10-2022

Making virtual project-based learning work during the COVID-19 pandemic

Yuanto KUSNADI
Singapore Management University, yuantok@smu.edu.sg

Gary PAN
Singapore Management University, garypan@smu.edu.sg

SHANKARARAMAN, Venky
Singapore Management University, venks@smu.edu.sg

Citation

MAKING VIRTUAL PROJECT-BASED LEARNING WORK DURING THE COVID-19 PANDEMIC

Kevin Koh, Yuanto Kusnadi, Gary Pan, Venky Shankararaman

Singapore Management University, Singapore

ABSTRACT

Project-based learning is an increasingly popular pedagogical approach in university education shown to be effective in fostering problem-solving, analytical, design thinking and teamwork skills. The COVID-19 pandemic has led to universities pivoting from project-based learning (PBL) in the classroom to a virtual learning environment. By examining local student consulting courses conducted virtually in a Singapore University (UNIS) during the COVID-19 pandemic, this study aims to address the knowledge gap in the PBL literature by identifying the roles played by digital literacy - in utilising the digital tools that support virtual learning, in a virtual learning environment. The study also serves to highlight students' major takeaways in virtual PBL setting.

1. INTRODUCTION

The COVID-19 pandemic has led to the unprecedented health and socioeconomic crisis which has severely impacted universities around the world (Crawford et al., 2020).A key measure taken by universities is changing the way they teach - from classroom teaching to 'emergency online education' (Murphy, 2020). The dire need for universities to pivot their teaching to online during COVID-19 pandemic has also affected the way students learn (Muller et al., 2021). One such teaching pedagogy that brings about severe changes in how students learn during the pandemic is project-based learning (PBL)(Duwi et al., 2020).

Generally in a PBL setting, students learn theory in the classroom, then apply what they have learned in the field, solving a wide array of business or societal challenges facing organizations, while at the same time, solidifying their own knowledge (Faridah et al., 2011).In such a setting, it is common for universities to form partnerships with relevant stakeholders, such as corporations and social organizations, in devising effective solutions to address complex problems (Heaviside et al., 2018; Lee et al., 2016). Some of these partnerships may also go beyond local shores to include industry partners in different geographical locations (Boss and Krauss, 2014).Therefore, with group interaction and collaboration central to PBL pedagogy (Pan et al., 2019), students in a PBL course are likely to be severely impacted by the effects of COVID-19 pandemic. This is mainly because without physical presence, student groups in the PBL course may find it more challenging to interact with one another and collaborate with their industry partners during the project (Seow et al., 2019).

Furthermore, swiftly pivoting to virtual PBL is no easy feat especially during a sudden emergence of COVID-19 pandemic (Crawford et al., 2020). Students' ability to embrace digital tools including video conferencing with breakout rooms, online applications and shared

electronic documents, is crucial to support their learning both asynchronously and in real time (Tesar, 2020; Lepe & Jimenez-Rodrigo, 2014; Lee et al., 2016; Garcia, 2016).

To date, little is known about the digital literacy skills that are required of students in a PBL course to pivot from classroom learning to a virtual learning environment when working with both local and overseas industry partners during a corona virus disease pandemic.By examining local student consulting courses conducted virtually in a Singaporean University (UNIS)during the COVID-19 pandemic, this study aims to address the knowledge gap in the PBL literature by identifying the roles played by *digital literacy* - in utilising the digital tools that support virtual learning in a virtual learning environment. The study also serves to highlight the major takeaways from students, industry partners, and faculty in virtual PBL setting.

The remainder of the paper is organized as follows. The following section provides a background to virtual PBL and digital literacy. This is followed by a description of our case study and a presentation of results and discussion. The paper concludes with implications for research and education.

2. LITERATURE REVIEW

2.1. Virtual PBL

According to Markham et al. (2003), PBL is a teaching pedagogy that relies on students' involvement in structured projects, with the objectives of enabling them to process complex questions in acquiring the necessary skill-sets and knowledge. Bell (2010) identifies several advantages of PBL that include active participation of learners; improved motivation and satisfaction, leading to better academic performance; preparation of students for employment; and development of work-related skills such as critical thinking, team work, design thinking and problem solving.

Information communication technology (ICT) is commonly used to support PBL. The ICTs are not only a fundamental instrument for communication between teachers and students, but also a means of strengthening collaborative work (Flores and Arco, 2012; Boss and Krauss, 2014). In fact, Cakiroglu (2014) has provided empirical evidence that suggests that by combining virtual manipulatives and PBL, students' understanding and academic performance of mathematics subjects may be improved.In addition, virtual PBL may bring about several benefits and disadvantages. According to Lepe & Jimenez-Rodrigo (2014), benefits of virtual PBL include ease of communication through using the same virtual platform; and flexibility of working times and group meetings, which offers greater adaptability and better time-planning opportunities. Disadvantages of virtual PBL include demand for a higher level of commitment to the project and to the communication channel used; and lack of adequate technology skills to utilise the ICT tools.

