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# The Study of Active Learning on the Course of Game Project Management with Agile

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**ABSTRACT – This paper presents the game project management based on an agile approach. The research questions are if active learning is appropriate to the course of game project management and how an agile methodology is more appropriate to game development management than the traditional ones. The research was an experiment to test the practice of project management. The participants of 41 undergraduate students participated in the study. Those are students who enrolled in the course of game development project management. The class was driven by the Scrum method and the project teams were grouped to develop a different game project. The study was designed based on project management phases: the planning and management phase, and the implementation phase. The scenarios of active learning were based on game development activities. The students were learning through the activities. We observed the values of project management factors: Individuals and interaction over process and tools, Working software over comprehensive documentation, Customer collaboration over contract negotiation, and Responding to change over following a plan. We evaluated the quality of solutions by the instructor who had expertise in game development techniques and tools. We created a questionnaire to evaluate the proposed learning method. The questionnaire consists of two main parts. It collects each project member's information including personal background, involved process, tools he used in the process, and relatedly potential limitations.**

**KEYWORDS:** Agile, Scrum, Active Learning, Project Management, Game Development.

# 1. Introduction

## 1.1 Motivation

This research relies on the study of active learning for a game project management course. In particular, we focus on project development by applying an agile methodology. The scrum method is applied to drive the project activities for developing a game project. This research also describes the use of a particular set of software tools as another platform of active learning that were employed in the class. We first provide thinking skills as well as information on visual learning, mind tools, mind maps, and mind mapping software. We then provide initial results of development efforts to create instructional modules and active learning activities that employ the visual tool of mind mapping to improve critical thinking skills.

## 1.2 Research Question

The focus of our research is to understand if a more structured process for guiding projects can enhance team outcomes. Specially, we focus on the following research question:

RQ1: How might active learning be appropriate to game project management course?
RQ2: How might agile methodology be more appropriate to game development project management than traditional ones?

To address our research questions, we use a sequential mixed-methods approach, which integrates both quantitative and data within a single study to gain a better understanding of the problem. We create a scenario of a game project development for students. The students study the principles and process of project management for game development through

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the active learning environment. Game development is an emerging field in multidiscipline that combines expertise across a range of domains, including software development, art and graphic design. We provide the scenarios of those and study the effectiveness of active learning.

The rest of the article is structured as follows. In section 2, we give the background of active learning and agile methodology. Section 3 describes the approach of our study. Section 4 discusses the quantitative phase of our study. Section 5describes the qualitative phase, focusing on the observations from students teams using the agile methodology. Finally, Section 6 presents a summary of our research results and discusses possible future work.

# 2. Literature Review

## 2.1 Active Learning

Active learning has been described by Bonwell and Eison [1] as an instructional technique that engages students in meaningful learning activities such as dialogue, debate, writing, and problem-solving, as well as higher-order thinking, e.g., analysis, synthesis, evaluation. According to [2] [3] [4], some case studies of active learning were developed. The utilization of active learning was one of Chickering and Gamson's "Seven Principles for Good Practice" [2] for undergraduate teaching. Prince [4] reviewed several forms of active learning i.e. collaborative learning, cooperative learning, and problem-based learning.

Moreover, some researchers have created case studies based on real scenarios of teaching and related to the school contents. According to [5], the Active Learning Framework (ALF) was developed to allow students with virtual patient encounters using web-based case studies and engage in open-ended, interactive technology. They found the benefits of using ALF as a platform for teaching clinical content. It was interactive and self-directed, "patients" in a completely safe environment that can be accessed anytime, anywhere. It applied interactive, problem-diagnosis. The authors also said that ALF gave the student concurrent feedback on their information processing and content mastery, and a summative evaluation at case completion.

According to [6], the authors purposed the method for designing courseware on algorithms for active learning with virtual board games. The research found out that students were quite creative and came up with alternative solutions. However, the usability and learning effect of these courseware products needed to be assessed.

