10.14943/J.HighEdu.24.9
J. Higher Education and Lifelong Learning **24** (2017)

Problem-based Learning and Problem Finding Among University Graduate Students

Ankit A. Ravankar,[1)*] Shotaro Imai,[2)] Michiyo Shimamura,[3)] Go Chiba[1)] and Taichi Takasuka[4)]

1) Research Faculty of Engineering, Hokkaido University, Japan

2) Institute for the Advancement of Higher Education, Hokkaido University, Japan

3) Innovation Promotion Office via Marine-Earth Science and Technology, Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

4) Research Faculty of Agriculture, Hokkaido University, Japan

Abstract — In recent years, problem-based learning (PBL) techniques have been gaining momentum in schools and university curricula around the world. The main advantage of the PBL method is that it promotes creative problem solving, improves cognition and enhances overall thought processes in learners. For most PBL-style programmes, problem solving is at the core, although the notion of problem discovery or problem finding is not seriously considered. In most cases, students are always presented with a structured and well-defined problem, but have no experience of solving an ill-structured problem or 'wicked' problem. The present study focuses on problem finding as a critical step towards developing problem solving skills in university graduate students. The study aims at understanding the importance of problem formulation and creativity, and focuses as well on our attempt to teach problem finding as an important tool in the development of creative thinking and problem solving among graduate students. The study is part of a special graduate programme called the Nitobe School at Hokkaido University in Japan, which started in 2015. In an active learning classroom setting, this course is intended to support graduate students in their discovery of ill-structured problems, help them to understand their formulation and thereby improve their problem solving skills. We present the results of our teaching method for the first year at the Nitobe School and share our findings through this work.

(Accepted on 2 December, 2016)

I. INTRODUCTION

The primary goal of university education programmes is to train young individuals who are capable of contributing to society and its development by applying the skills they acquired in the university setting. There has been a drastic transformation in the university education system over the last decade, with more programmes, which focus on PBL, increasingly being adapted within the context of education programmes. The PBL is a student-centric training approach, in which students discuss, in a team-based learning (TBL) environment, an open-ended problem or situation. The aim of the PBL style of teaching is to enhance students' knowledge, improve cognitive thinking, enhance creativity and make them better problem solvers (Barrows 1986; Basadur et al. 1982; Simon 1978).

The world is constantly teeming with new and existing problems, with challenges that need to be addressed every day. On the other hand, new problems

*) Correspondence: ankit@eng.hokudai.ac.jp

also need to be discovered from time to time, for example, the breakout of a deadly disease, natural calamity, such as an earthquake, or a global financial crisis can affect the population at large. There is a lot to be expected from young university graduates in terms of contributing to the development of society. Universities play an important role in this regard, with more of them focusing on education, that is problem-centric and addresses the crises faced around the globe. It is expected that training for PBL will improve the problem-solving skills of students in the long run after they step outside the university setting into the real world. However, within the problem-solving process, problem-finding has been mostly neglected or under-represented. Most studies focus on improving problem-solving skills by blending creative thinking with the problem-solving process, while altogether missing out the notion of problem exploration or problem formulation. The significance of problem-finding as an important skill has been previously discussed in works by Getzels (1975), Gallagher et al. (1992) and Okuda et al. (1991). However, there has been very little research on teaching problem-finding skills to graduate students. Problem solving remains at the core of PBL training and always requires a structured problem to be presented beforehand. It requires problems that are well defined or that already exist. But, in reality, most of the time, the problem itself does not exist and needs to be discovered. In a TBL scenario, a teacher presents a well-prepared and structured problem to the group of students, with clear goals. The problem-solving process then involves students brainstorming new ideas to address the given problem and come up with an existing or a new solution through mutual discussions. However, the problem then concerns whether there is in fact a well-defined problem in order to begin the discussion, such that the problem itself needs to be explored through careful observation. This situation is very much a practical one when we consider real-world problems. It is also important that such skills be included along with problem-solving to give students the intuitiveness towards tackling new and challenging problems. Thinking about and delving into the problem, rather than simply solving the problem, and then discovering and envisaging the solution by going deeper into the question represent important traits in problem-finding processes. Indeed, in great discoveries, the most important thing is that a certain question is found. Such skills can give new direction to the way in which students deal with problems, thereby making them better problem solvers in long run. As Einstein articulated in Einstein and Infeld (1971), "the formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advance in science." Previously, Getzels (1975) presented, in detail, the classes of problems or problem situations, namely, presented problems, discovered problems and created problems, depending on whether the problem already exists, who found it, and whether it has a known formulation, known method or solution. Based on these formulations, it becomes very important for students to spend quality time thinking about and dealing with problems before finding the solution. The present study aims at bridging problem-solving and problem-finding in a PBL framework for graduate students. Now that the first year of a related course, which was offered at Nitobe School, Hokkaido University, Japan, has concluded, we are able to present our method for teaching problem-finding in an active learning classroom with students from diverse backgrounds, as well as report the important lessons that were learnt from this course.

