International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-4, April 2019

Practical Implementation of Agile Approaches in Teaching process

Serein Al-Ratrout

Abstract*: *Teaching computer and software courses has never been a straightforward or simple process, such disciplines cannot be taught exclusively by traditional teaching techniques, and a great efforts have been aimed to improve the teaching and educating process for such disciplinary. The purpose of this study is to enhance the teaching of computer and software courses with practical implementation for successive techniques used in the current market, and measure the impact proposed educational method on students understanding and achievements. This study investigates practical implementation of agile methods within undergraduate software engineering program, through integration of agile approaches practically within Web Engineering course given in al-Zahra College for women; a case study where two popular agile approaches (Scrum and eXtreme Programming) have been considered. The proposed teaching technique and its impact on the learning outcomes will be evaluated through students' results, and questionnaires that will be given to students in order to obtain a feedback on their perceptions for this implementation.

Index Terms*: *Web Engineering, Software Engineering Education, Agile methods, Scrum, XP.

I. INTRODUCTION

Industry and real business at the current time trend extensively toward the web business, web applications become more and more vital at the current time and will continue at future [1, 2]. The market orientations and needs should be reflected in the educational programs, in order to bridge the gap between education and the real industry, and to prepare the new generations of software engineers for real challenges they may face in developing web applications [3, 4].

Web application encompasses everything from a simple Web page to a comprehensive website [5]. Web engineering is a framework for building industry-quality web applications. Quick delivery of good quality working web application is crucial in the current market [3, 5]. Agile approaches have proved their applicability and efficiency for this class of applications, due to the challenges associated with Web-based applications development such as: short development life-cycle times; small multidisciplinary development teams; continuous evolution, immediacy, and low cost of change [6, 7, 8].

Manuscript published on 30 April 2019.
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Since agile approaches proven their success in the market, many agile approaches have been extensively considered in real industry but not within the university education system [9]. Many universities started including these methods in their curriculum, but courses on practical practices for agile methods at the undergraduate and graduate levels are still few. [10, 11, 12]

Therefore, the author believes that investigating agile approaches from educational perspective according to specific educational requirements would positively influence the teaching process. Agile practices within university courses could enhance constructive communication skills, generate relationships among students, stimulate active team participation, and motivation learning. It should also adopt rapid software development, with high application quality, and easily changing requirements management [9, 13].

This paper presents a case study where two popular agile software development approaches (Scrum and eXtreme Programming XP) have been considered in the web engineering course. The objective of the study is to address the following concerns of educators: is it possible for university students to learn and practice the agile methodologies? Whether agile methodologies really generate good quality working web applications in a short time with university student's teams? What is student perception of the methodology used, and does this approach of education motivate the students during their education? And most importantly, what is the impact of using agile methods in educational process?

In order to answer the aforementioned research questions, a real-life business simulation was conducted inside a computer lab within a web engineering course students offered at Al-Zahra College for Women. A special arrangement was implemented and an in-class project was given to the participants. Questionnaire, assessment and direct discussion were conducted in order to evaluate the impact of implementing agile methodologies practically during educational process.

The rest of the paper is organized as follows: section 2 discusses agile development methods in industry and education. Web engineering process and web engineering course overview given in Al-Zahra College is presented in section 3. The research methodology used in this research is described in section 4. Section 5 explains the practical implementation for agile within web engineering course and section 6 presents analysis and the main outcomes of this research study, and section 7 concludes the papers.

II. AGILE METHODOLOGY

A. Agile in Industry

Agile development methodology refers to an iterative and incremental strategy that involves self-organizing teams working collaboratively to create the software [14]. The term Agile was introduced in the 1990s referring to flexibility in production systems [15]. The Agile Manifesto is a formal affirmation of Four key values and Twelve principles [16, 24]. Implementing these key values and principles in development should guarantee a proper interaction between the developer and the client which will result in involving the customer in the design and development stages and consequently delivering a convenient working software. It will also help both the developer and customer to respond to changes effectively. From the design and development perspective, agile methodologies should assure customer satisfaction in early stages, acceptance of changes in the requirements, cooperation between developers and clients, addressing requests from motivated individuals, team communications, and simplicity in the development process.