It is increasingly common for teachers to collaborate in the design and implementation of projects that cross geographic boundaries or even jump time zones (Flores & Arco, 2012).Lee et al. (2016) highlight students may struggle to engage with industry partners in their PBL courses, due to logistical and time constraints. At the same time, professionals working in the industry may find it tedious to travel to campus. For those who are based overseas, on-campus participation is even more challenging. Therefore virtual PBL may be a viable option to alleviate this problem by allowing remote participation, which makes it possible for teachers, students and industry partners to engage with one another in real-time regardless of their location.

2.2. Digital Literacy

Martin (2006) defines digital literacy as the individual realization, attitude and capacity of digital tools usage in order to access, manage, integrate, analyse and synthesize digital information sources. Acquiring digital literacy means the ability to access various information sources, the capacity to utilize digital tools for the management of information sources and the ability to generate and share different media, as well as the ability to efficiently present and communicate using proper tools and processes (Eshet-Alkalai, 2004; Kaeophanuek et al., 2018).

According to Gee (2012), digital literacy skills are categorized into:(1) Information skills: the fundamental concepts of information management and the techniques and methods related to information management;(2) Digital tools usage: the skills and competencies required to learn and use various software applications as well as a variety of cognitive skills to execute tasks in digital environments; and (3) Digital transformation: creating, improving, designing, producing and presenting new forms of information, generating new knowledge and developing digital innovation.

Overall, there is growing recognition that students need to develop sound digital literacy skills which allow them to thrive and lead in a digitally enhanced project work environment (Janssen et al., 2013).

3. RESEARCH METHODOLOGY

In this section, we employed a case study design, which is a qualitative research approach. The case study approach is particularly appropriate for our exploratory study since it allows us to capture the organizational dynamics of the phenomenon better (Yin, 2003). Its strength also lies in its ability to explain the phenomenon based on the interpretation of data.

Our case study involved an experiential learning courses: "Accounting for Entrepreneurs" that was taught in UNIS in the Academic Year 2020/21 from August 2020 to November 2020. The detail of the course is elaborated in the next sub-section.

At the end of an academic semester, course feedback evaluation would usually be conducted for students enrolled in every course in UNIS (including the two experiential learning courses we described in this paper). In the course feedback evaluation, students from these two courses were asked a number of questions related to the various aspects of PBL, such as: (a) Preparation and organization; (b) Clarity of objectives and expectations; (c) Simulation of interest in project-based learning; (d) Facilitation and mentoring skills; (e) Quality and frequency of feedback; (f) Creating opportunities to learn from others;(g) Enhancing students' analytical, problem-solving, and reasoning skills; (h)Enhancing students' capacity to integrate knowledge from two or more disciplines to solve a problem; (i) Enhancing students' ability to apply subject concepts to real-world issues; (j) Enhancing students' communication skills; (k) Preparing students to embrace uncertainty; (l)Overall ratings of the instructor; and (m) Overall rating of the course. The scores were captured on a Likert-like scale for the questions mentioned earlier, ranging from 1 (Very Poor) to 7 (Excellent).

Relating these aspects of the students' feedback to the three elements of digital literacy (DL) outlined in the literature review, we believe that information skills is captured by responses to (f), (g), (k), (l), and (m); digital tools usage is captured by responses to (c), (d), and (j); and digital transformation is captured by responses to (e), (h) and (i).

Besides the quantitative scores that measure the effectiveness of various elements associated with course feedback evaluation survey, the student feedback report also contains qualitative feedback written by each student on this question: "What perspective/learning/skills do you take away from the course?".

In addition, feedback from industry partners and faculty were obtained through emails. Both the survey data and qualitative feedback formed the main sources of our data. The quantitative and qualitative data from students' course evaluation reports are reliable because these surveys are uniformly applied across all courses and are taken by all students in UNIS (including experiential learning courses) and are made available upon request. Moreover, the qualitative feedback from the industry partners and faculty are transparent because the researcher could grasp these parties' interpretations of their actions and events, as well as their beliefs and aspirations.

