

# Hybrid PBL Teaching Practice under COVID-19 Impact – A Case Study

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In this paper, the authors describe the development of a hybrid problem-based learning model for teaching during the COVID-19 pandemic, explores its impact on student learning effectiveness, and collects feedback from teachers on the teaching site. This study adopted experimental teaching with 30 students in the elective course of “Technology Application and Practice” of a university of science and technology as the research subjects. The hybrid PBL teaching model was applied and a 9-week “SDGs (Sustainable Development Goals, SDGs) App Creative Design Project” was implemented to collect qualitative and quantitative data for inductive analysis. The results of this study indicate that, in order to respond to students’ learning inconvenience and the panic caused by COVID-19, “student-centered” hybrid PBL teaching should be implemented, and it is also necessary to provide students with care in learning and life. Furthermore, the real-time and functionality of the Line platform should be utilized for students’ interactions with teachers and peer exchanges during the hybrid PBL courses. In summary, the innovative hybrid PBL course implementation method, as proposed by this study, has been affirmed by most students, and has shown positive and significant improvements in learning content and skills, teamwork, and task achievement. Finally, advice regarding hybrid PBL course teaching is put forward as a reference for implementation and application on the teaching site.

**Keywords:** hybrid PBL; COVID-19; SDGs; education reform; teaching practice

## 1. Introduction

PBL (Problem-Based Learning) originated in 1963 from the medical education reforms of H.S. Barrows, a professor in the Department of Medicine of McMaster University in Canada. PBL is a student-centered learning, teaching, and curriculum design mode that enables students to combine theory and practice to solve authentic problems, improves students’ learning motivation, and cultivates practical skills, such as problem solving, independent learning, and teamwork [1, 2]. PBL is currently popular in the teaching of many disciplines in schools at all levels at home and abroad [3]. The “White Paper on Creative Education”, as proposed by the Ministry of Education, Taiwan [4], pointed out that problem-solving ability, innovative thinking, and critical thinking skills are all important basic abilities required by future world citizens;

obviously, the student-centered PBL teaching model has become one of the mainstream trends in the development of higher education.

With the popularization of the Internet and the advancement of digital technology, emerging digital technology has become an important tool for digital teaching, hybrid teaching, distance teaching, and other teaching modes. Moreover, through PBL teaching with network technology, many studies have networked PBL, in order to improve the effectiveness of traditional PBL teaching [5, 6]. The combination of distance and PBL teaching modes allows learners to be free from the constraints of time and space, provides learners with a diversified learning environment, and promotes learning effectiveness [7]. Nevertheless, the feasibility of distance teaching is often questioned, and it was not until the end of 2019 that distance teaching became popular due to the coronavirus pandemic.

COVID-19 broke out in Wuhan City, China in December 2019, and the World Health Organiza-

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tion (WHO) declared a global pandemic on March 11, 2020 [8]. Therefore, governments, public health systems, and medical systems all established emergency response strategies in the first instance [9]. At the same time, governments are also testing how education units can adjust courses and teaching to ensure the health and education rights of students in the context of the unclear developments of COVID-19 [10].

Thus, in response to the impact of COVID-19, this study urgently adjusted the traditional PBL teaching methods, formulated corresponding teaching strategies, developed a hybrid PBL teaching model, planned course unit content, and designed teaching activities. As COVID-19 has made it difficult for teachers to implement face-to-face courses, this study also conducted experimental teaching to understand the impact of this hybrid PBL teaching model on students' learning effectiveness and collected feedback from teachers regarding the teaching scenarios.

The research purposes are as follows:

- (1) to develop a hybrid PBL teaching model;
- (2) to explore the impact of hybrid PBL courses on student learning effectiveness;
- (3) to reflect hybrid PBL teaching practices under COVID-19.

