Consideration of Educational Tools and Methods of Software Engineering Education for non-CSE Students

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Abstract: In the 4th Industrial Revolution (4IR), one of the important issues is to educate software engineering not only to computer science and engineering (CSE) students who specialize in information but also to non-CSE students who major in humanities and society and so on. It is not only for gaining a job in developing and operating digital technology and systems, but also for solving many social problems such as sustainable development goals (SDGs) and also leading to ethics such as human happiness. It is necessary to combine all kinds of knowledge such as science, engineering, humanities, social science, etc. in order to solve complex social problems. Students majoring in humanities and society do not have enough knowledge and skills in engineering like first year student, so they need educational tools and methods to learn software engineering smoothly. In this case study, we conducted to combine the Learning Management System (LMS) of communication function which is a share tool by digital approach and Idea-sketching for idea generation by analog approach such as pen and paper. The classes for humanities and social science students who are not good at computer operation have found that they learn smoothly. As contribution of this study, it suggested a possibility effective as an educational tools and methods for first year students majoring in computer science as well as students majoring humanities and social science.

1. Introduction
The digitalization that develops in the global economy and digital transformation are attracting attention [1]. Germany is at Industry 4.0, Thailand is at Thailand 4.0, India is at Digital India, etc. In Japan, we are focusing on the development and utilization of systems that highly integrate cyber space and physical space. And we aim at the human-centered society (Society 5.0 [2]) which realizes the coexistence of economic development and solution of social problems by the system. Therefore, every policy has been raised in each ministry. In order to realize Society 5.0, it is required to combine all kinds of knowledge such as science and engineering, humanities and social systems.
However, the development of human resources who can build such a society is partially discussed. For example, with regard to the education of science and engineering and information systems in universities, examination is progressing on the ideal way of education that leads to the development of human resources who can develop systems. However, discussions on human-centered society that achieve both economic development and solution of social issues are not enough. There is a possibility that such education can be realized in human and social systems that are closely related to human beings and society, but it is not the current state where sufficient discussion has been made. From such a background, this paper focuses on issues in consideration of sustainable development goals, and discusses software engineering education for undergraduate students of so-called humanities and social universities.

2. Case study

In the software development class, at the knowledge creation [3] stage, we added the idea sketch of the interactive class analog tool to the digital collaboration tool the Moodle, and practiced learning by combining these. The students were able to develop the possibility of deepening their ideas, keeping records, and looking back on their records to inflate the next idea. The student's prior knowledge and conditions before learning are as follows.

1. Students have already learned how to use the Moodle in the learning management system. Students can use the function to submit reports, and can also use the function to post and reply to the Moodle online forum.
2. Students have already learned that there is a process of digital manufacturing and design thinking. The process includes items such as idea generation, conception, planning, design, implementation, testing, and evaluation.
3. The students understand Ideason and Hackathon. In this class, we practiced a method of expressing ideas in a free atmosphere, in the style of a world cafe.
4. Students have already learned the techniques for creating ideas. This study focuses on the technique of idea sketching. The idea sketch will be described later.
5. Students have already learned the techniques for presenting ideas. The key to presentation is to organize the logic and simplify the content you want to convey most. The concept is a presentation technique based on the spirit of Zen.

The students create ideas and develop the ideas through dialogue. The students write their ideas on the form and organize them. The students present the organized ideas, get feedback and make improvements. This study covers the process of presenting these ideas. The whole course, after this process, has design and implementation stages. At the design stage, students create activity diagrams and use case diagrams. The implementation is a hybrid application development of HTML5 using cloud service by JavaScript, CSS, and HTML. The process from idea creation to presentation is as follows (Figure 1).
1. First, the teacher explains the background of social issues and an overview of SDGs [4]. Next, there is an explanation of the relationship between the solution of these social issues and the problem solving by information technology. The teacher gives a topic on the solution of social issues as a class solving theme. The topic of social issues is to create useful tools and apps for disasters.

2. Each student thinks about the topic.

3. With World Cafe Style, the students are paired and talk freely on topics. The number of sets is three.

4. Students reflect on what they talked and draw an idea with a pen on a paper idea sketch style (Figure 2).

5. The student digitizes the idea sketch and uploads it to the Moodle forum.

6. Students present the materials of the forum and explain the idea sketch. As a listener, we listen to the presentation except for the presenter.

