CUSTOMIZATION OF REQUIREMENTS MODELING TOOL FOR SOFTWARE ENGINEERING EDUCATION

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ABSTRACT: Requirements modelling tools readily available in the market have been conveniently used as teaching and learning tools in the teaching of software engineering (SE) subjects. Students are expected to gain the skills of eliciting, analysing, specifying and validating requirements as they use the requirements modelling tools in class. However, these tools are mainly developed for industry purposes; hence they are not suitable for teaching and learning due to their high cost and complexity. This paper reports a study that develops an approach and supporting tool that customize the requirements modelling tool for SE learning purposes. The main objectives of this work are twofold: 1) to assist the learning process of the students to model the use diagram, and 2) to understand the syntax of the use case diagram. A requirements modeling tool, named CustomTool, which is customized for SE education has been developed, and it was tested for its effectiveness and usability using questionnaire survey. Based on the survey results, it can be concluded that users particularly students were satisfied and comfortable using the tool in the classroom.

KEYWORDS: CustomTool, UML, Use case, Software Engineering Education

1.0 INTRODUCTION

To be competent software developers, students need to acquire the knowledge and skills of software engineering that cover all of the software development phases: analysis, design, testing and implementation. However, many students face difficulties to acquire these skills since the common lecture approach in SE subjects tend to lead students to become passive learners [1] rather than they actively engage in the learning process. Students need to be given the exposure of using the requirements modelling tool in class. In SE education, lecturers usually use requirements modelling tools as a teaching and learning tool for eliciting, education analysing, specifying and validating requirements. The common modelling tools used in Requirements Engineering classes are, such as the StarUML, ArgoUML and Marama. Most of these tools are designed mainly for industry usages, and they use Unified Modelling Language (UML), which provide system architects that involve analysing and designing using one consistent language for specifying, visualizing, constructing and documenting the artefacts of software systems [2]. Since they are mainly developed for industry purposes, they do not provide a theory needed for teaching [3]. They are also too complex and expensive [4] to be used as educational tools. Further, combined with the theoretical nature and the diversity of the knowledge required, students can be easily confused, and they tend to misuse the utility of these tools when attempting to model specific components of the requirements. This results in students’ failure to deliver correct deliverables of the software projects leading to a high failure rate in most of the SE subjects.

This paper reports a study that develops an approach and supporting tool that customize the requirements modeling tool for SE learning purposes. This paper is divided into four sections: After the introduction, related works are presented in Section 2. This is followed by Section 3 which focuses on the description of the approach. Section 4 then reports on the usability study of the approach, and finally the conclusion of this paper is presented in Section 5.

2.0 RELATED WORK

Problems in SE education have been documented by Memon, Ahmad and Salim, et. al. [5] and they provide some suggestions to improve this course at the university. One of the problems they identified is students’ difficulty in applying the knowledge of SE in the real world. They provided several suggested, for example students should be given an example project from real industries, and students should be introduced to appropriate tools to perform requirements elicitation. Although lecturers are encouraged to use current technology, tools that can facilitate students learnability is nearly non-existence. Further, Khalid [3] and Cuddeback at el. [6] used a matrix technique to diagnosis requirements based on identification of an explicit set of consistency rules. They also found that there was no suitable requirements modelling tool that can be used to help students’ learnability.

There are several studies related to the requirements engineering work that highlight selected functions or features of the requirements modelling tools. Kamalrudin, Hosking and Grundy et al. [7][8] introduced automated and visual approach for inconsistency checking of requirements and improving requirement quality using Essential Use Case Interaction pattern in order to archive high quality requirements. They described an automated inconsistency checker called MaramaAI for checking high level inconsistency between textual requirements, abstract interactions and essential use case. This checker is able to check the completeness and correctness of the requirements captured by checking the consistency between modelled Essential Use Cases diagram with the EUC templates in the interaction pattern library. Although there are different types
of requirements modelling in the software engineering, their approach supports the EUC model to check the consistency and traceability requirements only. It is not customised for the usage of students learning.

In addition, Deepthimahanti and Babar [9] introduced an automated tool for generating UML models from natural language requirements, called UMGAR. This tool generates UML, specifically the use of case diagram, analysis class model and other models from natural language requirements that use efficient Natural Language Processing (NLP) tools. Although this tool provides a more comprehensive support for generating models with proper relationships in comparison to the other tools, it is limited for certain model only. Further, Sabetzadeh et al. [10] presented a tool that can check the consistency of conceptual models via model merging. This tool uses different techniques, such as graph based modelling to check the consistency requirements modelling. Yet, this tool is heavyweight, and it has not been proven as a suitable teaching and learning tool in the SE classrooms.