Roger S. Pressman proposed an agile framework for building industry-quality WebApps [5] in order to satisfy the modern business demands. Nowadays, business strategies and rules change rapidly, management demands near-instantaneous responsiveness and stakeholders keep changing their minds even as they demand rapid delivery.

As software engineering educators, it is our responsibility to adequately prepare our graduates in order to be able to appropriately face many challenges such as respond to changes. Changes in: the software being built, technology available, and the business requirements. The graduates should be able to recognize that software is developed by individuals working in teams, and that their skills and ability to collaborate are at the core success of the project. A well-known successful agile methodologies are Scrum and eXtreme Programming (XP); they have proven their excellency to release the software product rapidly and correctly [18, 19].

B. Scrum approach

Scrum [6, 18, and 20] is an iterative, incremental framework for software development, it was first introduced in 1990. The key characteristic is accepting information shortage at the beginning of the development; where the requirements cannot be fully understood before starting the development, and focusing on how to maximize the team's ability to deliver quickly, respond to emerging requirements, and adapt to evolving technologies and changes.

The process starts –as shown in Fig 1. Scrum model- by preparing product backlog; which is a prioritized list of feathers needed to achieve the projects goal, it is prepared by the product owner. Each feather is usually referred to a story presents a description of product functionality. Scrum structures the development in cycles or iterations called Sprints. Projects progress via a series of sprints; at the beginning of each sprint, the team selects customer requirements from a prioritized list, then they commit to complete the increment by the end of the sprint. The sprints have fixed duration and never extended, and they end on specific date whether the work has been completed or not. Each sprint includes the process of planning, development and controlling, during the sprint the chosen items do not change.

Iterations make it possible to gather feedback at the end of each cycle, the team obtains feedback and incorporates it in the next sprint. This feedback loop may result in revising or adding items to the product backlog; or it may cause changing to new functionalities that could influence the next sprint. This can significantly decrees the amount of risk concerning the project development. Scrum relies on a self-organizing, cross-functional team, and face-to-face communication.

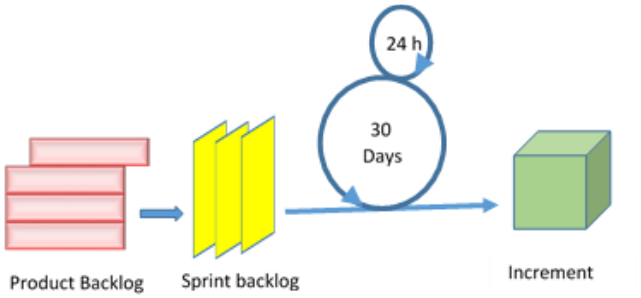

Fig 1. Scrum Model

C. Extreme Programming

Extreme Programming [6, 18] is one of the most widely used agile methodologies, it is incremental planning approach comes up with an overall plan that is expected to evolve through the life of the project. It is an efficient, low risk, flexible implementation of functionality responding to changing business needs, predictable, scientific, and fun method for developing software.

XP requires – as shown in Fig 2 XP model- all team members working together in the same place where the project and releases development take place, the releases should be small, completed, and adding value. It recommends the design of the system to be as simple as possible, the tests written before programming, developers not to work overtime or take work home with them, and to participate in a symbolic ceremony at the end of each iteration. Its reliance on close collaboration of programmers with ordinary skills.

The main goal behind XP is to reduce the underlining costs that are associated with high risks of emerging changes which are common in development projects. Changes occur during the development due to the fact that problem cannot be fully understood before starting the development and then gaining new knowledge is needed as the project progresses.

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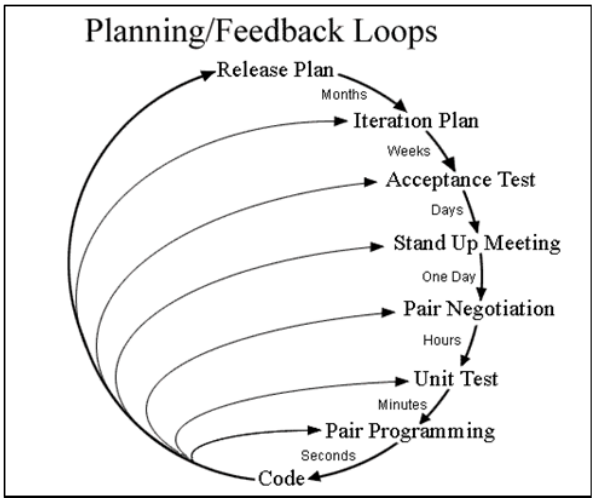

Fig 2. XP Model

Table I summarizes a description of Scrum and XP methods employed in this investigation along with their advantages and disadvantages.

