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Students' Perceptions and Experiences of Online Cooperative Problem-Based Learning: Developing 21st Century Skills

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ABSTRACT

Cooperative problem-based learning (CPBL) has been introduced in engineering education globally as an effective technique for developing students' professional skills. Moreover, the method is essential for engaging students in learning and developing 21st century skills. However, students are usually "shocked" by such inquiry learning because they face sudden changes in the learning environment. In addition, its implementation in online learning is another challenge. Therefore, this study aims to identify students' perceptions of online CPBL in vocational pre-teacher education institutions. A self-reporting questionnaire was designed focusing on 21st century skills and distributed to 71 students of Mechanical Engineering Education in a state university located in Central Java after the end of the semester. Quantitatively, the data of questionnaire was analysed using SPSS software and described using descriptive statistics. The results show that online CPBL improved students' collaboration, communication, and problem-solving skills. In general, they agreed that online CPBL improved the development of 21st century skills. However, the students faced some difficulties during the online discussion session due to internet connection problems and poor team member involvement. Details of the items are also discussed.

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1. INTRODUCTION

At present, engineering education is facing challenges in developing graduates prepared for the 21st century. It forces major changes in terms of rapid changes in technology, borderless competition, and various other complex problems. Teaching as usual cannot overcome these challenges. Engineering graduates need to be better prepared to deal with rapid technological developments, massive information, and complex problem solving. Essentials skills for survival in the 21st century consist of 16 sets of skills, such as critical thinking, complex problem solving, and coordinating with others. Skills needed by engineering graduates to face the multi-disciplinary, complex, and multi-faceted problems in the world include being team-players, effective communicators, and leaders (Yusof, K. M., Aziz, A. A., Kamarudding, M., Hamid, A., Ariffin, M., Hassan, A., Hassim, H., Ahmad, S., Syed, H., & Nma, A., 2004). In this context, problem-solving skills are critical in the 21st century (Phungsuk, R., Viriyavejakul, C., & Ratanaolarn, T., 2017).

Considering the rapid global changes, little has changed in the way engineering graduates are taught. Problem Based Learning (PBL) is proposed as an alternative to traditional lectures in engineering to accommodate the demands (Yusof et al., 2004). This requires students to develop their understanding and knowledge through experience. PBL instruction is effective for long-term retention and performance improvement (Strobel & van Barneveld, 2009).

One of the challenges in PBL implementation in the field of engineering education is if many students enrol on a course and the class becomes big. In this case, PBL is more practical than traditional lectures, although its implementation is difficult to monitor. Cooperative Problem Based-Learning (CPBL) was introduced as an alternative to solve this problem. CPBL is a combination of cooperative learning and PBL for use in learning and problem solving in a medium-sized class up to 60 students with one floating facilitator (Yusof, K. M., Hassan, S. A. H. S., Jamaludin, M. Z., & Harun, N. F., 2012). CPBL was originally introduced and implemented in Universiti Teknologi Malaysia (UTM) by Yusof et al. (2012) as a modification of the work of Tan (2003), and comprised the PBL cycles implemented in much medical education. Engineering education is typically conducted with many

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students in medium to large classes (20 to more than 60 students). CPBL is an appropriate approach for this situation. Phang and Nawi (2017) showed that CPBL successfully created active learning, and supported students' constructive learning process. Moreover, students perceived that CPBL could encourage their learning motivation and performance (Phang, 2012).

Today, the Covid-19 pandemic has forced the use of an online learning environment. However, education institutions are still not ready to face the related challenges; some teachers have difficulties in to conducting suitable online-learning (Towip, 2020). The implementation of CPBL in online learning should be made with extensive preparation. Employing teaching methods effectively will improve academic performance and student satisfaction. This study aims to identify students' perceptions of online CPBL implementation in their development of 21st century skills.

2. MATERIALS AND METHODS

A quantitative approach was employed using a survey design. According to Blaine (2019), much research on perception takes a survey approach. This study focuses on exploring insights into students' perception and experience of developing 21st century skills through online CPBL, with descriptive analysis used to investigate the results of the survey.

PARTICIPANTS

The study subjects were 71 pre-teacher students from Mechanical Engineering Education in a state university located in Central Java, Indonesia. There is no specified size of the sample for a field/pilot test (Chaudhary & Israel, 2014). The selected main subject was the Industrial Metrology course, with students enrolled on various other engineering courses. They were requested to participate in the study during the last lecture session in the end of the semester. All the data collected from the respondents was confidential and clearly informed.

RESEARCH INSTRUMENT

The questionnaire was developed according to a theoretical framework and the research objectives. Subsequently, three main areas relating to 21st century skills were recognised and developed in line with the survey constructs. The overall inquiry areas were (a) Collaboration Skills, (b) Communication Skills, and (c) Problem Solving Skills. The survey only focused on these three examples of 21st century skills. The content of the survey is shown in Table 1.