II. BACKGROUND

A new trans-graduate school programme called Nitobe School was launched in 2015 as a part of the Top Global University Project at Hokkaido University (Yamanaka and Shimamura 2016). This programme aims to fill the gaps in the currently underdeveloped skill sets of graduate students from different graduate schools, by nurturing generic competences through TBL and PBL

Table 1. Nitobe School Curriculum

Course	Term	Outline
Start-up Course	Spring Term	Guidance and basic knowledge and skills (i. e., Facilitation, Project Management, Promoting Social Entrepreneurship and Marketing), which will be necessary in the summer term and provided in subsequent terms.
Global Issues Course	Summer Term	By focusing on the environment, society, economy and culture, the students will learn about global challenges and acquire an interdisciplinary viewpoint.
Problem-solving Course	Fall Term	Each student will propose a solution for the set theme. Students will learn about organizational work and collaboration, which are necessary for solving problems. The goal of this course is to instil competency with regard to solving problems through teamwork.
Problem-finding Course	Winter Term	Students will learn the process of problem-solving from the determination of the problem to the analysis of its causes, surveying and assessing solutions found in the past, and proposing ones own solution. This class will be conducted with the cooperation of teaching staff with relevant expertise and external collaborators, including members of the local community and businesses.

classes.

In 2008, the Ministry of Education, Culture, Sports, Science and Technology in Japan (MEXT) defined generic competences of knowledge, generic skills, perspective and creative thinking, which undergraduates need to demonstrate in order to achieve the ‘Gakushi-ryoku’ diploma (CCR 2008). Within the framework of the Top Global University Project, Hokkaido University was nominated as a top university (Type A), having potential to make a transition towards becoming a truly global university (MEXT 2016). The Hokkaido University Campus Initiative (HUCI) was started in 2014 in order to plan the future strategies to achieve this goal (HUCI 2016). Reflecting this goal is the following motto, ‘Hokkaido University for the resolution of global issues,’ which is underpinned by four basic philosophies: ‘frontier spirit,’ ‘global perspective,’ ‘all-round education’ and ‘practical learning.’ Nitobe School aims to fulfil these philosophies by providing a common platform to graduate students from different graduate schools, irrespective of their expertise and field of study. It gives the students a suitable platform to come together and acquire competitive skills through active learning. The style of teaching at Nitobe School is primarily TBL and PBL, such that graduate students from different cultural and academic backgrounds can study with and learn from each other in a truly global classroom and acquire skills, which will enhance their career and research standards.

A. Nitobe School Curriculum

Nitobe School was established in 2015 and currently of fers four courses, to graduate students, which forms the basic course programme. Table 1 shows the basic structure of the courses offered by Nitobe School. More details can be obtained from the programme’s official website (NS 2016). Apart from the basic courses, students are supported by Nitobe School Portfolio (NPF) system, access to mentors and advisers, and English language training (Yamanaka and Shimamura 2016; Shimamura et al. 2016). The NPF is a web-based system, allowing students to track their learning progress over the period of the course and providing a means of promoting students’ proactive learning and quality assurance within Nitobe School. Using the system, students can update their records, visualize coursework, complete homework, submit assignments and reports, and communicate with teachers or colleagues. The advisers are all professors, who are close to the respective students’ field of expertise or from the same graduate school, and act in a supporting role with the students. Mentors are senior alumni and young professionals from Hokkaido University who are employed in multinational companies or as young researchers in universities in Japan and abroad. The mentors are generally in their 30s and help students with career counselling, introducing them to companies and developing their job profiles, and networking with professionals. The mentors act as role models for students and share their successful career journey with students.