## 2.2 Project Management for Game Development

The context of project management course evolves from individual assignments to tracking the whole process. It requires a discipline of a project team. The team approach starts from developing an assumption and collaboratively learning.The approach requires teamwork, problem-solving, communication, and leadership skills [7]. One of course objectives is to prepare students to be able to encounter in the workplace. The students need to learn the reality of working in project teams [8]. According to [7, 9-11], authors suggest an increase in the activities of teams throughout the course curriculum.

One way to explore why a process methodology may work better than the other methodologies is by using a team knowledge theoretical framework. The team then can better prioritize the work that needs to be done, especially with the game development projects, where there is significant ambiguity in the tasks that should be completed as week as the duration of those tasks. According to [12], they defined a model based on [13] which consists of four team knowledge categories: (a) task-related, (b) team related, (c) process-related, and (d) goal-related. The categories in the model are described as follows:

(a) *task-related knowledge* includes shared understanding about the content of the task, how the parts of the tasks interact, and how a task is connected to its environment. It also includes a shared understanding of how a task is supposed to be accomplished by the team so that a sufficient level of performance can be achieved, and how task work is allocated to members.

(b) *team related knowledge* includes team members' knowledge, skills, attitudes, preferences, and tendencies. It also includes shared knowledge of where expertise is located and where it is needed.

(c) *process related knowledge* includes a shared understanding of team processes such as communication, leadership and coordination. It also includes shared expectations of how to behave and useful patterns of action.

(d) *goal related knowledge* includes a shared understanding of the goals, visions, and overall agreements about the team's work. Such goals are mental representations of the overall goal or mission for the team, its performance objectives, and also strategic goals for the organization.

The project management course is extended to support gamification. Gamification commonly employs game design elements that are used in non-game contexts. The contexts can improve user engagement, organizational productivity, flow, learning, crowdsourcing, employee recruitment and evaluation, ease of use, the usefulness of systems, physical exercise, traffic violations, voter apathy, and more [14].

Many works have applied gamification to support education and learning areas. For example, Microsoft released the game Ribbon Hero 21 as an add-on in their software package. It is used to train people to use it effectively. SAP has used games to educate its employees on sustainability [15]. Also, Khan Academy applies gamification techniques in online education [16]. The use of gamification also appears in various situations. For examples, Gbanga launched the educational location-based game "GbangaZooh for Zurich Zoo" that asked participants to save the animals and bring them back to a zoo. Players can learn virtual habitats across the Canton of Zurich to attract and collect endangered species of animals [17]. This evidence shows that gamification can motivate learners in educational situations.

The software tools for game development have been developed to support new technology platforms. One of the popular game tools in Unity. Unity can be considered one of the most renowned virtual reality cross-platform tool for game development software. Unity 3d Game engine is an effective instrument in developing a 3D game, real-time 3D animation and other interactive projects. The most remarkable aspect lies in the train-platform ability which is powerful. Windows and MAC OS systems are engine compatible with all stream platforms. This compatibility extends further towards PC, iPhone, Android, MAC, Wii, Windows Phone, PlayStation, Xbox, etc. Microsoft Visual Studio and Mono Development are also supported by Unity. The user can create script programming on these two development tools. Laying out levels, creating menus, doing animation, writing scripts, and organizing projects are key functions enabled by a complete 3D environment, which can be found in an application created by Unity. The user interface is well-structured and the panels can be fully customized by dragging and dropping.

Besides, assets are any resources in a game such as 3D models, materials, textures, audio, scripts, and fonts. Objects may be realized in diverse appearances such as cube and sphere. The assets can be created externally using 3D modeling applications and painting tools then imported into Unity. By default, 3D game engines have generally been specific objects and are highly particularized about what files a developer gives them. The developer is required to attentively convert all non-Unity files. At present, it accepts 3D file-formats including Maya, 3D Studio Max, Blender and FilmBox with all the rigging, materials and texture intact. Furthermore, all common image file formats such as PNG, JPEG, TIFF, and also layered PSD files directly from Photoshop are within functions of Unity. For audio files, Unity supports WAV and AIF, ideal for sound effects, and MP3 and OGG for music.