Table 1. Survey Content

21st Century Skills	Statements	
Collaboration Skills	Q1	I had the same perceptions as peers in the CPBL group discussion
	Q2	I have learnt with my peers in the CPBL group discussion
	Q3	I took part in brainstorming with peers to reach the same understanding during the CPBL group discussion
	Q4	I enjoyed the CPBL group discussion
	Q5	I improved my knowledge during the CPBL group discussion
	Q6	I collaborated in preparing the presentation and discussion report
Communication Skills	Q7	Sharing knowledge was achieved effectively in the CPBL activities
	Q8	Group brainstorming took place effectively in the CPBL activities
	Q9	Discussion of task distribution was undertaken effectively
	Q10	I participated actively during the group discussion
	Q11	I actively gave my opinion during the group discussion
	Q12	CPBL implementation improved my verbal communication skills
	Q13	CPBL implementation improved my writing communication skills
Problem Solving Skills	Q14	My engineering problems were solved during the CPBL learning
	Q15	My critical thinking improved during the CPBL learning

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Q16	The problems presented were clear and easy to understand
Q17	The problems were related with real engineering problems
Q18	I had different understanding than my peers fof typical problems
Q19	CPBL encouraged me to find more courses references
Q20	I had clear understanding about problems given

The questionnaire comprised 20 questions based on the research guidelines, separated into three sections. The first section concerned the respondents' demographic information; the second section contained 5-point Likert type questions related to developing 21st century skills; while three open-ended questions in the third section related to benefits, challenges and students' suggestions. The survey took no longer than ten minutes to complete.

DATA ANALYSIS

IBM SPSS statistical software for Windows was used to export and analyse the data. Quantitative data from the survey were analysed with various statistical methods, including descriptive statistics. The data were gathered using a 5-point Likert scale ranging from strongly disagree to strongly agree. The disagree column included combined strongly disagree and disagree responses. Similarly, the agree column included combined strongly agree and agree responses. An outline of the questionnaire is shown in Table 1. The descriptive analysis focused on participants' perceptions of the development of 21st century Skills through online CPBL implementation.

3. RESULTS

PARTICIPANT DEMOGRAPHICS

Table 2. The participants' demographics

Participant Demographics		n	%
Gender	Male	59	83%
	Female	12	17%
	Total	71	100%
Age	<19 Years	15	21%
	19 - 21 Years	56	79%
	Total	71	100%
Number of Extra-Curricular Activities	1 Activity	19	27%
	2 Activities	30	42%
	3 Activities	3	4%
	>3 Activities	7	10%
	No extra-curricular activities	12	17%
	Total	71	100%

The respondents were dominated by males (83%), with female constituting only 17%. Most participants were in the 19-21 year old group (79%), with only 21% under 19 years old. The majority of respondents participated in other activities outside of teaching and learning activities on campus, with only a small percentage (17%) not doing so. This information will provide an overview in the analysis of students' soft skills.

1. CPBL Implementation for Developing 21st Century Skills

Both developed and developing countries are realising that the skills gap is an educational issue. A report by the World Economic Forum (WEF) shows that certain skills are required in the 21st century (World Economic Forum, 2015), which are known as 21st century skills. Fig 1 summarises the set of 16 skills.

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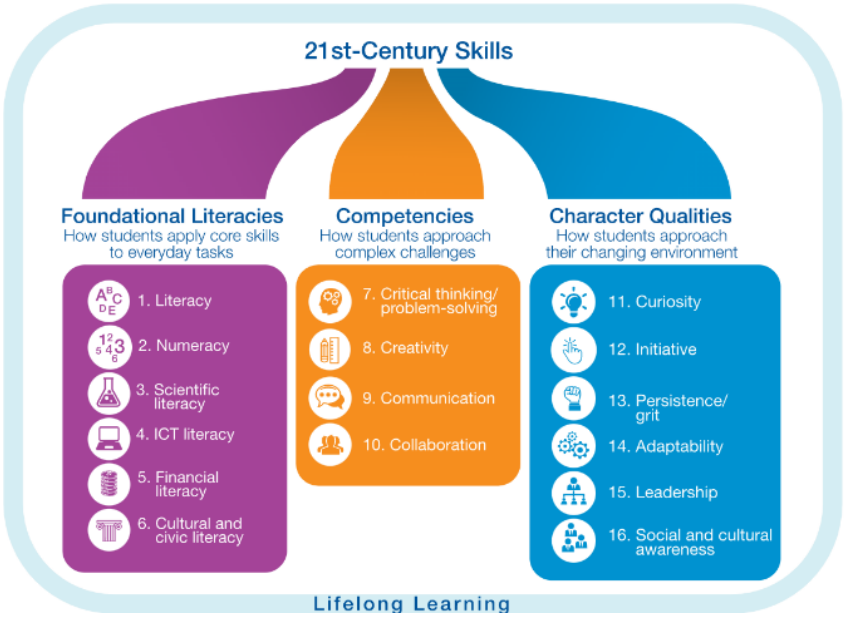

Fig 1. Student requirements for the 21st century (WEF, 2015, p. 3)

One of the skills is problem-solving, which is important for new millennials (Kuo, F. R., Hwang, G. J., & Lee, C. C., 2012). Therefore, this study focuses on the related skills of collaboration and communication.