## 2. Literature Review

### 2.1 Campus Pandemic Prevention and Teaching Response Measures against COVID-19

In response to COVID-19, the Ministry of Education announced the key points of campus safety and pandemic prevention, and schools were advised to set up a pandemic prevention team to implement pandemic prevention regulations. If a student is confirmed to have the disease, the entire class will be suspended, and the entire school will be suspended with two confirmed students, and schools have been notified of the distance teaching precautions. In terms of courses, schools can provide different response methods, including synchronous remote teaching during class time, synchronous learning and teaching for various locations, and the postponement of summer vacation to make up

for missed lessons or practice; however, it must consider the quality of teaching and learning, and accurately grasp the students' conditions [11].

Regarding the health of teachers and students, the case university has convened a number of Meetings for the Prevention of the COVID-19, planned response strategies in coordination with the national colleges and universities, announced the postponement of the start of classes, mobilized the entire university staff to jointly prevent the pandemic, and asked the Academic Affairs Office to use newsletters and Line to send pandemic prevention notices and health precautions. Moreover, the university should be notified of anyone with a fever to monitor the health of the students in the class, and any persons with a fever should rest at home, as well as other relevant measures, such as relaxation of school opening, registration, additional withdrawal time limits, and leave, in order to protect the physical and mental health of the entire university [12]. In response to the suspension of classes, "distance online teaching and coordination matters" have been developed. As distance online teaching programs are adopted for teaching during the suspension period, the various departments and schools are required to prepare in advance, and teachers are requested to prepare textbooks and upload teaching content in advance. In addition, relevant online course resources, video platforms, and tools are provided, as shown in Table 1, for the reference of teachers and students during teaching in synchronous or asynchronous online (distance) courses [13].

As students are unable to attend classes, this study adjusted the teaching methods to respond to the impact of COVID-19. The online course resources, as recommended by the Ministry of Education, are used as textbooks for synchronous and asynchronous online teaching of courses, which are combined with face-to-face courses to develop hybrid PBL courses, and are expected to provide students with complete and uninterrupted learning resources and environment under the influence of the pandemic.

### 2.2 Connotation of Hybrid PBL

First, the methods and limitations of traditional

**Table 1.** Summary of Online Course Resources

Name	Number of courses	URL
e_want	About 394	<a href="https://www.ewant.org/">https://www.ewant.org/</a>
Open Edu	About 500	<a href="https://www.openedu.tw/">https://www.openedu.tw/</a>
Share Course	About 500	<a href="https://www.sharecourse.net/sharecourse/">https://www.sharecourse.net/sharecourse/</a>
Taiwan LIFE	About 367	<a href="https://taiwanlife.org/">https://taiwanlife.org/</a>
General Education TW	About 190	<a href="http://get.aca.ntu.edu.tw/getcdb/">http://get.aca.ntu.edu.tw/getcdb/</a>
Open Course Ware Consortium Taiwan	About 1398	<a href="https://www.tocec.org.tw/web/index.jsp">https://www.tocec.org.tw/web/index.jsp</a>

PBL are discussed. Docherty, Hoy, Topp and Trinder [14] considered the implementation of the traditional PBL method, as follows: 1 hour of lectures per week with 3 hours of PBL discussions, and teachers will promote discussions and give demonstrations during class. Rounds and Rappaport [15] mentioned that, in the traditional PBL method, students meet once a week, thus, there are time and space constraints. In addition, McLean and Murrel [16] believed it is difficult for PBL to be implemented at a fixed location with space constraints if there are a lot of students.

Furthermore, the advantages and disadvantages of remote PBL are discussed in this study. The advantage of implementing remote PBL is that learners can study at school, at home, or any place with Internet access; asynchronous online discussions are provided, in order that learners' discussions and communications will not be affected due to time and space factors [17]. Compared with the traditional PBL method, remote PBL allows learners to flexibly adjust their learning progress. The disadvantage of remote PBL is that most learners often feel frustrated, their learning can be hindered or learning interest affected due to their unfamiliarity with the use of a computer network and operating errors [18]; and in the unfamiliar distance learning environment, as students are not very clear about the requirements of the course and how to prepare homework, it seriously affects the frequency of students' participation in online discussions, asking questions, and answering questions [19, 20]. For teachers, remote PBL requires more time to prepare and develop online multimedia PBL course materials, and it is difficult to

find a time for synchronized online discussions [21].