### 2.3 Agile Methodology

The software engineering discipline encompasses a large body of knowledge [7] concerning software development technique and project management practices. Software development is difficult not only because the end product is complex with a huge state space, but also because the process is complex involving many aspects, including human, organizational, and technical [3].

Agile methodology was implemented in several new lightweight software development methodologies such as DSDM (Dynamic Systems Development Method), Crystal, XP [9], and Scrum [10]. These methodologies are short cycled, less wasteful, and focus more on the human aspect of software development. Agile practices get running code in production as early as possible and use customer feedback to drive further improvements and changes.

Scrum is a management and control process that focuses on building software. It is primarily a team-level process that can wrap existing practices, development standards and techniques.

## 3. Approach

Active learning has been used as a tool of education for years. The course of project management focuses on how students develop their skills and disciplines. The project management originally replies on how to apply engineering theories and principles to have a project succeeded. The project management course is also based on software engineering methodologies. In particular, the methodology has been focused is agile. The course is also extended to support the context of game development. In this work, our approach supports a course that has students learnt with multi-disciplines. Our approach is based on a team-taught course and interdisciplinary student teams. The five distinct groups of students to be involved in this study are the undergraduate game major. To meet the needs of all groups, the instructor collaborated on projects.

[1]www.ribbonhero.com

It is important that the interaction between sessions in the course and among students in term of agile. Agile software development practices emergefrom the need to have better support for changing requirements, among other reasons. It would not have been possible to foresee the needs of the students in this course. Each project is overseen by the instructor. There is a software tool to support communication between teams and instructor.

## 3.1 Research Design

The initial phase is a field experiment to test the practice of project management. A total of 41 undergraduate students participated in the study. A majority of the students major in in-game interactive and development. All of them are junior students. The course designed for the experiment is a 3-credit, more particularly the course content related to game development project management. The class is driven by the Scrum method, and the students have described the perceived benefits of using Scrum. The class contents encompass the team-developed game design documents and prototypical software implementations. The students are organized to be five groups of 7-9 members. They are asked to develop a different game project. The class is scheduled for Thursday meetings of 15 minutes during the fourteen-weeks time. The students form project teams including game artists, game designers, game developers, and project manager, and scrum master. The course is divided into two phases that spanned the fourteen-week term. The first five weeks are scheduled for the planning and management phase, and the students were assigned different roles contributing to the projects. The following seven weeks are scheduled for the implementation phase. The students work and communicate following the Scrum activities. The students are also coached on how to apply the software tools supporting the Scrum activities. For the last two weeks, the class is driven by retrospective activities and project closure.

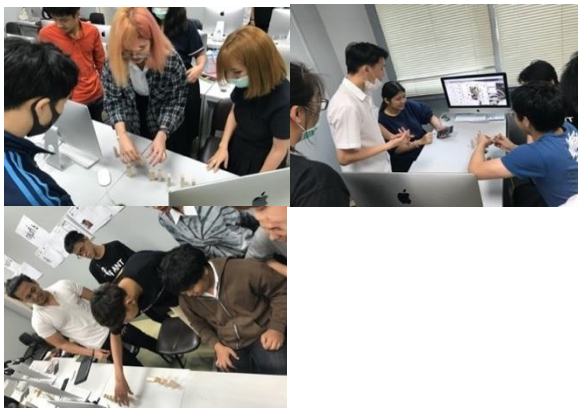

*Figure 1. The participants and experiment of active learning*

## 3.2 Research Scenarios

We have adopted the traditional game development process as shown in Figure 2 and applied it with the Scrum approach as shown in Figure3. The study is also based on project management phases. Those are the planning and management phase, and the implementation phase. The scenarios of active learning are based on game development activities. The students learn through the activities.