Data analysis was carried out by providing statistical analysis of the empirical data, which primarily comprises the results of the students' survey questionnaires. The mean and standard deviation of each aspect of the course, from (a) to (n) were calculated and then compared to the overall University average scores. We further compute the p-value of the difference between the scores obtained in the two courses and the University average score, to assess the effectiveness of the PBL carried out in both courses. In addition, we arranged the qualitative feedback from students along the 3 elements of DL identified in our literature review. We reliedon the theoretical lens related to DL to map the qualitative feedback of students to the important components of DL. These additional analyses would provide greater insights to the roles of DL in facilitating effective virtual PBL during the Covid-19 pandemic, which is the main contribution of this study.

3.1. Background and Growth of UNIS-X Pedagogy

UNIS-X is a university-wide project-based experiential learning pedagogy which was launched by UNIS (a public university in Singapore) in 2015. From two pilot courses in 2015, UNIS-X has grown over the years to offer 60 courses to close to 4,000 undergraduate students. In each course, the instructor needs to identify suitable industry partner(s) as project sponsor(s). Subsequently, both parties will need to scope the project deliverables, which often involve recommendations from students, to solve real issues and problems faced by the project sponsor(s) before the semester begins. Students enrolled into the course will then work together as teams to develop solutions to address real issues and problems assigned by the project sponsor(s). Another important element of the UNIS-X pedagogy is active mentorship provided by both the project sponsor(s) and the instructor involved in the course. Throughout the semester, students will have to present their project progress (at least once) and they will be given regular feedback to refine their recommendation in the project. At the end of the semester, students will have to present their recommended solution, which is a key project deliverable, in front of the instructor, senior management of the project sponsor(s), and fellow students.

In essence, the UNIS-X pedagogy involves a tripartite collaboration between faculty (as instructor of the course), students and the industry partners working on real-world problem(s). The project collaboration is akin to a student consultancy program, which helps to develop students' critical thinking ability, communication skill and the ability to handle uncertainties in projects. For example, it is common for students to adapt to changes in the project scope during the project, which could be attributed to changing circumstances surrounding the project.

In the next few sections, we will describe a case study involving UNIS-X (virtual) courses that UNIS faculties conducted pre and post-pandemic to provide a comparison by drawing some

insights to the unique features of each course and interesting feedback given by the students with respect to the changes undertaken in PBL due to the COVID-19 pandemic.

3.2. Case Study: Accounting for Entrepreneurs

Accounting for Entrepreneurs (AFE) is an elective course under the *Managing* basket of the *Capabilities* pillar in the UNIS Core Curriculum. The topics coverage comprises financial and managerial accounting, accounting information system, financial planning, taxation, and internal control. In AFE projects, the clients usually involve Small-and-Medium Enterprises(SMEs) in Singapore.

3.3. Changes due to the COVID-19 pandemic

In response to the emergence of the COVID-19 pandemic, UNIS acted quickly to prepare its instructors and students for a virtual learning environment. To support its instructors, UNIS's Center for Teaching Excellence put together some tips and strategies to help make instructors' online lessons more engaging. These resources were curated and listed on the Center's website to help instructors to locate information according to their teaching needs.

In addition to these resources, the Center had also incorporated practical tips by instructors as well as feedback from students. Students generally found the interactive synchronous sessions conducted via Zoom helpful, especially when instructors engaged them in discussions either through the chat function or provided opportunities for them to express their views verbally. Instructors were also trained to learn how to record Zoom sessions, pre-recorded videos, and slides with narrations to support students' learning in a virtual environment. Students were taught how to use forums/collaborative tools and breakout sessions on Zoom as an extension of class participation to facilitate group discussions and consultations with their instructors. In addition, instructors were also trained to use classroom response systems, such as Wooclap and Kahoot to further increase interaction and engagement online. To make training possible, UNIS's Center for Teaching Excellence set up a series of online workshops that aimed at providing tips, strategies, and hands-on practice in facilitating various online teaching and learning activities for both instructors and students. These training sessions were beneficial since they better prepared instructors to plan, organize and teach their course in a virtual environment.

The outbreak of the COVID-19 pandemic in early 2020 has affected the PBL pedagogy in a number of ways. First, regular lectures and mentoring sessions which were conducted face-to-face (before 2020) had to be shifted to a virtual mode (usually via teleconferencing software such as Microsoft Teams, WebEx, Google Meet, or Zoom). Initially, this change had created much inconvenience as all parties were trying to adapt to the new way of learning remotely and virtually. As time progressed, by Summer 2021, we were comfortable with virtual meetings and in away, the effect had become positive as meetings could now be recorded and students did not have to commute to meet their project mentors.