In summary, with the rapid rise of global information networks and the innovation of educational technology, educators believe that integrating the advantages of traditional teaching methods and online learning methods can enable students to achieve the best learning results [22]. As "digital learning" has broken the time and space limitations of traditional learning methods, it allows users to learn through digital electronic resource media, such as computers, intelligent vehicles, and the Internet, and creates learning experiences through their digital content and teaching methods to achieve the purpose of learning [23]. In view of this, in the early stage of the impact of COVID-19, this study adjusted the teaching method in accordance with the policies of the Ministry of Education, used face-to-face and online teaching, applied synchronous and asynchronous teaching methods, and implemented hybrid PBL teaching to provide students with high-quality teaching that features safety concerns by reducing the infection of students gathering in groups.

### 3. Research Design and Methodology

The design process of this study is shown in Fig. 1. Due to the impact of COVID-19, the study adopted a literature review to integrate PBL, remote PBL, campus epidemic prevention and teaching response measures, and then developed a hybrid PBL teaching mode and planned hybrid PBL courses. The SDGs App Creative Design Project was divided into seven stages, including a preparatory stage, problem discovery, planning for problem solving,

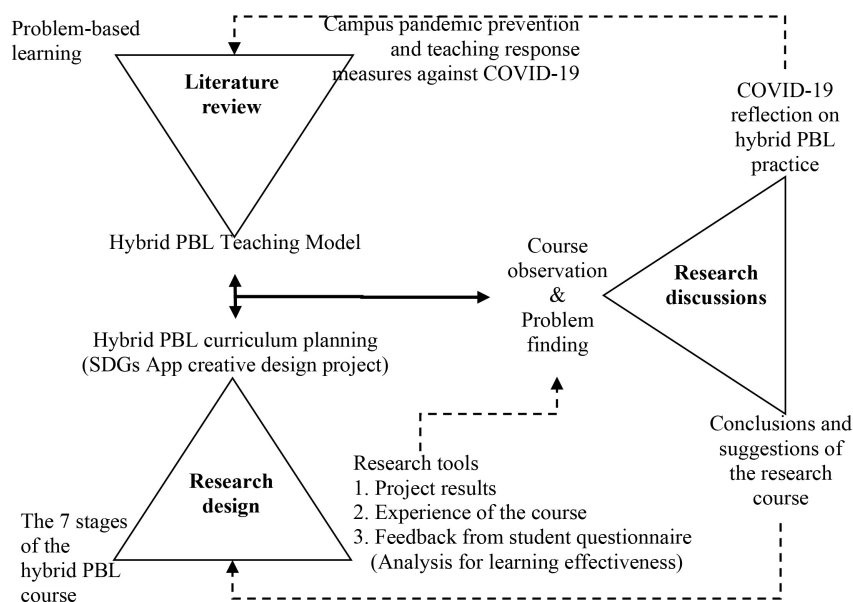


Fig. 1. Research Process.

self-study, group discussion, presentation on the results of problem solving, and a teaching summary and evaluation.

In addition, the study took 30 students from a university of science and technology as the research subjects and implemented a nine-week experimental teaching plan based on the quality hybrid analysis method. In terms of the quantitative analysis, this study developed the Questionnaire on Learning Effectiveness of Hybrid PBL Courses by referring to the three dimensions of learning content and skills, team cooperation, and task accomplishment. The Cronbach's alpha of each dimension was 9.13, 8.96, and 9.39, and the overall Cronbach's alpha value was 9.14, indicating that the reliability of this study was very good in exploring the performance of the students' learning effectiveness. In terms of the qualitative analysis, this study designed a seven-stage learning feedback sheet and a final report outline through the teachers' observations and by collecting the students' learning feedback, so as to understand the status of the students' learning process in a two-pronged way and then propose a teaching reflection. The results

of this study could be used as a reference for revising the hybrid PBL course.