*Planning and Management Phase*

The first activities of the project are the creation of game concept documents and making a project plan. A project manager creates the project plan by applying Gantt and WBS techniques and using tools i.e. Trello Gantt [18]. Every Thursday in the class was scheduled for the Scrum meeting. The project manager and team members communicatevia Slack [19] and Trello [18]. Some documents are created, for example, a conceptual report that expresses the vision of the game, describes the contents of the game, and presents a plan for the game implementation. The basic components of the document are the introduction, description, key features, genre, platform, and concept art. It also describes business logistic issues such as feasibility, cost, time, and talents. The team members play different roles in game development and they discuss and followthe issues together via Trello. The students havea meeting and discussion via Slack. During the five-week planning period, the team members are required to involve to pursue complete games. The game designers produce the design documents, particularly by applying UML techniques [20] and using tools i.e. Lucichart [21] for game interaction and behaviour, Blender[22], 3ds Max [23], Maya [24], and Z-brush [25] for three-dimensional object modelling, and Unity [26] for game programming.

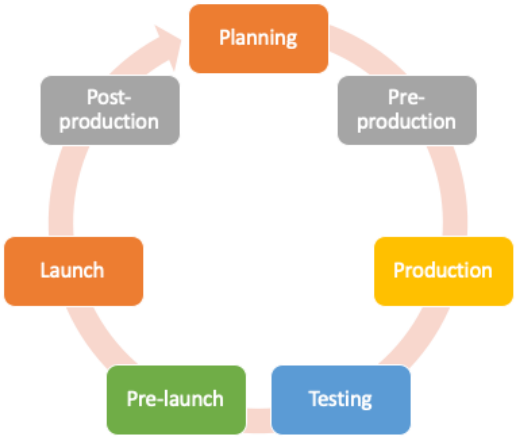


*Figure 2. The traditional process for game development*

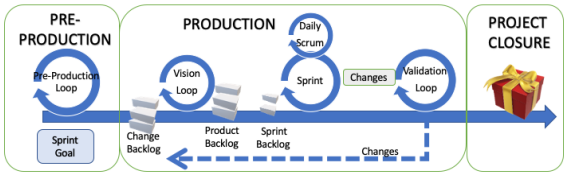


*Figure 3.Tthe adopted process for game development based on the Scrum approach*

In software engineering terminology, the design document presents a functional specification for a game. It describes such aspects as game mechanics, user interface, art and video, sound and music, story and narrative, and level requirements. A good design document should be able to translate into a technical specification and software implementation by game developers.

However, the study applied Scrum practices as a kind of agile methodology. As shown in Figure 3, we have adopted the Agile scrum methodology that is used to develop software systems. Specifically, the team is instructed to do sprints (burst of work) that final two weeks. The team collectively determines what could be done in the sprint (the two-week work effort) with the result being something useable at the end of the sprint. The students are further instructed that the work to be done in the sprint should not change for the duration of the sprint (any thoughts and suggestions would go into the planning of the next sprint). The team is to make sure it finished all the goals of that sprint in the two weeks allotted for that sprint.

The students are asked to make a sprint plan and backlog for each sprint. The meeting is held to review spin planning and backlog. They need to work together to define the goals for the upcoming sprint. while the agile scrum artefacts such as a burntdown chart and processes such as daily meeting are processed via the software tools.
The methodology combines with Kanban. The Kanban board is developed via tools e.g. Trello. It can easily be seen and tracked. The Kanban board includes to do, in process, and completes phases of tasks. Within each phase, there are a maximum number of work-in-progress tasks. Those could be in the phase. Each team is able to define their work-in-progress limits, and the work-in-progress. Limits are explained so that the team members understand a situation. The limits are a key to minimize unfinished tasks. The team members ensure that all work in progress. Moreover, we consider baseline with no defined methodology. In this condition, the students were not given any specific project

*Implementation Phase*

The final seven weeks of the class consist of active development by the interdisciplinary teams. The engineers work exclusively on the software implementation of the games, while the designers split their time between working with the engineers and exploring other topics of game design [2, 6]. We adopt Scrum for agile team management [4]. The students in both courses form the Scrum team. There are three teams, one per project, and each team hasan instructor who acts as a composite Product Owner and Scrum Master.