D. Impact of Agile Methods in Education

Teaching Computer courses and Software Engineering has never been a straightforward process, traditional teaching and educational methods have certain limitations for interactive courses such as programming or software development. After years of exploring industry requirements, it has been notices that agile approach possesses significant characteristics and practices students should experience in their educational progress.

Many educational institutions are exploring and experimenting with ways to integrate agile concepts and practices into academic programs in areas such as computer science, software engineering, and information systems. Agile practices seem to be appropriate for software development done in universities and colleges as course or final year graduation projects. Students in programming courses develop programs for a specific problems; besides, in most university's projects a good quality working software that is delivered in tight time is a must. In these scenarios, agile practices help by focusing on rapid programming of software that meets the specified requirements.

Integrating agile methodology into academic will help to better understand the importance and role(s) of agile concepts and practices [22]. In reality, students working together with good communication and interaction can operate at higher levels than when they use their individual talents, agile project teams focus on increasing both individual competencies and collaboration levels.

Some studies observe agile practices used in education and explore its impact to learning, the results indicate positive influence on students' skill specially on students' with weak programming skills. Moreover, it has a big effect on average variance between their project mates' skills. In addition, it positively influences on higher marks for coding and final evaluations of their projects on average [23].

Sharp et al. [10] investigated how agile principles and practices would improve teaching process through implementation of agile into the classroom, they believe in the potential of the agile methodology to enhance the educational process. To the best of the authors' knowledge, there is no systematic research conducted about the use of agile for course development itself. And their work would inspire educators and researchers to consider integrating agile into their teaching and learning. They suggested further research to fully understand and apply agile software development techniques in the context of information systems education.

Magana eta al.[12] presented a study that integrated agile-scrum and cooperative learning guidelines into a systems analysis and design course, to encourage the teamwork, communication, and problem-solving while teaching systems analysis and design methods. They concluded that this integration can guide students to effectively analyze and design software solutions, to reflect on their team performance and learning process, and to effectively frame, plan, and manage group projects on different aspects of team performance such as time management, communication, quality of work, and progress toward completion

Hu et el. In [21] reported a case study on the design of a teaching process that used agile- scrum in software process course for a web development task, where requirement changes introduced during the project development. In this study, both individual and group assessments included in order to let students learn all the aspects in Scrum development process. The case study described the student's perceptions to the course and concludes with lessons learned. The authors concluded that individual and group projects are necessary in the mentioned course. Regarding changes during software development, student's handling was satisfied at the project management level, and also at a development technical level such as model-driven development and rapid development.

Agility is a broad concept that needs to be delimited and tuned according to specific educational requirements to positively influence the teaching process. An agile approach should foster rapid software development, promote application quality, and make changing requirements easy to manage. It should also stimulate communication, work organization, active team participation, good relationships among students, and motivation for present and future learning.

III. WEB ENGINEERING COURSE

Web engineering process [5] involves set of activities that are applicable to all Web application projects, the activities are iterated and repeated for each increment. As shown in Fig 3, the activities are: communication, planning, modeling, construction and deployment. Each activity is populated by a set of actions; and each action contains a collection of related tasks that produces a work product.

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Table I: Scrum and XP Description

Agile method	Overview	Advantages	Disadvantages
Scrum	An iterative and incremental framework, feedback-driven, self-organizing development team works as a unit to reach a common goal. 30-days release cycles	• High communication level with team member • Client participation • Self-organizing team • Respect team members	• lack of documentation • Close interaction • Lack of formal leader • specialized skills and test plan • can easily get out off track
eXtreme programming (XP)	Frequent "releases" in short development cycles, customer driven development, XP argues that the code is the only truly important product of the system development process. daily builds	• Team communication, • Technical practice • Frequent feedback • encourage for effective actions • Respect team members • End user involvement • Enhance quality • open to employee creativity, freedom and self-control and innovation	• hard to write good test • frequent iterations compromise quality • better applicable if all team members can work at the same location • implicit design