#### 4. Hybrid PBL Curriculum Planning

The research subjects of this study were 30 students who had taken the elective course "Technology Application and Practice" in a university of science and technology. In response to COVID-19, the implementation of the "Technology Application and Practice" course was adjusted, and a 9-week "SDGs App Creative Design Project" was planned, as shown in Table 2, including a 7-stage preparation phase with problem-finding, problem-solving planning, self-study, group discussion, presenting problem solution results, and teaching summary and evaluation. The project course was mainly based on teaching with App Inventor 2, and a 6-week online course was planned with the online textbook of Open Edu's "APPs basic implementation". This course planned synchronous teaching over a 2–4 week period in combination with the video conference function of the Line course group (whole class), in order to ensure that students correctly

**Table 2.** Implementation Plan of Hybrid PBL Course

Week	PBL	Course unit	Description	Hybrid teaching
	Preparation stage	***	Plan student-centered face-to-face and online teaching materials, and teaching activities and progress, and develop App Inventor 2, SDGs, COVID-19, and other themes.	***
1	Discover the problem	* Course introduction * SDGs introduction	Hybrid PBL project course implementation method, group cooperative learning (including Line group), online resource OpenEdu -APPs basic practical course	Face-to-face teaching
			Consider "What do I want students to do?", "How do I know if they can do it?", "What opportunities must I provide to help them succeed?" Let students give substantial feedback, encourage students to reflect and understand their own learning situation.	Line group
2–4	Problem solving plan Independent learning Group discussion	* Build the first APP * Declare variables and logical judgments * Loops and arrays	Increase students' motivation for learning Students' App Inventor 2 basic ability building	Online
			Increase opportunities for teacher-student interactions Synchronous online discussions to master the student's learning status	Line group
5	Group discussion Present problem solution results	* Creative thinking tools * Theme setting	SDGs App creative design theme setting	Face-to-face teaching
			Building capacity for Network data collection	Line group
6–8	Independent learning Group discussion Present problem solution results	* Subprograms and comprehensive practice * Application of drawing, animation and mobile phone sensor * Data access and image recognition	Increase student motivation for learning Students' App Inventor 2 advanced ability building	Online
			Increase opportunities for teacher-student interactions Asynchronous online discussions to make students reflect on the content of learning	Line group
9	Teaching summary and evaluation	* Results release	Release of results of each group of students	Face-to-face teaching
			Post-test questionnaire	Line group

operate the learning website to successfully complete the online course. In the 6th–8th weeks, asynchronous teaching was implemented, including a chat room, notepad, photo album, and video conference of the Line group (each group), to assist student groups in cooperative learning.

In addition, there were 3 weeks of face-to-face courses (weeks 1, 5, and 9), which focused on App Inventor 2 practice supplemented by lectures, in order to allow students to build programming experience through App implementation and accumulate knowledge through experience, which can strengthen students' confidence and increase their interest in learning. Finally, in order that students could prove their abilities in App Inventor 2 operation and basic programming, students were asked to show what they had learned in class, and students' learning results were presented through the final report.

In terms of the theme of students' projects, the 17 SDGs main indicators were taken to encourage students to incorporate sustainable development goals into the creative design concept of the App. In addition, this course required all groups of students to establish a "Line Group" as a platform for teacher-student interaction and real-time consultation, as well as group synchronous and asynchronous discussions and information sharing.

In terms of online course planning, according to the different starting behaviors of students, a flexible 6-week online course was designed in combination with the implementation of the Open Edu online course, as recommended by the Ministry of Education. The course of Apps Basic Implementation was jointly offered by Associate Professor Yao-Cheng Hung and Associate Professor Bo-Ting Wan of Feng Chia University, as shown in Table 3. The course implementation method was mainly to record teaching videos in a relaxed and lively manner, which stimulated students' learning motivation and is different from the traditional univer-

sity lecture course. In addition, the program concept was introduced in a simple and easy-to-understand manner, and the program design concepts and applications were illustrated with examples, such as the voice calculator App, real-time Chinese-English translation App, and image recognition App. In addition, the course content was interspersed with different video categories, such as interviews of App competitions, unplugged program board games, App program concept challenges, etc., in order to increase students' motivation to watch the videos.