Not all class time is reserved for the development of the course projects. The team members need to spend extra to work on the projects. They communicated and discuss through the tools i.e. Trello and Slack. Also, the Project Manager has to update their project plan and inform their team members via Trello Gantt. The discussions are designed to complement the students' projects.

# 4. Observation and Results

Through the work with the agile environment, we have come to value:

- Individuals and interaction over process and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

To measure the effectiveness of the method, we apply [Ko et al.'s 30] to measure the success of tasks in terms of solution quality and user perceptions.The evaluation is focused on the project milestones and deliverables. The updates and task progress are communicated among team members through the Trello tool [18].

Also, we apply Hackman's model [27] to identify factors related to team effectiveness. It focuses on the input factors i.e. task output, team collaboration, and team members' satisfaction.

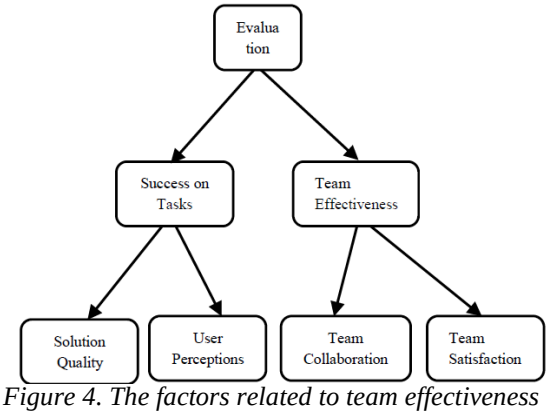


*Figure 4. The factors related to team effectiveness*

We evaluate the quality of the solution by the instructor who have an expertise in game development techniques and tools. The user perceptions and team collaboration are validated by students and using the online survey. Team satisfaction is also validated by students and instructor and using the online survey. More specifically, we employ two sets of an online survey to validate different key measures i.e. user perceptions and team collaboration.

Therefore, we create a questionnaire to evaluate the proposed learning method. The questionnaire consists of two main parts. The first part inquiries about the background information (i.e. major, year, the toles of project member, the tools they used in the process).

The second part provides the list of potential limitations for which we developed the three features. The three features are created based on the factors [27]. Those are:

Feature 1: Task Effort
In this feature, the effort that team members spent on tasks or user stories exceeds the original estimate. It is worth it that the tasks are targeted and achieved by the affected team members e.g. task owner, owners of the dependent tasks, project managers, etc.

Feature 2: Prioritization User Story
This feature supports the release planning activity, which states that the product owner prioritizes the user stories. The feature aims to improve the release of backlog prioritization by using a Priority Quantification Model (PQM) [b8]. When the product owner has a discussion with the project stakeholders to prioritize the user stories, he can use this feature to assist him in the user stories' prioritization.Priority Quantification Model (PQM) is created by SaikatDutt [28]. It takes these important criteria into account during the prioritization process (among others): customer satisfaction, the impact on system architecture, business value, complexity, user story risk, frequency of use and reusability.

Feature 3: Adding New Requirements/ User Story and Re-prioritize Requirements/ User Story
This feature supports the customer involvement in the planning process, by allowing the customer to send a request to add a new user story or to re-prioritize the user stories in the release backlog.

We have implemented the three proposed features in each group project. When a team member communicated task progress through the dashboard. Other members could be notified and informed of the details as their role.

