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Implementation of Project-Based Learning for Freshmen in Online Learning During COVID-19 Pandemic

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***Abstract*—The engineering project course in form of project-based learning at GMIT, Mongolia, is adapted from the engineering program at the Technical University of Darmstadt and has been implemented since 2014. The transition from traditional to online learning during COVID-19 pandemic disrupted the engineering education process. Due to COVID-19 pandemic, the engineering project course is conducted online. The current study presents the analysis of questionnaire surveys done during COVID-19 and non-COVID-19 pandemic and discusses the advantages and disadvantages of online learning.**

Keywords—engineering education, COVID-19, first-year engineering project course, GMIT

I. INTRODUCTION

Due to COVID-19 outbreak, the education sector received a big impact. The teaching and learning process has been changed and the online process has become popular. Project-based learning **(**PBL) for freshmen engineering students, the goal of which is while learning the course content through collaboration and sharing of knowledge and experience [1] to achieve a shared goal, at the German-Mongolian Institute for Resources and Technology (GMIT), Mongolia, transformed to online during COVID-19. Even though online learning became popular in the education system, the PBL in online learning showed both advantages and disadvantages in learning. This study introduces the implementation of PBL for freshmen engineering students at the GMIT to illustrate the distinct learning process during COVID-19 and non-COVID-19 periods.

II. METHODOLOGY

The Technical University of Darmstadt developed an engineering course entitled "Introduction to Mechanical Engineering" in 1998 with the purpose to advance active and collaborative learning techniques [2,3]. Certain methodological approaches and didactic concepts are well-designed and adopted [4]. The course became an essential element in the curriculum and was later adopted in South Dacota School of Mines and Technology and Virginia Tech, United States, and GMIT, Mongolia [4]. The results of the comparison between course-participants and non-participants at the Technical University of Darmstadt showed clear differences in dropout rate and further success in their studies. PBL provides opportunities for students to obtain several skills including collaboration, self-learning, problem-solving, communication skills, etc. [5].

The first-year engineering project offers an elaborated didactic concept (Hampe and Wolf, 2006; Dirsch-Weigand et al., 2015). The course is held for a whole week. The course becomes a first-ever PBL course in the engineering curriculum at the GMIT. A comprehensive, challenging, sufficiently complex, motivating, engineering problem is given to students. Professors, team assistants, and expert advisors are actively involved in this course. Their roles can be defined below:

- Professors are responsible on selection of an appropriate engineering problem, give an introduction to the problem and have to assign tasks to students.
- Team assistants supervise in general and assist the team in the development of teamwork.
- Expert advisors are available once at certain hours when the teams become familiar with a given problem and provide information and relevant material to teams. Experts and assistants take roles in providing general/indirect replies to students' specific questions since one of the goals of the course are to develop the self-learning skills of learners.
- Student teams: An engineering project course is done in teams. A teamwork ability is important to achieve successful results. Since the choice and autonomy on solutions are given to students, the students are likely to be less productive than in traditional teacher-centered learning, thus in order for students to work productively, the team assistants provide them with the tools to direct the appropriate direction.

- Evaluators: Evaluation of presentations is done by an odd number of professors and experts at the end of the final presentations. Team effectiveness is assessed by presentation content, presentation delivery, poster, and final report.

On the last day of the class the teams should deliver a written report, a poster and a presentation, where other students, faculty members, and others who are interested can attend the final presentations of the teams.

The PBL of engineering project course for freshmen was technically successful during COVID-19. However, the creativity and involvement in the teamwork of students were limited. The current study presents the analysis of the survey taken during COVID-19 (2021) and non-COVID-19 (2019) and illustrates the advantages and disadvantages of online learning for PBL for freshmen engineering students.

III. RESULTS

As the PBL engineering project is a part of the engineering study curriculum at GMIT, it has continuously been implemented for freshmen in their first semester. Students work in teams, make decisions as a team, set networks with teammates, professors, and experts through efficient communication and problem-solving. Students are divided into teams, usually consisting of 7-12 members. The interdisciplinary task is given to teams and the teams work individually. Daily surveys are done during the course period to evaluate the progress of the intrateam work.

Survey analysis, which is done during non-COVID (2019) and COVID (2021) times, are presented in this study. A total of up to five questions were asked to students every day. As an example, Figure 1 shows the response to the question "*How do you evaluate your contribution to your team?*". Students responded differently in the two periods. Teamwork, active involvement in the team, and appreciation by the team are likely to be challenging during online learning during COVID-19 pandemic. More detailed results will be presented in the presentation.

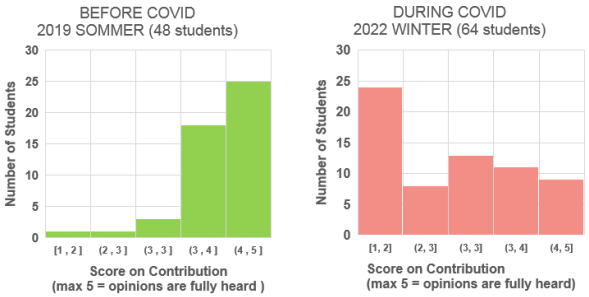

Figure 1. Responses to the survey question

IV. DISCUSSION AND CONCLUSIONS

Online learning enables students to provide flexibility, better time management, self-learning, etc. However, there are certain disadvantages of online learning for PBL, which were pronounced during the project course for freshmen at GMIT, Mongolia. The surveys taken from students were evaluated. Distinct responses were shown during non-COVID and COVID periods.

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