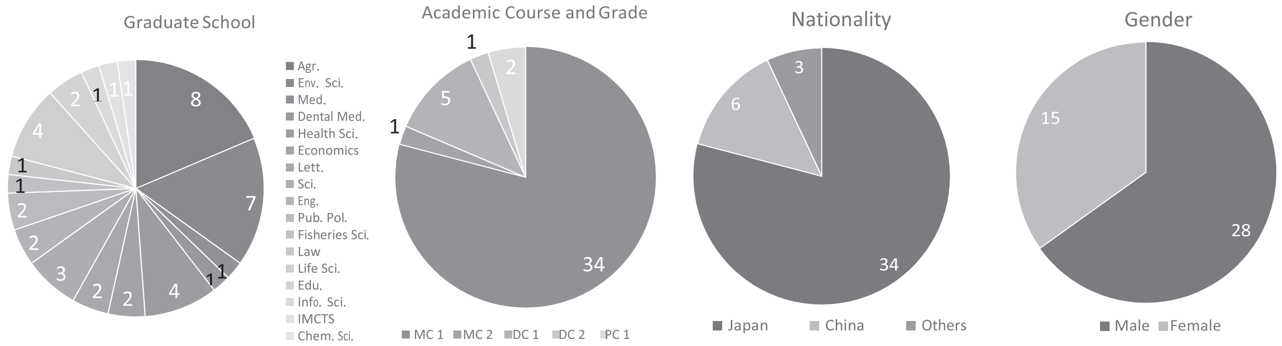


Fig. 1 Student Distribution and Grade Level

Table 2. Nitobe School, winter term (Problem-Finding) schedule

Week	Date	Task
Week 1	1 and 3 December	Guidance and special lectures
Week 2	8 and 10 December	Group discussions and topic selection
Week 3	15 and 17 December	Group discussions: hypothesis planning
Week 4	23 December	Intermediate presentations and mentors meeting
Week 5	7, 8 and 9 January	Fieldwork
Week 6	19 and 21 January	Group discussion and analysis of fieldwork
Week 7	26 and 28 January	Group discussions
Week 8	2 February	Final presentation

In the next subsection, we will discuss the course structure for the problem-finding course. All classes in Nitobe School involve active learning and TBL, with students becoming acquainted with the method of active learning during the first two quarters ('Start-up' course and 'Global Issue' course) and being made well aware of the process of group discussion and brainstorming, as well as facilitation and group presentations. For example, students enrolled on the programme learn the basics of group discussions and team building with students of different nationalities and graduate schools in the first quarter. They learn about group discussion techniques and facilitation in the second quarter, in which there is a focus on a specific global issue theme, which is decided for the class. In the third quarter, they learn how to apply creative thinking, brainstorm and generate new ideas and solutions to a given problem (global or local issue). We will limit our discussion to the problem-finding course for the sake of this article.

B. Course Structure and Framework

The problem-finding course was the fourth course in the one-year basic programme at Nitobe School and offered in the winter term. The schedule for the classes is given in Table 2. The course consisted of eight sessions lasting 180 minutes each and was offered biweekly for two different batches of students on Tuesdays and Thursdays. The course was offered immediately after the problem-solving course. It was assumed that the students were well aware of the process of problem-solving from the previous course and able to approach finding the solution to a given problem through team discussion and brainstorming.

A total of 43 students participated in the course. The students came from 17 graduate schools at Hokkaido University and were divided into two separate classes (Tuesday and Thursday). Having a diverse group of students from different academic backgrounds, studying for either a Master's degree or a PhD, ensured that a wide variety of ideas (analytical and logical) and experience was brought to the discussions. The student distribution can be found in Fig. 1, which shows the distribution of participating students from the different graduate schools. It also shows the grade level of the students who participated in this course (MC: Master course; DC: Doctoral course; PC: Professional course).

C. Course Goal

The goal of the fourth quarter of the problem-finding class was to instigate problem exploration and curiosity towards problems in general. The aim was for the students to not only think of a solution to the given problem, but also try to discover and investigate the reason why the problem existed in the first place. As problems exist everywhere, it was important to stress that problems do not arise by accident, but for a reason. In order to arrive at an appropriate solution, it was imperative that the problem was thoroughly formulated. It had to be posed in a structured and organized way, such that an effective solution could be obtained. The reason why the notion of problem discovery and problem-finding was taught as a separate subject in Nitobe School was to enable the graduate students to understand that problem formulation is a tedious process, and that people who actively engage in this process and spend more time understanding the problem tend to arrive at more creative solutions, thus becoming better problem solvers (Getzels 1979).

The students in each class were divided into teams of five to seven students each. They were divided in such a way that each group comprised members with diverse backgrounds and grade levels. Having students with contrasting academic expertise in a group helps to generate ideas that do not easily emanate from ones own expertise. It also helps students to learn from each others experiences. Fig. 1 also shows the nationality distribution of the students.