In the implementation of PBL, cooperation between each student and the facilitator is needed to ensure success in the learning environment. Therefore, to increase its effectiveness, cooperative learning (CL) is integrated with PBL (Yusof et al., 2012). Cooperative problem-based learning (CPBL) creates a supportive learning environment in which to develop problem solving, analytical skills, and communication. According to Yusof et al. (2012), CPBL comprises three phases: problem identification and re-statement (1st phase); team discussion, synthesis and consensus (2nd phase); and presentation, reflection and closure (3rd phase).

2. Student perceptions of CPBL implementation

Student evaluation of CPBL implementation in online learning is limited to the aspects of improving collaboration, communication, and problem-solving skills. Table 3 shows details of the results.

Table 3. Student perceptions of improving soft skills

Skills	Statements	Disagree (%)	Agree (%)	Total (%)	M	SD
Collaboration Skills	Q1	3	97	100	3.13	0.412
	Q2	58	42	100	2.28	0.74
	Q3	7	93	100	3.07	0.457
	Q4	39	61	100	2.61	0.643
	Q5	13	87	100	2.94	0.444
	Q6	65	35	100	2.21	0.754
Communication Skills	Q7	58	42	100	2.38	0.663
	Q8	65	35	100	2.31	0.6
	Q9	66	34	100	2.25	0.603
	Q10	27	73	100	2.76	0.547
	Q11	23	77	100	2.85	0.525
	Q12	7	93	100	3.11	0.494

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	Q13	4	96	100	3.1	0.419
	Q14	10	90	100	3.04	0.491
	Q15	4	96	100	3.1	0.419
	Q16	79	21	100	2.08	0.627
Problem Solving Skills	Q17	34	66	100	2.65	0.657
	Q18	83	17	100	2.1	0.483
	Q19	0	100	100	3.42	0.497
	Q20	7	93	100	3	0.378

Based on Table 3, the application of online CPBL has improved students' collaboration skills (M: 3.13, SD: 0.412); communication skills (M: 3.11, SD: 0.494); and problem-solving skills (M: 3.42, SD: 0.497). They mostly agree that it has encouraged them to seek more courses references to help solve problems. On the other hand, most of the problems faced related to collaboration with peers during the discussion session (M: 2,21, SD: 0.754); the effectiveness of task distribution among peers (M:2.25, SD: 0.603); and the different understanding among peers of typical problems (M: 2.1, SD: 0.483). The implications of this research can be used for improvement in the subsequent learning process.

Regarding the open-ended questions about the benefits and challenges and students' suggestions, some of the students' comments are given below.

Benefits of Online CPBL:

"Able to collaboration in the team discussion, as required in the real world of work in the future"

"Able to share ideas, improved our communication skills, and developed problem solving skills".

Challenges of Online CPBL:

"In my opinion, the greatest challenge of CPBL is how to make us unified as a group and able to work together."

"My challenges were limited to the internet network during the online discussions, and some group members were less involved"

Students' suggestions:

"Problems should be more relevant to work problems and group members should be divided with fewer members for more effective discussion"

"Members of groups based on interests, so students can communicate with each other more easily"

4. DISCUSSION

Regarding the analysis, CPBL has been shown to improve the development of 21st century skills in terms of collaboration, communication, and problem solving. These are important skills that are required to survive in the 21st century (World Economic Forum, 2015). Regarding the online CPBL implementation, students show a positive attitude and support the classroom activities. This is in line with the study of Phang and Nawi (2017), who found that CPBL improved students' understanding for the importance of learning and they understood how to learn by themselves collaboratively. Moreover, students who joined live online PBL classes had higher learning achievement, problem-solving skills and class involvement than those taught using teacher-based methods (Aslan, 2021). CPBL therefore helps to improve the development of 21st century skills. However, students had some difficulties during the online discussion session due to internet connection problems. One of the challenges in conducting online learning interaction relates to such problems (Towip, 2020). Moreover, since CPBL is still new in engineering education in Indonesia, better knowledge and preparation are needed to improve teaching and learning activities.

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5. CONCLUSION

CPBL is a teaching and learning approach that is suitable for typical engineering education. A combination of cooperative and problem-based learning (PBL) can produce a suitable learning environment for medium-sized and large classes. It can improve the development of 21st century skills in terms of collaboration, communication and problem-solving. However, in the implementation of online learning, internet connections and student interaction remain the big challenges. The study findings should be useful for policymakers and universities lecturers to provide a better learning experience and achieve student satisfaction. Moreover, this study may provide research models or guidance for those with the same research interests.

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