Second, progress and final presentations which were usually conducted in a classroom setting had to be shifted to the virtual mode starting from March 2020, as classes had to be shifted online owing to safe distancing rules. Moreover, out of the 43 students enrolled, a few foreign students were still based in Japan, China and India. With the changes in the mode of learning from face-to-face to virtual, the importance of digital intelligence in facilitating a smooth transition could not be overemphasized.

Overall, these initiatives are linked to the first two components of digital literacy as outlined by Gee (2012): information skills – in terms of techniques and methods related to managing an

online classroom setting; as well as digital tools usage. The ability of the instructor as well as the students to effectively utilize these digital skills, has enhanced their learning in a virtual PBL setting.

The switch to a virtual mode of learning was well-received by the project sponsor(s) and faculty as they could now access to recorded presentation for their reference. Students could also prepare their presentations and record them, and send the link to the presentations in advance, without having to wait until the actual presentation day itself. This might mitigate the nervousness some students felt when they were presenting face-to-face in front of the faculty and the senior management of the project sponsor(s).

The online presentations delivered by the project groups as well as the output of the projects (which require students to design useful dashboards and develop product prototypes for their project sponsors) constitute the last component of digital literacy, namely digital transformation as it enables students to create and design new form of presentation and develop digital innovations to their project sponsor(s).

4. RESULTS AND ANALYSIS

4.1. Students and Project Background

In Academic Year 2020/21, Term 1 commenced in August 2020 and concluded in December 2020. Table 1 illustrates the breakdown of the 41 UNIS undergraduate students enrolled in the course, out of which 41% were male students and the remaining 59% were female students. Majority of the students were in their Year 2 and 4 of their studies (37% and 32%, respectively). It was also interesting to note that 15% of the enrolled students were freshmen, which indicatesan increased willingness of students to take more challenging PBL course in their first year of study.

Table 1. Distribution of Students

Total number of students	41	
Male	17	41%
Female	24	59%
Year 1	6	15%
Year 2	15	37%
Year 3	7	17%
Year 4 and beyond	13	32%

The project sponsor was Company A, an e-commerce analytics start-up based in Singapore. Compared to larger markets like the United States and China, accessibility to market performance data for retailer brands on electronic commerce (e-commerce) platforms like Lazada and Shopee in Southeast Asia is limited and fragmented. Company A is committed to developing Southeast Asia's most sophisticated digital commerce intelligence platform to enable brands of consumer goods to have a better grasp of their e-commerce performance. By applying data science techniques to capture digital data points from the web, and then using artificial intelligence technology to analyse the data, Company A generates commercial insights and provides actionable data dashboards & predictive analytics to shape these brands'e-commerce strategy.

Company A provides two data service offerings: The first product is called Service X which is a competitive intelligence/market research offering that gives brands a holistic view of their entire market on an ongoing (weekly) basis, hence allowing brand managers to study their brands' relative market share in the online market and identify potential areas of improvement.

The second product is Service Y, a key performance indicators (KPIs) monitoring tool on brands. By focusing on the brand products listed online, the tool provides important analytics such as "are my product listings looking good?" or "do I get good ratings & reviews?" on an ongoing (daily) basis.

Currently, Company A offers these two products on an annual subscription basis at competitive price points (elaborated below), which varies according to the customization of customers' solutions. However, such a pricing strategy may not always attract customers and as a result, it may hinder the sustainability and scalability of the business.

In terms of the student project deliverables, students were expected to: (i) Develop a Business Model Canvas (BMC) for the service offerings; and (ii) List recommendations on the potential new revenue stream and its corresponding cost structures for Company A. Besides the recommendations, students had to come up with a budget and a profitability analysis for the next 3 years, which would shape the business to be sustainable and scalable.The project required students to bring together a set of integrated knowledge from accounting, finance, strategy, and marketing disciplines.

4.2. Recommendations by Students

All the changes mentioned in Section 3.3 have affected the delivery of in-class seminars as well as the project collaboration with Company A. However, despite the switch to virtual mode, students were able to deliver excellent online presentations in the Mid-Term Progress as well as Final Presentations at the end of the semester, for the two senior management members of Company A. This clearly demonstrates students' ability to integrate the digital literacy skills acquired in the virtual PBL collaboration with Company A (as elaborated below).

One of the student recommendations was to target smaller fast moving consumer goods (FMCG) companies as customers. As Company A has so far only focused on FMCG MNCs, it is neglecting a sizable market of smaller clients. These clients are either local or regional brands who fulfil at least one of the conditions: 1) Revenue of not more than S$100M; 2) Do not have more than five best-selling product categories. While Service Y is well-suited to meet the needs of these clients, Company A, however, has not diversified its client base to include the smaller clients, which could present an opportunity for the company to increase its revenue.