*Findings*
At first, the instructor provides a comparison of the quality of the projects. The overall quality of the project is different, based on the experimental condition. This is because the topic of projects was game design and development. The projects are designed and developed with various tools and techniques. The genre of game projects is diverse. Then the instructor analyses the student perceptions about using each of the software tools and techniques concerning the usefulness and scalability of each tool/techniques. Finally, the instructor provides the online survey regarding tools and techniques for students and observes the feedback via Trello.

*1) Solution Quality*
The instructor evaluates each project which isa total score of 100. The evaluation is focused on the project milestones and deliverables i.e. tasks in Trello, game characters design, 3D model, project plan, Gantt chart, WBS, and game design document, and source code.

The final project presentation is driven online. Each team provided a video clip of a project presentation and submitted it to google classroom. The handouts and other materials are also attached to support the presentation.

The questions from the instructor are posted via the comments and the students managed to give the answers. Finally, the feedback of the project is posted for the team members.The attached documents and game project materials are focused on explaining the results of the projects.

Across the projects, the scores from half-term evaluation and final evaluation correlate 0.8. and no project has a difference between the two presentation evaluation. As shown in Table 1, the average score of each project is given. We have also calculated the standard deviation (Std. Dev.) between the scores of projects. Based on the characteristics of game projects, we found the projects 1 and 2 have some common requirements as the projects 3 and 4 have some common ones. The standard deviation values of projects 1 and 2 are a few different as the ones of projects 3 and 4 are also a few different. We then notice that similar projects can be driven with both methodologies without significant results.

*Table 1. Average Score and Standard Deviation*

| Projects | Average Score (1-100; 100 is the best) | Std. Dev. |
|---|---|---|
| 1 | 65.5 | 1.2 |
| 2 | 78.0 | 1.1 |
| 3 | 84.0 | 0.4 |
| 4 | 70.5 | 0.6 |

*2) Limitations on planning and management*

Regarding agile planning, the students are asked to determine the extent to which they agree that limitations during the project development process.

Firstly, more than half of the students (62.5%) agree or strongly agree that the efforts spent on some tasks may exceed the original estimate, and the lack of awareness about the delay may cause some user stories of an iteration to not be completed in the due date. Besides, 18.75% of the students neither agree nor disagree with this limitation as shown in Figure 5. Therefore, we can conclude that there is a reasonable need to provide support for this limitation.

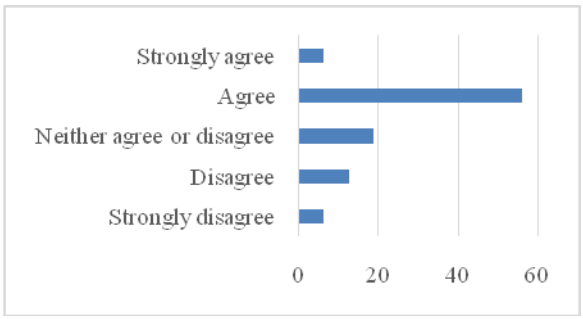


*Figure 5. Students' opinions about the first poin.*

Secondly, the majority of the students (79%) agree or strongly agree that some product owners and project stakeholders may face challenges to prioritize the user stories and so thy need guidelines or criteria for proper prioritization as shown in Figure 6. Therefore, we can conclude that there is a clear need to provide support for this limitation.

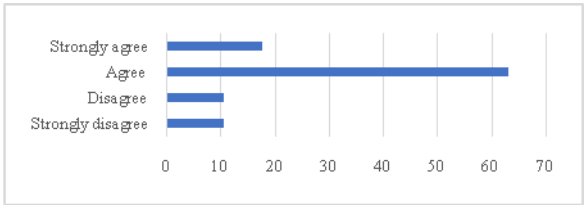


*Figure 6. Students' opinions about the second point*

Moreover, most of the students (70%) agree or strongly agree that the customers may lack proper support to change the priority of existing user stories or add new user stories, while 25% of the students neither agreed nor disagreed with this problem as shown in Figure 7. Therefore, we can conclude that there is a clear need to provide support for this limitation.