D. Role of Students and Teachers

Each team was given the task of creating a virtual client and acting as a think tank for the client. Since the members of the team came from various graduate schools, each member had to refer to their own specialism and act as an expert to the think tank. A think tank is a group of people with varying expertise, who are generally hired to identify and solve complex problems. Think tanks around the world have a good sense of identifying problems. The students first had to find the hidden problem from the given keyword. The keyword was given to the whole class in the first week during the guidance. The keyword for the fiscal year 2015-16 was ‘energy.’ Using the keyword, the think tank had to first formulate a virtual client and then instigate the hidden problem. The students were given complete freedom to interpret the keyword in any way they chose; for example, one team interpreted the term energy in relation to energy from food, while another group perceived it with regard to the emotional energy of high school students.

All the teams were assigned a tutor, who acted as a facilitator to the group and supervised their progress. The tutors were young faculty members from different graduate schools, as well as from Nitobe Schools. A previous study by Imai et al. (2016) reported the use of multiple instructors in an active learning setting. The role of each instructor was to observe and give critical feedback to the team if needed. They were not to influence the team discussion in any way, but should make sure that the discussions were progressing in the right direction, without the students being intimidated. We believed that fact finding would help the students to come up with different ideas through brainstorming. Each team had to formalize the subject and the fictitious client by the end of second week. In each class, the students were briefed about the task in hand and given a review of the previous weeks task by the instructors. In this active learning setting, the students were provided with tools, such as poster sheets, sticky notes, whiteboards, marker pens, stationery and other related items to use during the discussions. The students were given 150 minutes for the discussion, followed by 45 minutes for a group presentation on the days progress by each team during every session. Feedback was given to each group after the

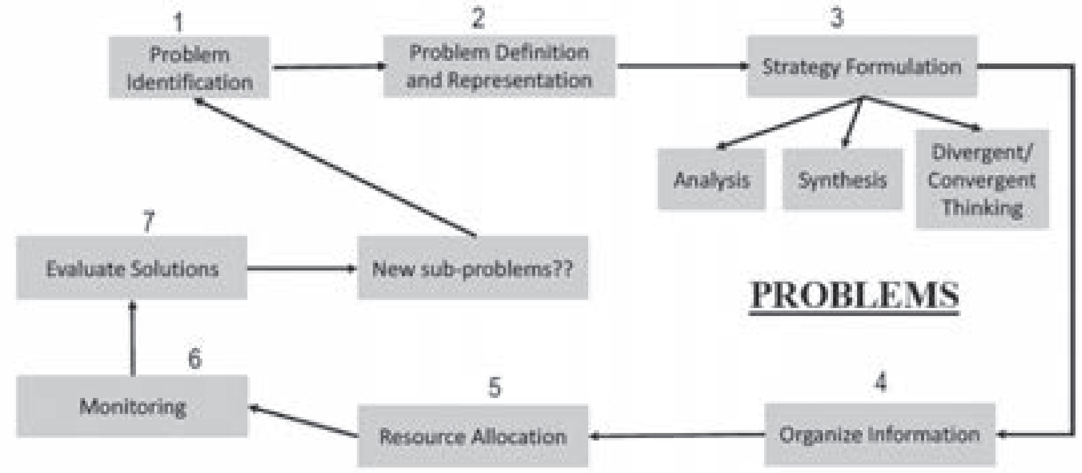


Fig. 2　Problem-solving cycle

presentations by other teams and instructors, who also suggested ideas to further strengthen each team's hypothesis. This was done for all classes except during the final presentation.