4.3. Feedback from Client Partner and Faculty

Despite the virtual experience (including the mentoring sessions and presentations), the CEO of Company A commented that: "*The collaboration is not only a great experience, but also a beneficial one for the business as the students demonstrated a professional attitude and has developed an innovative solution to address our business problem. The students were also quick to acknowledge that the issues faced by a small start-up such as ours, often were not fully described in textbooks. Nevertheless, students were able to adapt their knowledge learnt in school and think critically before proposing a set of viable business solutions.*"The CEO's feedback highlighted the important roles played by online surveys and interviews conducted by students in their primary research (information skills), and the communication channels such as Zoom and Slack (digital tool usage) that resulted in high quality final presentations with

innovative recommendations (digital transformation). He hoped that UNIS's experiential learning model of active engagement with the industry could continue as it would be hugely beneficial for the students and the companies alike.

The faculty member involved in the course highlighted: "*While physical interactions with students and the project sponsor were constrained by the social distancing rules, the availability of digital platforms to connect all three parties implies that the virtual mentoring sessions have played a vital role, especially for students as they have developed a set of feasible and practical solutions for the consultancy projects. In a way, students' digital literacy is being enhanced amidst the change in the mode of learning and mentoring, hence resulting in them being agile and adept in using various digital platforms to conduct not only productive discussions with the project sponsor, but also in delivering online presentations seamlessly. In fact, the relationship among all three parties grew even stronger as the setting in the mentoring sessions was more relaxed, compared to physical face-to-face mentoring sessions which were usually more rigid and formal*." The positive feedback from the faculty indicated that he too has benefited from the virtual PBL. Besides, the faculty also believed that students' positive experience was mainly enabled by students' acquisition of relevant digital literacy skills.

4.4. Feedback from Students

In general, the evidences presented in Table 2 suggest that the virtual PBL collaboration with Company Ain the "Accounting for Entrepreneurs" course was successful. Various aspects of digital literacy acquired by students played important roles in facilitating effective virtual PBL. The information skills related to conducting primary research during a pandemic (i.e. disseminating online surveys and conducting online interviews to potential clients of the industry partner) and learning about the e-commerce analytics industry have allowed students to learn from others (mean score = 6.667, standard deviation of 0.530); enhanced their analytical, problem-solving and reasoning skills (mean score = 6.487, standard deviation = 0.721); and prepared them to embrace uncertainty (mean score = 6.513, standard deviation. = 0.790).

The usage of digital tools was important and essential in a pandemic. With all UNIS courses turning online, the use of tools such as mentimeter, Kahoot, Zoom break-out rooms was instrumental in stimulating students' interest in content and project based learning (mean score = 6.769, standard deviation = 0.427). Moreover, the use of communication tools such as WhatsApp, Slack, and Telegram has helped to facilitate effective mentoring sessions with the industry partner (mean score = 6.737, standard deviation = 0.503). These tools have also enhanced students' communication skills (mean score = 6.487, standard deviation = 0.898) – among one another, as well as with the faculty and industry partner.

Digital transformation skills acquired by the students, in terms of receiving timely and constructive feedback on the progress of their project from the faculty and industry partner (mean score = 6.744, standard deviation = 0.498), helped them integrate interdisciplinary knowledge to improve the quality of their recommendations to the industry partner (mean score = 6.590, standard deviation = 0.785), generating new knowledge and developing digital innovation that solve real-world issues faced by the industry partner (mean score = 6.333, standard deviation = 0.923).

Overall, the mean scores for the overall rating of the instructor and course were 6.872 and 6.436 respectively, which were well above the University average scores of 5.927 and 5.935 respectively. In addition, the *p*-values of the difference between the mean scores obtained for various aspects of the course versus that of other courses in the University were presented in the

last column. We observe that all (except one) of the *p*-values are below 0.01; suggesting that the three aspects of digital literacy contributed to effective virtual PBL collaboration in the course.

Despite the shift from physical classes to virtual mode, the mentoring sessions and face-to-face presentation of PBL were still able to achieve students' learning outcomes. These findings have important implications and provide useful contribution to the existing literature on PBL (Seow et al., 2021) which suggest that an experiential learning activity through virtual project collaboration, would enhance students' knowledge creation, analytical, problem-solving, communication skills (how to work with industry partners), as well as preparing students to embrace uncertainty.

More importantly, various use of digital tools and students' ability to integrate the information skills into project management and developing effective online presentations with innovative recommendation, contribute to the components of digital literacy as outlined by Gee (2012).Therefore, our paper further highlights the importance of acquiring digital literacy in achieving effective virtual PBL.