Communication includes requirement gathering through interaction and collaboration with customers. In planning phase web engineers create a work plan, modeling encompasses creation analysis and design models, and Generation for code and testing are done by constructions. Deployment includes delivering the webApp increments to customer who would evaluate it and provide feedback**.**

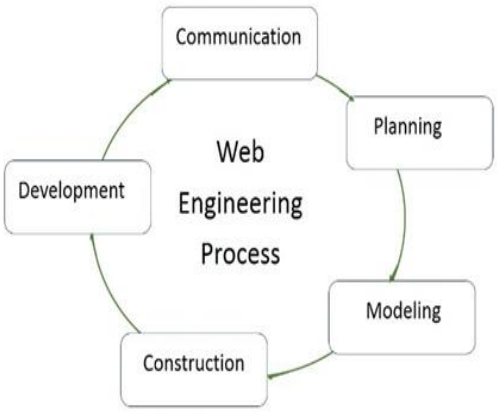

Fig 3. Web Engineering Process framework

Web Engineering is a mandatory course for Software Engineering specialization in Al-Zahra College for Women. Senior students are expected to study this course who have programming skills and experience in developing web applications. This course introduces students to verity of concepts, methods and techniques used in web-based system development. Students should learn in this course the Web Engineering process framework activities and actions needed to create web applications, and how to use them in a collaborative environment while properly utilizing web engineering methodologies. The course includes a project to use the educated agile approach and to create a robust web application, they will be asked to apply analysis principles and methods applicable to web engineering, and then to implement rabidly web application project by simulation a modern real-world environment. This would help students to distinguish between various developments processes, and identify the possible drawbacks and problems. The project takes place over the 12 weeks of course term, includes multiple releases, and students should work in teams of three members. The students will be requested to apply two agile methods; namely; Scrum and eXtreme Programming as development framework process. At the end of the course, questionnaires distributed to the participants, analysis for questionnaires' responds will be completed, assessment for students will be done, and discussion will be conducted to collect feedback. The course has the following main objectives and outcomes:

1) Teach students how to apply software engineering principles, skills and strategies for Web application development.
2) Apply analysis principles and methods appropriate for web engineering
3) Rapid development for web application through simulating a real-world environment.
4) Distinguish between various development approaches, and identify the possible benefits and drawbacks for each.

I. RESEARCH METHODOLOGY

Inductive research approach has been adopted in this study, starting from collecting data and observations of individual cases to generate broad general ideas and theories. The study involves the following phases:

1. Conducting Real-life business simulation inside computer lab in two stages.

I) Stage one: teams of web engineering students assigned to develop web application within tight deadline, the members of these teams have the basic programming skills, and have learned the basics of agile development methodologies, and each team follows either Scrum or XP, each team worked separately in building the required web application following the specific agile methodology.
II)Stage two: changes and a new requirements will be emerged, teams have to incorporate the new requirements in their projects.
2. Preparing and distributing questionnaires to participants in two rounds:
a. First round aimed to comprehend students' perceptions and feedback about the applied approaches after the completion of the development. The purpose of the questionnaire is to gain clearer insight about the students' perceptions for methodologies used, teamwork, their motivation, and their attitude towards changing requirements.
b. Second round aimed to address problems students' may face during the implementation of agile practically for educational purposes within undergraduate computer and software courses.
3. Analyzing the participants responds to reach deeper and wider understanding which would eventually enhance the Web engineering undergraduate program teaching process, in order to prepare students for exciting career and successful articulation in this field.
4. Assessment for students is done, in order to evaluate the efficiency of the followed educational technique compared with traditional one for Web Engineering course, and how it affects positively on students understanding for critical concepts and their results and grading.

II. ANALYSIS

A practical implementation for agile within web engineering course has been implemented, real-life business simulation conducting inside computer lab in two stages.

1. Stage one: teams of web engineering students assigned to develop web application within tight deadline, the members of these teams have learned the basics of agile development methodologies, each team follows either Scrum or XP, each team worked separately in building the required web application following the specific agile methodology.
2. Stage two: After delivering some increments, changes and a new requirements will be emerged, teams have to incorporate the new requirements in their projects

A) QUESTIONNAIRE AND OPEN QUESTION

Questionnaire is prepared in order to gain clearer insight into the students' perceptions about methodologies used, teamwork, motivation, and their attitude towards changing requirements. The student responds and results have been collected, and analyzed as shown in Table II and Table III.