E. Hypothesis

If we carefully look into the problem-solving cycle, as described in Fig. 2, it can be seen that the cycle begins with the identification of the problem, while problem identification is the final goal of the problem-finding process. In other words, the first step in problem-solving is the last step in problem-finding. The problem-solving cycle involves different stages of searching for and collecting existing facts and findings in order to reach the next stage, in which both divergent and convergent thinking is required. When one encounters a problem, the knowledge related to that problem is activated in our memory, while facts and concepts related to those structures are retrieved. This happens unconsciously and results in the generation of solutions. For problem-solving, the new ideas and solutions that are generated will most certainly resemble solutions to similar problems from the past, unless and until a cognitive effort is directed towards expanding ones information and perception (Reiter-Palmon and Illies 2004). In this regard, defining the problem becomes very critical. Problems can be divided into two broad categories: presented problems and discovered problems. In the former situation, the problem has a known solution and a known method. Meanwhile, in the latter situation, the problem does not have a known solution; indeed, no solution exists at all. The most extreme case with regard to the discovered problem situation can be when the problem itself is not presented and must be discovered. Here, only a general dilemma exists; although the question itself needs to be discovered, it may not contain a solution. In this case, the investigator needs to sense the problem. They needs to see, imagine and feel the unidentified problem (Ravankar et al. 2016), as well as formulate and develop the solution, believing that it exists as the problem is discovered. Such problems are termed as 'wicked' problems, In 1973, Rittel and Webber (1973) introduced the term 'wicked' problem with the following characteristics: (a) There is no definite formulation of a wicked problem; (b) wicked problems have no stopping rules; (c) solutions to wicked problems are not true-or-false, but better or worse; (d) there is no immediate and no ultimate test of a solution to a wicked problem; (e) every solution to a wicked problem is a 'one-shot operation'; (f) wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan; (g) every wicked problem is essentially unique; (h) every wicked problem can be considered to be a symptom of another problem; (i) the causes of a wicked problem can be explained in numerous ways, and the choice of explanation determines the nature of the problems' resolution; (j) when working with wicked problems, the planner has no right to be wrong. With wicked problems, the goal is not to find the truth, but to improve some characteristic of the world in which people live. While in the hard sciences, researchers are allowed to make hypotheses that are later refuted, when dealing with wicked problems there is no such immunity. The idea was to introduce the notion of such 'wicked' problems (ill-defined problems) to the students and make clever hypothesis in order to understand them.

In our efforts to teach problem-finding, we wanted the students to go to extremes when thinking about how the problem originated. This involves a task that is difficult, but fruitful in the end, as it creates a body of entirely new knowledge about problem discovery and its existence. A hypothesis is an important tool to encourage students to overcome the first hurdle in attempting to discover the problem. The hypothesis represents an imaginative preconception or an inspired guess about some particularly interesting aspect of the world. Every discovery in the world begins with a hypothesis. In our case, the students were asked to come up with a hypothetical situation in order to start working with the problem. As the keyword for the task has been prescribed, the teams had to create and imagine a situation for an appropriate hypothesis to exist. The team spent the first three weeks generating a hypothesis in response to the keyword. In the fourth week, a poster presentation was organized with the mentors and advisers, in which the teams presented their hypothesis, as well as their hypothesis and fieldwork plan, and explain what they believed the problem to be and why it existed. During the poster session, the teams received critical feedback from the mentors and advisers about their fieldwork.

F. Envisaging the Problem

To challenge the students into coming up with a good hypothesis and generating creative ideas by thinking outside of the box, Nitobe School offered the teams the opportunity to undertake fieldwork in relation to their respective hypothetical situation. This was the main feature of our teaching method in helping the students to envisage and sense an ill-structured problem. An ill structured problem has the following characteristics: (a) more information is needed than is initially available in order to understand the problem; (b) the problem may change as more information is added; (c) for the same problem, there may be different perspectives to interpret the information; and (d) there is no absolute right or wrong answer.

In the fourth week, during the midterm poster presentation, the teams had to decide upon the site of and plan their respective fieldwork assignment, in which they would test their hypothesis. The fieldwork sites were chosen by the students and located in the Hokkaido region of Japan. We believed that the fieldwork would give students a feel for the problem in hand. Through careful observations, communicating with stakeholders, and discussions, it was expected that the students would be able to justify their hypothesis. The fieldwork was also an opportunity for the students to understand the factors and situations under which a certain problem exists. For most of the students it was also the first hand experience at conducting the fieldwork for research and learning the know hows of how to conduct a good fieldwork. The students were encouraged to interview stakeholders associated with their hypothesis in order to more fully explore the respective problem. They had to investigate the most minute details and try to instigate the hidden problem through interviews, understanding the local situations and applying communication and observation