Table 2. Summary of Student Course Evaluation Feedback

Question	Mean score	Std Dev	University Average	*p*-value
(a) Preparation and organization	6.795	0.409	5.951	(0.000)
(b) Clarity of objectives and expectations	6.795	0.409	5.779	(0.000)
(c) Stimulation of interest in content and project-based learning	6.769	0.427	5.916	(0.000)
(d) Facilitation and mentoring skills	6.737	0.503	5.906	(0.000)
(e) Quality and frequency of feedback	6.744	0.498	5.869	(0.000)
(f) Creating opportunities for you to learn from others	6.667	0.530	6.051	(0.000)
(g) Enhancing your analytical, problem-solving and reasoning skills	6.487	0.721	5.942	(0.000)
(h) Enhancing your capacity to integrate knowledge from two or more disciplines to solve a problem	6.590	0.785	5.999	(0.000)
(i) Enhancing your ability to apply subject concepts to real-world issues	6.333	0.823	6.101	(0.103)
(j) Enhancing your communication skills	6.487	0.898	5.943	(0.001)
(k) Preparing you to embrace uncertainty	6.513	0.790	6.018	(0.001)
(l) Overall rating of the instructor	6.872	0.339	5.927	(0.000)
(m)Overall rating of the course	6.436	0.788	5.935	(0.001)

4.5. Main Takeaways from Qualitative Feedback from Students

Apart from the statistics displayed in Table 2, additional insights could be gained from students' qualitative feedback on the virtual PBL collaboration with both local and overseas companies. With regards to DL, the delivery of virtual lessons and students' engagement were enhanced through the use of online platforms such as mentimeter, Kahoot!, Padlet, and the recording function of Zoom. In the virtual sessions, the students swiftly adapted to using various digital tools (such as Zoom, LinkedIn, Telegram, Slack, etc.) in their interaction with their project sponsors. Throughout their project, the students were able to find, understand, create, and communicate digital information. The students were also able to use diverse technologies appropriately and effectively to retrieve information, interpret results, and access the quality of that information. Overall, the students have clearly demonstrated a high level of DL which is important for learning in a virtual PBL environment (Crawford, 2020). It is likely students' DL skill could have been enhanced through various training workshops conducted by the Center for Teaching Excellence, numerous practices and the frequent use of information retrieval system, such as electronic database resources (Kaeophanuek et al., 2018).

Table 3. Qualitative Feedback

Feedback by students	Component of Digital Literacy
1. The client was very forthcoming with information that could help us along the way.There was a lot of good communication that was facilitated by putting us in the same communication channel on Slack. Moreover, they were always keen to arrange meetings online to go through any questions that we might have on any part of our online presentation.	Information skills Digital tools usage Digital transformation
2. Interactive, well-integrated use of software for class engagement, ease of discussion with client. It was easier to review the classes as they were recorded. Class participation was also made easier with less disruption.	Information skills Digital tools usage
3. Interesting insights as to what you have to do to thrive in the business world: Why businesses have failed because they failed to innovate; I also polished my soft skills through the project work - how to communicate with teammates, how to get our ideas across in more succinct ways in our online presentation; how to organize our information so it has better flow etc.	Information skills Digital transformation
4. The e-commerce analytics industry is relevant to the current world and the demo of the client's product shows that our recommendations can value add.	Information skills Digital transformation
5. Learning about people skills. A lot of communication had to be done with all kinds of parties both inside and outside the module. One of the mentors is also based overseas, which implies that we had to coordinate online meeting at a time zone that is suitable for him.	Information skills, Digital tools usage

The following feedback in Table 3 highlights an interesting observation on the use of digital tools: "*There was a lot of good communication facilitated by putting us in the same communication channel on Slack. Moreover, they were always keen to arrange meetings online to go through the questions we might have onour presentation.*"

In addition, through the collaboration with Company A in semester 1 (August – December, 2020), students also learnt more about the e-commerce industry, which has taken off since the pandemic struck early last year. This is highlighted by the following feedback by a student: "*I've gained a better understanding of the e-commerce industry when working with our project sponsor. Also, I have learned better communication and interview skills when reaching out to potential partners*". This represents an important accomplishment as the information skills gained on the digital e-commerce landscape has helped the students acquire digital transformation skills. This allows them to process the feedback given by the faculty and project sponsors and develop high-quality online presentations, which involve practical and innovative recommendations to the project sponsors.

