE Curriculum?*

S1, S2, S3, S4, S10 and S14 proposed framework or model with respect to SE education but S1 focused more on the introductory course of Software Engineering and not the curriculum per se. S10 reviewed the curriculum [6] that was used as the reference or guideline for S1, S3, S4, S7, S9, S18 and S20. As for HCI-centered model of framework, S14, S15, S16 and S17 mentioned about applying HCI in the SE curriculum.

In S10, there were four different patterns introduced to fit the needs of different type of SE curriculum. In North America and Japan, the SE curriculum have been modified to fit in the four years curriculum where as SE is a three years programme in the UK.

[Q2] *How has Usability been integrated in SE education?*

Usability is the subset of HCI and our main focus. It is undeniable that there were attempts where usability has been suggested to be included into the SDLC visibly such as the requirements phase [6, 7] or at the design phase [8]. However, as it has been previously mentioned before, usability should be introduced at the education level [3] particularly SE undergraduate programme.

S16 pointed out that in order to integrate Usability Engineering (UE) with SE in non higher education background itself; there were several barriers in combining these two disciplines:

- **Differences in requirements representation.**

UE focuses on the visual aspect when it comes to requirements interpretation and SE is more text-based.

- **Differences in testing.**

Usability testing tests little by little at every SDLC stage and SE has its own independent stage for testing.

- **Differences in terminologies.**

Scenario in SE means how the system will be used and interacts among each other and scenario in UE means story telling or narration.

- **Dependencies and constraints.**

Requirements gathered by both sides are different and conflicts might exist between UE and SE. SE is about the functional requirements and UE is hierarchical tasks analysis

S17 is about Computer Science in general but it has adapted usability evaluations in its CS curricula as a standard practice for introducing usability or HCI in the early undergraduate level. The same practice was adopted by S15.

[Q3] *How are we going to measure the effectiveness of the usability integration after the study?*

S4 mentioned partially or briefly regarding how to measure the effectiveness of the integration through the customized outcomes that will be used later to improve the program's effectiveness.

S17 used feedback from the ex-students and professionals to find out whether or not introduction to HCI should be a compulsory subject. The result was a satisfactory because even the practitioners agreed HCI is important from the industry experience. The clearer picture of the effectiveness was photographed through the implementation of HCI over the course of several years.

S15 adopted S17's practices but it was not measured according to S17's methodology. It was actually measured through the presentation conducted by the students. S1 was measured through questionnaire and S18 was through the student's general satisfactory score.

5. Conclusion

There is no established study regarding usability injection into the SE curriculum in Malaysia since all the results found are actually from different parts of the world such as China, Peru or Chile [S3, S5, S7]. There is clear evidence that the integration would definitely benefit the students and equip them with the knowledge needed in their future SE practices. Our future research is to identify the current SE curriculum in Malaysia and to propose SE curriculum with usability integrated.

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