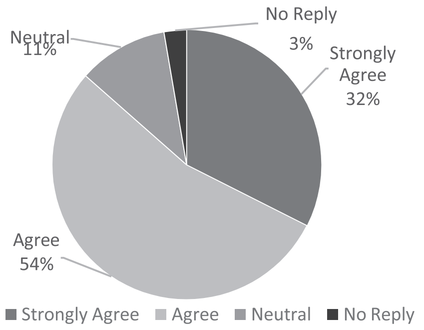


Fig. 3 Overall response for the course

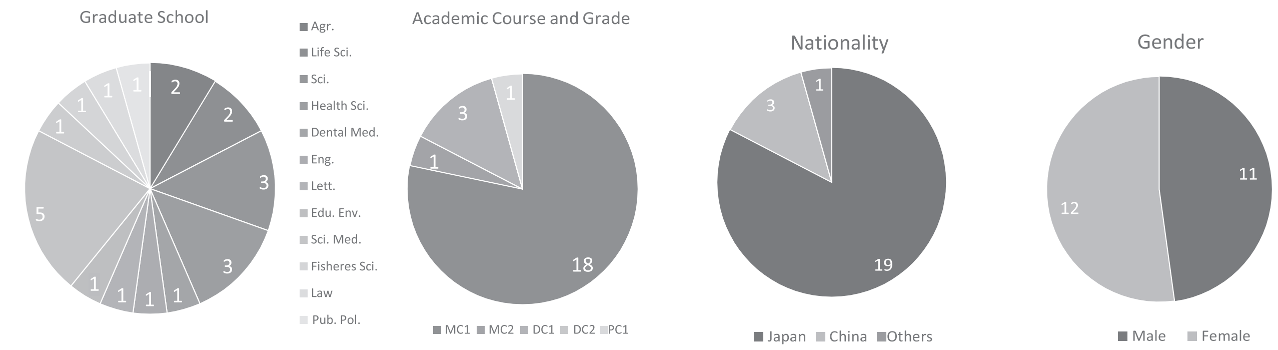


Fig. 4 Number of respondents to the questionnaire

skills. There was also the possibility that a teams hypothesis could be wrong or that the situation did not exist. In such an eventuality, the teams were allowed to change their hypothesis and create a new one based on their observation and investigation. The students were also allowed to change the problem. The goals were concerned with discovering the interdisciplinary nature of real-world problems (or local issues) and improve their observations through actual field visits, during which the problem could be felt, seen and judged.

The field trip was accompanied by the tutors, whose role was simply to observe the students approach to investigating the hypothesis. The tutors were allowed to make critical comments if they felt that the students were becoming intimidated and moving away from problem-finding. The tutors were there to supervise and assist students in arranging interviews with stakeholders, making travel arrangements and taking part in discussions when the teams were confused in the course of their fieldwork.

The students spent the last two weeks formulating their respective problem and final presentation. The students were free to discuss any solutions to the problem that they had discovered, but this was not compulsory.

III. RESULTS AND DISCUSSIONS

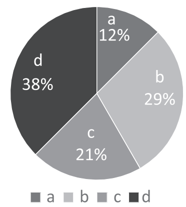
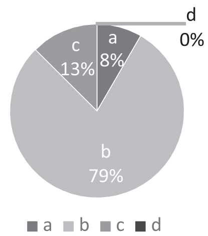
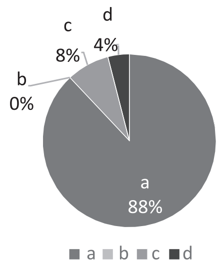
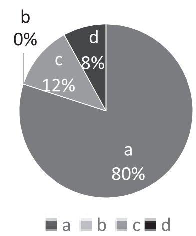
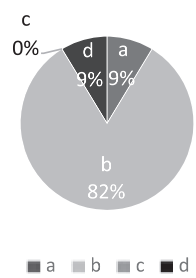
A. Questionnaire

A questionnaire was conducted after the class in order to evaluate the course. A web-based questionnaire was made available to the students from 8th March to 18th March, 2016 in both English and Japanese. Since it was the first year of the problem-finding course to be offered to the graduate students, the purpose of the questionnaire was to evaluate the teaching and enable the faculty to make necessary changes to the course structure or teaching style when the course is offered again next year. A total of 24 students out of 43 completed the questionnaire. Fig. 4 shows the number of respondents who completed the questionnaire out of all the enrolled students (Fig. 1). The questionnaire is presented in Table 3. The low response rate could be attributed to the timing of the questionnaire which was done after the course was over. The time usually marks the beginning of month long spring break and not all students answered the questionnaire due to this fact.

According to the questionnaire results, most students responded positively to the course (86%), and that the course was useful for their future career. The majority of the students agreed that the course helped them understand about problem-finding.

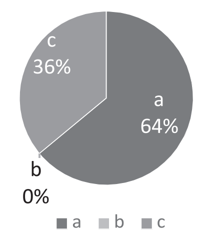
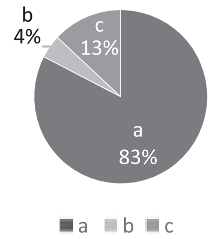
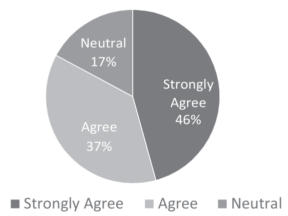
For most of the students, this was the first time they studied problem-finding as a separate course. To the question about how they approached the problem before joining the course, 12% responded that the problem was always given to them and they just solved it as instructed. 29% responded that they only considered the solution and not the problem so much. 21% responded that they considered both the solution and the problem and its background. Meanwhile, 38% responded that they tried to find the existence of the problem, as well as the solution, using different approaches.