TABLE III: SCRUM RESULTS

Criteria	Agree	Disagree
1. Scrum Methodology understanding	80%	20%
2. Team members motivation	80%	20%
3. Better Communication among members	90%	10%
4. Enjoyable way	56.6%	43.4%
5. Better Organization to work	73.3%	26.7%
6. Methodology's general efficiency	83.3%	16.7%
Overall Satisfaction	76.64	

TABLE IIII: XP RESULTS

Criteria	Agree	Disagree
1. XP Methodology understanding	82%	18%
2. Team members motivation	85%	15%
3. Better Communication among members	86.6%	13.4%
4. Enjoyable way	70%	30%
5. Better Organization to work	82%	18%
6. Methodology's general efficiency	66.3%	33.7%
Overall Satisfaction	77.98	

Both teams' members have been motivated during the course, this is reflected on their a big jump in understanding Agile approaches applicable for Web Engineering, student could have better understanding for the approaches and principles; around Eighty Two percent and Eighty percent better understanding for XP and Scrum respectively. Both teams have positive feedbacks regarding the communication between team members, organization to work and the methodology efficiency, which helped to find out bugs easily, and work with high degree of autonomy. Most XP team members felt it was enjoyable learning way, while around Half of scrum members have enjoyed. All participants agreed that this way of educating for such computer courses enhance their creativity, innovation, facilitate the communication, help organization to work, and efficient for software application development. However, XP has higher satisfaction average which is around Seventy Eight, while Scrum is around Seventy Seven.

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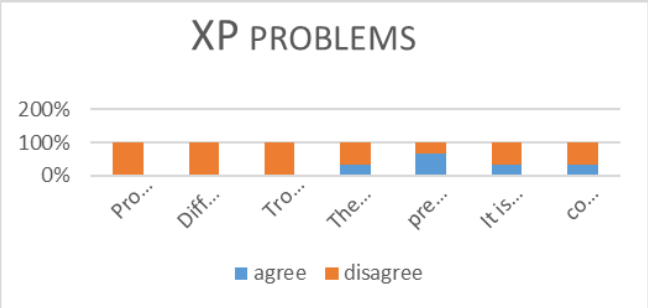

Fig 4. XP Problems

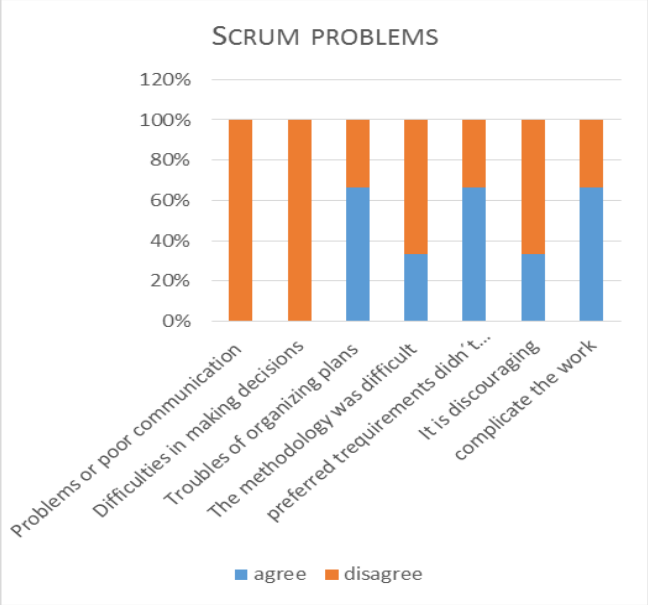

Fig 5. Scrum Problems

Further questionnaire distributed and analyzed to investigate the problems students may face during applying of the proposed teaching technique of implementing the agile methodologies practically, while delivering the web engineering course. The results were very positive and optimistic as shown in Fig 4 and 5.

All participants in both methodologies did not feel any problems or poor communication between project members, or any difficulties in making decisions.