Finally, an additional insight from the virtual PBL projects is that besides being proficient in DL skills, students were also competent in their communication and were professional in handling their clients, which can be observed from the qualitative feedbacks Table 3. A virtual PBL could provide students with the opportunity to develop skills shown in Diagram 1 below.
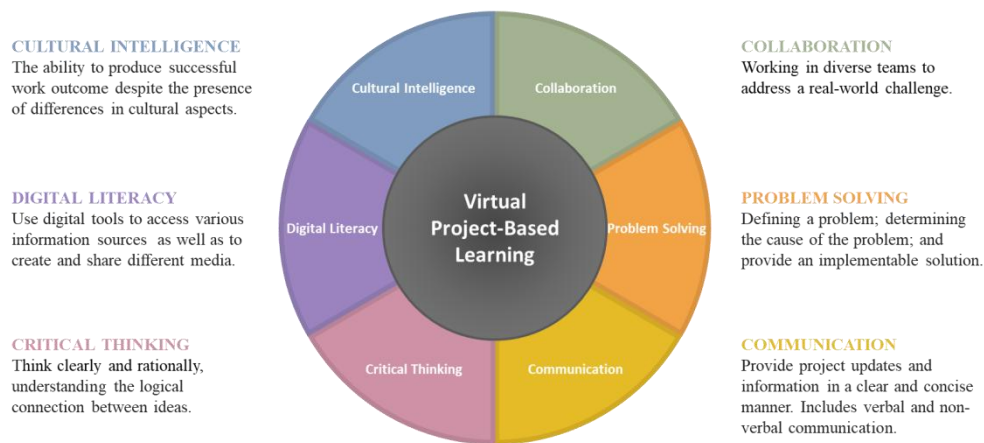

Diagram 1

5. IMPLICATIONS AND CONCLUSIONS

Our study has explored a virtual PBL course at UNIS during COVID-19 pandemic. Traditionally, a PBL course would focus on teamwork, problem-solving skills, the use of verbal and non-verbal communication, and critical thinking skills in learners. In addition to these skills, our study has shown that a virtual PBL course would also emphasize on DL skills.

For researchers, this paper contributes to the PBL literature by identifyingthe importance of DL skills that are required of students in a PBL course to pivot from classroom learning to a virtual learning environment when working with both local and overseas industry partners.This serves as one of the first exploratory studies that examines virtual PBL during a corona virus disease pandemic in the PBL literature. For educators, this study offers useful insights to understanding

students' needs in a virtual PBL setting. Besides DL, Universities may also want to equip their students with adaptability and agility skills, so as to prepare them to swiftly pivot to a different learning environment.

For university students, the insights from the study suggest that learning is no longer happening only in classroom. Students should learn to be adaptable to virtual classes or blended learning environment. Similar to PBL in a classroom setting, virtual PBL has also proven to have enhanced students' problem-solving, analytical, design thinking and communication skills.

For industry partners, virtual PBL may be a way to bridge the gap between academia and industry. The industry partners may find it interesting to look at their businesses from fresh perspectives. They often feel that it takes time for students to adjust to the working environment coming from the university but virtual PBL acts like a guided internship and allows students to work on substantial projects under the direct supervision of company staff and faculty. In this way, companies may also get to know potential hires better and vice versa. This enhances the cultural fit between the student and the company. Also, as students work on real business issues, developing solutions that are practical and workable, may also help to address business problems. The Covid-19 pandemic has forced universities and businesses around the world to pivot their mode of operation and rapidly adopt the use of technology. DL is not confined within the classrooms and targeted at the students. It is equally important to faculty members and business leaders as they prepare graduates to be future-ready and shape the future workplace respectively. For a virtual PBL course to be successful, access and support must be provided to help develop DL among the project stakeholders.

While this study represents an important step toward understanding virtual PBL in acoronavirus disease pandemic setting, longitudinal field studies involving multiple case studies are clearly called for, to reflect the varied nature of virtual PBL courses in different geographical locations or crisis settings.

REFERENCES

[1] Bell, S., (2010) Project-based Learning for the 21st Century: Skills for the Future". The Clearing House, 83(2), 39-43.

[2] Boss, S., and Krauss, J. (2014) Reinventing Project-based Learning: Your Field Guide to Real-World Projects in the Digital Age. International Society for Technology in Education.

[3] Cakiroglu, U. (2014) Enriching Project-Based Learning Environments with Virtual Manipulatives: A Comparative Study. Eurasian Journal of Educational Research, 55, 201-222.

[4] Crawford, J., Butler-Henderson, K., Rudolph, J.,Malkawi, B.,Glowatz, M., Burton, R.,Magni, P.A., and Lam, S. (2020) COVID-19: 20 Countries' Higher Education Intra-period Digital Pedagogy Responses. Journal of Applied Learning and Teaching, 3(1), 9-28.