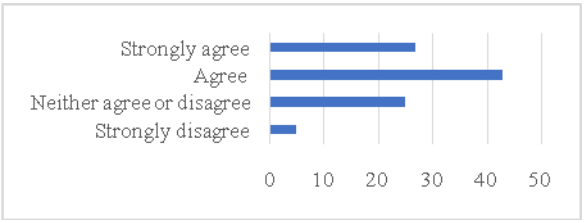


*Figure 7. Students' opinions about the third point.*

*Implementation of the Features*

According to the features described in the previous section, the feature to find out how the Scrum approach and agile tools course it is found that the majority of the students (62%) agree or strongly agree about the implementation based on Scrum practices and agile tools; followed by 21% of the respondents neither agree nor disagree about implementing the task effort notification feature as shown in Figure 8.

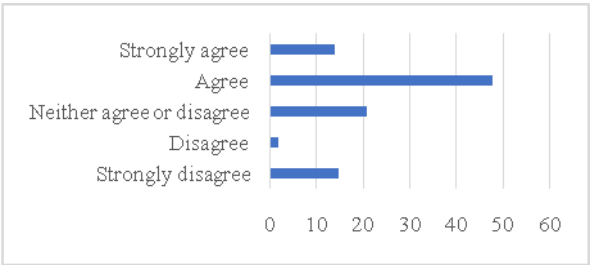


*Figure 8. Students' opinions about the implementation of task effort notification.*

Moreover, it is found the majority of students agree or strongly agree about improving user story prioritization. More than three-quarters of the students agree that user story prioritization can be improved by agile planning tools.

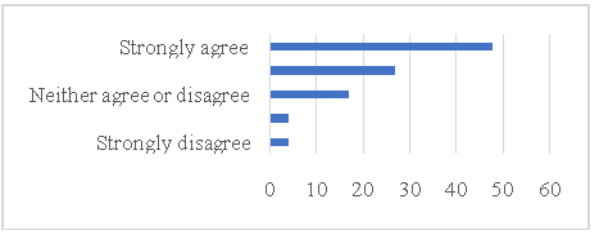


*Figure 9. Students' opinions about improving user story prioritization*

Besides, most of the students (58.82%) neither agree nor disagree about the implementation of adding a new user story and re-prioritizing user story by a customer in the agile planning tools. Also, 30% of the students disagree or strongly disagree regarding the implementation of the extent as shown in Figure 10.

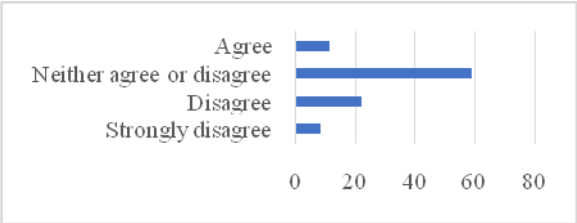


*Figure 10. Students' opinions about adding a new user story and re-prioritizing user story*

## 5. Conclusion and Discussion

The results show us the active learning is appropriate to game project management course. The learning progress of students who apply the Scrum approach comparing with the learning progress of ones who apply the traditional approach is insignificant different.

We found that user story prioritization is the most need in the agile planning tools from the students' perspective. It is found there were two significant factors. First, the software agile development teams require incorporating more factors during the prioritization process i.e. customer satisfaction, the impact on system architecture, business value, complexity, user story risk, frequency of use and reusability). Second, the complexity of calculating the priority of each user story, there is a need for tools to support agile teams.

Moreover, the limitations of agile planning support are highly suggested. Most of the students are not satisfied with simple tools.

Project management planning tools for agile teams are currently widely available. The majority of them support the key functions for planning activities; however, they still have limitations.

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