Overall, the problems and difficulties faced by students and lecturers in SE education have been highlighted in the literature, and so far a requirement modelling tool developed specifically for teaching and learning environment is non-existence. There have been several works/studies attempted to introduce requirements modelling software tools. In spite of this, it only focuses on selected features, such as consistency and traceability. Further, most of the works are still immature and have limitations and difficulties. It is also found that most of the works adopt one type of modelling approach in checking the consistency requirements modelling. Yet, there are no tools specifically develop to support the teaching and learning of requirements engineering in the SE education.

3.0 OUR APPROACH AND TOOL SUPPORT

From the gaps found in the previous section, we are motivated to develop an approach and supporting tool that customises the requirements modeling tool for SE learning purposes. The objectives of this work are twofold: 1) to assist the learning process of the students to model the use diagram, and 2) to understand the syntax of the use case diagram. For this stage, we only focus on the use of case diagram as it is important to capture the functional requirements at the very beginning of modeling and analysis activities. It is also important to get this right before modeling other diagrams as most of the diagrams depend on the captured functional requirements. This approach also enables students who are considered as novice requirements engineers to automatically model the use case diagram based on the provided requirements. Here, students could easily model the use case diagram and write the use case description. Templates to input the requirements for both tasks are also provided to avoid incorrectness and incompleteness to happen. It also helps students to understand better the syntax of the use case diagram. Thus, the researchers strongly believed that this approach could help to ensure the consistency, correctness and completeness of the generated requirements as well as to assist students to easily understand and capture quality requirements.

Our developed tool is called CustomTool. It runs in web-based and it is free to use for academic purposes. The tool is developed using HTML 5, Java, and JavaScript as its programming language, apache tomcat as a server, and MYSQL as a database. Here, Eclipse Juno platform is used to build the tool and SQLyog is used to create the database. Figure 1 shows the architecture of developing CustomTool which comprises of three components: the users, system interface, and database.

The main components of this tool are: 1) defining the introductory information on the elements and rules involve in use case diagram, 2) creating the use case diagram, and 3) creating the use case description. Figure 1 shows the features of our CustomTool. Item (a) shows the features that exist to help in automatically generating the use case diagram. Firstly, the user needs to input the user’s name and then input the boundary’s name (1). From here, the boundary’s name will be automatically displayed in the use case model (1a). The user needs to input the actor’s name (2), and the tool will automatically generate the actor (2a). Next, the user needs to input the use cases (3) and finally the association (4). Both use cases and association are auto-generated as shown in items 3a and 4a. As for the association, the user could also select the add-in button. In this case, user has the options to choose the “include” or “extend”, and then choose the related use case with it. Each input from the user will then be stored into the database and the user can return to their diagram anytime and anywhere for any update, deletion or addition. Item (b) shows the features that enable user to create the use case description following the template. By using this, users just need to input the requirements as required by the template and the whole set of the description will be automatically generated as shown in Figure 1(b).

4.0 EVALUATION

In this section, we carried out an evaluation of the effectiveness and usability of the tool in supporting the SE education. Here, we conducted an end user study to evaluate users’ perceptions of the tool. Participants in this study were 71 first year software engineering students. Each participant was given a brief explanation about the tool. Then, they explored and applied the tool to solve the scenario given. After they are familiar with the tool, users are requested to complete a questionnaire about the effectiveness and usability of the tool. The questionnaire consisted of five parts, which include the usefulness, ease of use, ease of learning, satisfaction, and cognitive dimension. A five-part Likert scale was used for each question.
**Figure 1:** High-Level Architecture of CustomTool

**Figure 2:** Example of Features in CustomTool: a) Create Use Case diagram and b) Create Use Case description
Once students were..., as such...[2013/PBPI(9D/S01210], pp. 531-230). The small percentage of disagreement (less 3%) over the usefulness and satisfaction is related to ability of the participant to understand the case study given to apply with the tool. This indicates that this tool can be a useful educational tool in SE education since students were somehow satisfied using it.

5.0 CONCLUSION
The requirements modeling tools commonly used in SE classes are not suitable to be used in the teaching and learning tools as they are expensive and complex. As such, there is a need to develop requirements modeling tools, suitable for the teaching and learning of requirements engineering in SE education. We have developed a requirements modeling tool that runs in web-based and it is tailor-made for SE education. We evaluated the effectiveness and the usability of our tools using questionnaire survey. The results showed that most of the participants agreed upon the usefulness and the ease of use of the tool. The results are promising with most of the users are satisfied with the tool.

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