Table 3.　Questionnaire

Question	Response
1. Before joining the problem-finding class, how did you approach the problem? (a) As the problem was always given, I just solved it as instructed. (b) I only considered the solution, so I did not think about the hidden problem. (c) I considered both the problem and solution and the background to the problem. (d) I tried to identify the existence of the problem and then solve it using different approaches.	
2. In terms of difficulty, which do you consider as more difficult, problem-solving or problem-finding? (a) I found problem-solving to be more difficult. (b) I found problem-finding to be more difficult. (c) I found both to be difficult. (d) Both of them were easy for me.	
3. Through team discussions, were you able to broaden your critical thinking and understanding of the problem? (a) Yes, team discussions helped me a lot in broadening my understanding. (b) No, it did not help a lot. (c) I could understand the problem, but did NOT use critical thinking. (d) I could NOT understand the problem, but was able to use critical thinking.	
4. With respect to problem-finding, did having team members from different fields (graduate schools) help you in your group discussions? (a) Yes, I was able to learn many new things from my team members. (b) I found the team members ideas to be similar. (c) No, it did not matter to me. (d) I was NOT able to understand their viewpoint as it was NOT related to my field.	
5. In terms of problem-finding, how did you think the field trip helped you understand the problem? (a) Our assumptions before and after the field trip were the same. (b) Our assumptions before and after the field trip were different, but we found a new problem as a result of the field trip. (c) The field trip did not affect our understanding of the problem. (d) The field trip made our problem more difficult.	

When asked to compare the level of difficulty between the problem-solving course and the problem-finding course, 79% found that problem-finding is more difficult than problem-solving. 8% responded that they found problem-solving to be more difficult, while 13% found both courses to be difficult.

To the question on the effect of TBL and active learning on the problem-finding process, 88% responded that team discussions were helpful in improving their critical thinking and understanding of the problem. While 80% of the students stated that having team members with diverse backgrounds and expertise helped them gain

Question	Response
6. During group discussions, how strongly did your team members idea influenced your way of thinking? (a) It helped me a lot to see the problem and solution differently. (b) It did not helped me a lot, I basically used my own ideas. (c) I combined my idea with others' idea and proposed a new idea.	
7. In terms of problem-finding, did your perception towards finding the problem improve after the course and do you now look at problems with confidence and ownership? (a) Yes, now I will try to analyse every problem carefully by considering all the options. (b) No, I still look at problems in the same way as before. (c) Yes, I look at problems differently, but still use the traditional approach to finding the problem.	
8. You would recommend this course to your friends in future. (a) Strongly agree. (b) Agree. (c) Neutral	

new knowledge in the process. 64% responded that discussions with fellow team member with diverse backgrounds and expertise influenced their thinking during team discussions.

With regard to fieldwork, 83% responded that the hypothesis, before and after the field trip changed, and that they discovered a new problem in the course of fieldwork. Almost all students agreed that fieldwork helped them understand the problem better.

In terms of how the students perception improved after the course and whether they look at problems with more confidence and ownership, 83% of the students responded positively, stating that, in future, they will try to analyse every problem carefully by considering all the options before jumping into solving the problem. When asked about whether they will recommend this course to their friends or colleagues in future, 83% responded positively.

B. Discussions

The problem-finding course was an excellent experience for us to teach to the graduate students and there are many positive lessons that we can take from this course. In line with Nitobe Schools vision to impart the 3+1 competences to graduate students and create globally competent graduates, the problem-finding course is a step forward towards achieving our goal. The course was very effective at improving creative thinking among the students and giving them the confidence to discover new problems. Most of the students were able to understand the importance of finding the right problem, recognizing that doing so is a crucial process in problem-solving. The field trip proved to be one of the key points of the course. We found that, while engaged in fieldwork, the students were able to understand that it is important to look at all aspects of any problem. By interviewing different stakeholders and making careful observations, the students were able to understand the problem better.

The problem-finding process is only the first step in the problem-solving process, but the course proved that formulating the problem correctly can make the problem-solving process much easier. Although the course could have been challenging for many students, we believe that, with further refinement of our methods and a smooth transition from the problem-solving course to the problem-finding course, this course will become more accessible to students in the future. The findings from teaching this course in an active learning environment further prove the success of the course. The course provided good faculty development training for the instructors. Many students did not answer the questionnaire (19 students) and we believe it was due to timing of the questionnaire as many students were on holiday due to university spring break. If they had answered the questionnaire, the results could have been much better. For next year we will plan carefully such factors to get maximum response from the students. We also plan to include more parameters in our study such as faculty response, student contribution based on grade level, graduate school (science and non-science) and its effect on the creative thinking and discussion in active learning.