Regarding organizing plans and discussing solutions together, XP participants did face any troubles, while majority of Scrum participants said they faced many trouble. This is due to the fact that Scrum relies on a self-organizing team, there is no overall team leader who decides which person will do which task or how a problem will be solved. While XP requires programming in pairs and doing extensive code review together.

The majority of both teams' members felt that the methodologies were not difficult to understand or to implement by students. For educators; this is an excellent feedback obtained from the first experience for such technique. When this educational approach applied for more course, surely students will have more positive perspectives. And this will minimize the gap between education and practical industry.

The majority of both teams' members preferred requirements did not changed; requirement change will cause a lot of work to redo. But both teams accepted the change and did not feel any discouraging since agile approaches are flexible, iterative, incremental framework for projects and product or application development.

Majority of Scrum participants felt complication of work in case of team member absence. While the minority of XP method felt that. This is because Scrum is cross functional approach, which mean everyone is needed to take a feature from idea to implementation. While XP requires programming together and all members can understand all the achieved work.

B)ASSESSMENT AND EVALUATION FOR STUDENTS

Assessment has been done to measure the improvement in student performance. Assessment done for two classes of students; participants and non-participants students. Fig. 6 shows the assessment results for class of students who did not participate in the simulation project, while Figure 7 shows the results of participants. Non-participants grades average was 83% while the grades average for participants was 85%;

The standard deviation for non-participants was 15.4 .while for participant it was 8.9. It could be concluded that the proposed teaching method could enhance the student understanding and recognizing of agile techniques and principles, and minimizing the difference between students level of understanding.

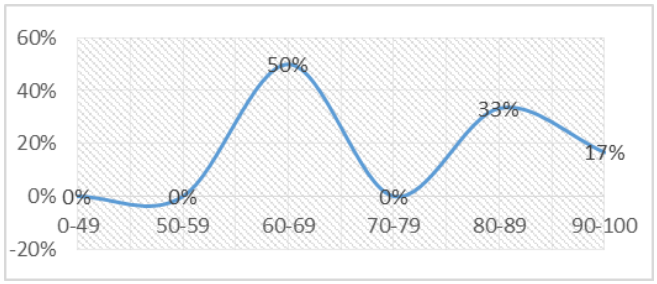

Fig.6. Evaluation for none-participants

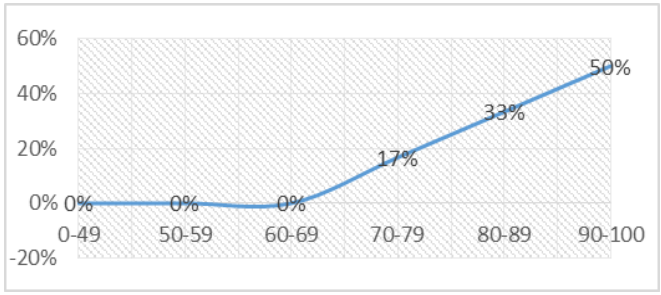

Fig. 7. Evaluation for participants

III. CONCLUSION

The impact using agile methods in software engineering education curricular was investigated in this paper. A case study was conducted in web engineering course where a new teaching approach was proposed which involves educating agile development methods practically. The aim of the new approach is to bridge the gap between the students' education and the real practical experiences in the industry through actively engaging students in using different agile development methods.

The study examined and evaluated two popular agile software development approaches (Scrum and XP) form educational perspective. In this case study, two students' teams were assigned to develop same web application where one group applied XP, and the other group used SCRUM. Results showed that the students working together with good communication and interaction can operate at higher levels than when they use their individual talents. Further, it was revealed that both XP and SCRUM teams were efficient and can produce good quality software within tight deadline. This implied that the adopted approach can be implemented easily with undergraduate students.

It was found that both approaches are enjoyable, enhance the motivation, facilitate the communication, and help organizing the work for web application development.

After analyzing a questionnaire and the assessment results, and based on the investigator's observations, it is concluded that using agile practices in educational framework would positively influence the teaching process. Agile approach in undergraduate software engineering courses could stimulate communication, good relationships among students, active team participation, and motivation for present and future learning. It should also foster rapid software development, promote application quality, and make changing requirements easy to manage. The participants had a great preference among other students, and could more realize the agile principles, and how to deal with uncertain environment where evolution and changing requirements inevitably required.

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