7. Auditors give constructive comments and questions on the presenter's ideas.

8. The presenter concludes with a word after receiving feedback from the audience.

9. The facilitator briefly summarizes the outline and prepares the next presenter for presentation.

10. During this time, the audience will use the Moodle to give feedback.

11. The presenter looks back on his idea, also referring to the Moodle reply.

12. Repeat the process of numbers 6 to 11.

Figure 1. Process and methods of idea creation to solve social problems for non-CSE Students
3. Results and discussion

In this section, the main points of the organizational knowledge creation theory are organized to give a perspective on co-creation activities from the viewpoint of the organizational knowledge creation theory. Organizational knowledge creation is understood as the process of systematically amplifying the knowledge created by an individual and crystallizing it into the organization's knowledge network [3]. There are various definitions and classifications of knowledge. In organizational knowledge creation theory, knowledge is divided into explicit knowledge and tacit knowledge. The knowledge here is that formal knowledge is knowledge that can be expressed in a formal language found in sentences, technical specifications, manuals, etc., tacit knowledge is other knowledge. There are know-how, skills as perceptual aspects, mental model [5], and perception as perceptual aspects. The mental model means a practical model of the world created by manipulating the analogies that are born in the mind [5]. In addition, the focus is on the knowledge of individuals and organizations, and there is knowledge conversion from individuals to organizations and from organizations to individuals. There is a model in which knowledge is classified into formal knowledge and tacit knowledge, individuals and organizations, and classified into four quadrants called the SECI model. Each of the four processes of socialization, externalization, combination, and internalization is known and is described in detail in Ref. [3].

When knowledge of idea creation is divided into tacit knowledge and explicit one, the latter is regarded as the tip of the iceberg, most of which is tacit knowledge. This insight leads to a Japanese-style knowledge view that emphasizes tacit knowledge, and can be classified into each process by applying the SECI model. By doing so, it is possible to provide a viewpoint based on organizational
knowledge creation theory, and it is possible to consider by analogy similar to the framework for knowledge creation so far. Therefore, our practice can apply knowledge creation theory as a framework. “Thinking Time” is a process of accessing tacit knowledge and digging deep inside thoughts through dialogue. Dialogue has access not only to others but also to the inside of oneself. “Creating Time” is the process of expressing tacit knowledge into a form. This process can externalize tacit knowledge by expressing inner thoughts on paper. This has the role of organizing and summarizing ideas by expressing personal thoughts in a concise manner. “Presentation Time” is a process of communicating as tacit knowledge to others using an idea sketch form expressed as explicit knowledge. In other words, there is a role to convert explicit knowledge to tacit knowledge. Through this process, tacit knowledge formed as a joint activity matures. “Reflection Time” will further deepen the hierarchy through internalization and reflection of tacit knowledge.

In our practice, the LMS shared by the group was adopted as a communication support tool, however there were some problems such as not being able to communicate easily and not fully communicating the intention. On the other hand, text information (explicit knowledge) is more advantageous than tacit knowledge because of its high ability to retain information for information propagation and long-term recording. One of the future study is how to communicate and share tacit knowledge. In order to promote co-creative learning among students, one of the attempts is to create a “Ba (place)” where people can interact in a relaxed atmosphere. The Idea Sketching has been practiced in a variety of technique by different field. In our case study, we performed the practice by considering a sheet that you could begin to write a headline and just write three sentences in turn, so that everyone could create ideas easily even you are not a designer. In addition, there is the blank on the sheet so that everyone can insert a figure or a picture in and can describe an idea or the explanation just comes to your mind freely (Figure 3, Figure 4).

As a result, there was an idea of a game that uses location information among smartphone functions. There was also an idea for selecting clothes using the AR function. Students use smartphones every day. However, there has never been an opportunity to think about ideas on the side of developing the application, so it became a good learning opportunity as a way to learn creative thinking and digital manufacturing. A variety of ideas were created during the classroom practice of Idea Sketching. We formed the impressions of Idea Sketching from students as following.

a. Through the technique of Idea Sketching, I can see general construction by making my image to the figure.
b. It is a figure that shows what a designer or creator is imaging. As the figure is embodying someone’s images, it is not suitable for team work.
c. The advantage is what it is easy to see. It is expressed through the figure and keep the words to a minimum. Furthermore, the figure is drawn by the headline of the theme of idea so that it is consistent with the theme. It’s an effective way to express one’s ideas briefly.
d. We can shorten the period of development through developing the software according to the inventor’s intention.
Figure 3. Process of Knowledge Transformation from Co-creation Activities to Idea Sketching

Figure 4. Process of Knowledge Internalization and Knowledge Socialization
4. Conclusion

We carried out idea creation technique called the Idea sketching during the process of the software development class with LMS function such as Moodle forum. The classes for humanities and social students who are not good at computer operation have found that they learn smoothly. The students were able to develop the possibility of deepening their ideas, keeping records, and looking back on their records to inflate the next idea. We assume the application of knowledge exploitation from the phase of plan making before demand specifications. As contribution of this study, it suggested a possibility effective as an educational tools and methods for first year students majoring in computer science as well as students majoring humanities and social science. In this field, like agile development and DevOps, the acceleration of R&D period and the agility efficiency of R&D can be observed in the world. Furthermore, we will focus to attach importance to user experience.

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