IV. CONCLUSION

There has been little study on how to introduce problem exploration and discovery to graduate students. This study helped us understand that problem-solving and problem-finding are a continuous process and, in order for students to become better problem solvers, the problem itself needs to be carefully studied. The difference between the two processes are that, in a problem-solving scenario, the thinking starts with an already existing, well-structured problem, whereas it needs to be uncovered from the hidden layers when exploring or finding the problem. PBL scenarios could significantly improve if more emphasis is given to such techniques. The quality of the problem being formulated will enhance the quality of the solution to the problems, while giving greater confidence to young minds in addressing global problems of the future and fulfilling the 3+1 competences of Nitobe School.

ACKNOWLEDGEMENT

The authors would like to thank Professor H. Haga and Associate Professor M. Namba for organizing and designing the course for the fourth quarter at Nitobe School. We would like to thank Dr. M. Shimamura for collecting the questionnaire. Special thanks to the British Council teachers for supporting the students with English language training. This work is supported by the MEXT Top Global University Project and Nitobe School at Hokkaido University, Sapporo, Japan.

REFERENCES

Barrows, H. S. (1986), "A taxonomy of problem-based learning methods," *Medical Education* **20**(6), 481-486

Basadur, M., Graen, G. B. and Green, S. G. (1982), "Training in creative problem solving: Effects on ideation and problem finding and solving in an industrial research organization," *Organizational Behavior and Human Performance* **30**(1), 41-70

CCR (2008), "Towards construction of the undergraduate education," *Central Council for Education MEXT, Japan*, 52

Einstein, A. and Infeld, L. (1971), *The evolution of physics: The growth of ideas from early concepts to relativity and quanta*. CUP Archive

Gallagher, S. A., Stepien, W. J. and Rosenthal, H. (1992), "The effects of problem-based learning on problem solving," *Gifted Child Quarterly* **36**(4), 195-200

Getzels, J. W. (1975), "Problem-finding and the inventiveness of solutions," *The Journal of Creative Behavior* **9** (1): 12-18. Getzels, J. W. (1979), Problem finding: A theoretical note. *Cognitive science* **3**(2), 167-171

HUCI (2016), *Hokkaido University Campus Initiative*.

https://huci.oia.hokudai.ac.jp/en/overview.html. Last accessed on September 2016

Imai S., Ravankar A. A., Shimamura, M., Takasuka, T. E., Chiba, G. and Yamanaka, Y. (2016), Discussion on a method of team-based-learning style lecture for graduate students in a research university. *In 2016 5th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, 537-541

MEXT (2016), *Top Global University project (in Japanese)*. http://www.jsps.go.jp/j-sgu/gaiyou.html. Last accessed on September 2016

NS (2016), *Nitobe School Homepage*. http: //nitobe-school. academic. hokudai. ac. jp/en/about/. Last accessed on September 2016

Okuda, S. M., Runco, M. A. and Berger, D. E. (1991), "Creativity and the finding and solving of real-world problems," *Journal of Psychoeducational assessment* **9**(1), 45-53

Ravankar, A. A., Imai, S., Shimamura, M., Chiba, G., Takasuka, T. and Yamanaka, Y. (2016), "Nurturing problem-finding skills in graduate students through problem based learning approaches," *In 2016 5th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, 542-546

Reiter-Palmon, R. and Illies, J. J. (2004), "Leadership and creativity: Understanding leadership from a creative problem-solving perspective," *The Leadership Quarterly* **15**(1), 55-77

Rittel, H. W. and Webber, M. M. (1973), Dilemmas in a general theory of planning. *Policy sciences* **4**(2): 155-169

Shimamura, M., Imai, S., Ravankar, A. A. and Yamanaka, Y. (2016), "How does the english ability of the student change through the postgraduate education?～the case report of "nitobe school program" in hokkaido university～," *In Advanced Applied Informatics (IIAI-AAI), 2016 5th IIAI International Congress on*, 547-551, IEEE

Simon, H. A. (1978), *Problem solving and education*. Carnegie-Mellon University, Department of Psychology

Yamanaka, Y. and Shimamura, M. (2016), "A trans-graduate-school education program awaking competencies to graduate students in research university: The concept of nitobe school program in hokkaido university," *In 2016 5th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, 533-536