[5] Duwi, E., Widiyanti, and Basuki. (2020) Revisiting The Impact of Project-Based Learning on Online Learning In Vocational Education: Analysis of Learning in Pandemic Covid-19. 4th International Conference on Vocational Education and Training (ICOVET), 19 September, Malang, Indonesia.

[6] Eshet-Alkalai, Y. (2004) Digital Literacy: A Conceptual Framework for Survival Skills in the Digital Era.Journal of Educational Multimedia and Hypermedia,13, 93-106.

[7] Faridah, M , Mufti, N., Latiff, R and Amin, M. (2011) Project-based Learning: Promoting Meaningful Language Learning for Workplace Skills. Procedia Social and Behavioral Sciences, 18, 187–195.

[8] Flores, O., and De Arco, I. (2012) The Impact of ICTs on Lecturer and Student Interaction in University Education Processes. Universities and Knowledge Society Journal, 9(2), 31- 47.

[9] Garcia, C. (2016) Project-based Learning in Virtual Groups – Collaboration and Learning Outcomes in a Virtual Training Course for Teachers. 2nd International Conference on Higher Education Advances, 21-23 June, Valencia, Spain.

[10] Gee, J. P.(2012) The Old and the New in the New Digital Literacies.The Educational Forum, 76, 418-420.

[11] Heaviside, H., Manley, A., and Hudson, J. (2018) Bridging the Gap between Educationand Employment: a Case Study of Problem-based Learning Implementation in Postgraduate Sport and Exercise Psychology. Journal of Higher Education Pedagogies,3(1), 463-477.

[12] Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., and Sloep, P. (2013)Experts' Views on Digital Competence: Commonalities and Differences. Computers & Education, 68, 473-481.

[13] Kaeophanuek, S., Na-Songkhla, J., and Nilsook, P. (2018) How to Enhance Digital Literacy Skills among Information Sciences Students. International Journal of Information and Education Technology, 8(4), 292-297.

[14] Lee, M., Ritz, C., Vial, P., and Li, Wanqing. (2016) Enhancing Project-based Learning Through Student and Industry Engagement in a Video-Augmented 3-D Virtual Trade Fair. IEEE Transactions on Education, 59(4), 290-298.

[15] Lepe, E., and Jimenez-Rodrigo, M. (2014) Project-based Learning in Virtual Environments: A Case Study of a University Teaching Experience. Universities and Knowledge Society Journal, 11(1), 76-90.

[16] Markham, T., Larmer, J. and Ravitz, J. (2003) Project Based Learning Handbook: a Guide to Standards-focused Project Based Learning (2nd Ed.). Novato, CA: Buck Institute for Education.

[17] Martin, A. (2006)A European Framework for Digital Literacy.Digital Kompetanse, 2, 151-161.

[18] Muller, A., Goh, C., Li, ZL., and Gao, XL. (2021) COVID-19 Emergency eLearning and Beyond: Experiences and Perspectives of University Educators. Education Sciences, 11(1), 1-15.

[19] Murphy, M. (2020) COVID-19 and Emergency eLearning: Consequences of the Securitization of Higher Education for Post-pandemic Pedagogy. Contemporary Security Policy, 41, 492–505.

[20] Pan, G., Seow, PS., and Koh, G. (2019) Examining Learning Transformation in Project- based Learning Process.Journal of International Education in Business, 12(2), 167-180.

[21] Seow, PS., Pan, G., and Koh, G. (2019) Examining an Experiential Learning Approach to Prepare Students for the Volatile, Uncertain, Complex and Ambiguous (VUCA) Work Environment.The International Journal of Management Education, 17(1), 62-76.

[22] Tesar, M. (2020) Towards a Post-COVID-19 'New Normality?': Physical and Social Distancing, the Move to Online and Higher Education. Policy Futures Education, 18, 556–559.

AUTHORS

Kevin Koh is the Head of the SMU-X Office. His research interests is in the area of experiential learning

Dr. Yuanto Kusnadi is Associate Professor of Accounting (Education) at the Singapore Management University. His research interests are in corporate governance and innovative pedagogy.

Dr. Gary Pan is Professor of Accounting (Education) at Singapore Management University and the Associate Dean (Undergraduate Admissions and Students Development) of the School of Accountancy at the Singapore Management University. He is also the Academic Director of SMU-X at the Provost Office. His research interests are in information technology enablement of accounting processes and innovative pedagogy..

Dr. Venky Shankararaman is the Vice Provost (Education) and Professor of Information Systems (Education) at Singapore Management University. His research interests are in digital business technologies and transformation, enterprise systems and integration, and education pedagogy.