## 5. Results and Discussion

Due to the impact of COVID-19, a hybrid PBL method was adopted to implement the nine-week SDGs App Creative Design Project. The experimental teaching results were analyzed from the aspects of student learning feedback and student learning effectiveness.

### 5.1 Teaching Implementation and Student Feedback

This study was implemented in accordance with the 7 stages of the hybrid PBL course, where the students' learning feedback were collected and analyzed, and the description is, as follows:

#### (1) Preparation Stage

In accordance with the requirements of the hybrid PBL curriculum design, teachers planned a "student-centered" teaching model for face-to-face and online teaching materials, teaching activities, and teaching progress, and developed themes for discussion, including App Inventor 2, SDGs, COVID-19, and other themes.

#### (2) Discover Problems

The first week was the face-to-face teaching course. At the beginning of the course, the "Technology

**Table 3.** Introduction to Online Courses

Category	Description
Course name	APPs Basic Implementation
Course Introduction	This course uses App Inventor 2 as the development environment, which leads students to understand the basic structure of the programming language, including the core concepts of variable declaration, loops, logical judgments, arrays, and subprograms. The establishment of program concepts helps students to have the ability to implement several Apps.
Course targets	(1) Understand the basic concepts of program design and become familiar with App project implementation. (2) Understand the concepts of UI designs and software operation.
Course outline	(1) Create the first App (2) Declare variables and logical judgments (3) Loop and array (4) Subprograms and comprehensive practices (5) Application of drawing, animation, and mobile phone sensor (6) Data access and image recognition
Course URL	<a href="https://www.openedu.tw/course.jsp?id=787">https://www.openedu.tw/course.jsp?id=787</a>

Application and Practice” course objectives and App Inventor 2 teaching units were introduced to strengthen the integration of students’ new and existing knowledge. Furthermore, the face-to-face and online teaching methods of hybrid PBL were explained. The 1st, 5th, and 9th weeks were face-to-face courses, and the remaining 2nd to 4th weeks and 6th to 8th weeks were a total of 6 weeks of online Open Edu “Apps basic implementation” course teaching. In addition, in order to guide students in active learning, this course was supplemented with Line student groups serving as a platform for teacher-student interactions and student exchanges and discussions. Moreover, in terms of student grouping, it was planned to adopt cross-departmental and heterogeneous grouping methods to encourage student teams to conduct cooperative learning.

This course mainly took the 17 sustainable development goals planned by Transforming Our World: the 2030 Agenda for Sustainable Development of the United Nations as open-ended themes, and guided students to discover problems, such as food safety, life safety, elderly care, education equality, and other themes. These issues made students care about the real problems and situations in their lives, encouraged the student groups to discuss and find solutions, aroused students’ motivation and interest in learning, and helped cultivate students’ cooperation and high-level thinking ability.

*Students’ Feedback:*

S0201: In the course, we learned about the 17 sustainable development goals of the United Nations, and we also further understood the problems around us in our lives. Through the Line group discussion, we thought about solutions to the problems.

S0402: It turns out that our living environment and problems are severe, and we hope to solve the problems of our daily lives through innovative applications of technology.

*(3) Problem Solving Planning*

Weeks 2 to 4 were the App Inventor 2 basic online learning course. Teachers used the Line course group to understand the students’ learning status in the online courses, including getting familiar with the software operation interface, declaring variables, making logical judgments, and creating loops and arrays for building simple basic App capabilities.

Furthermore, in terms of problem setting and subject area-related knowledge in this course, the teacher in the Line course group guided students to discover real-life problems in accordance with the

17 sustainable development goals of the United Nations, in order that each group of students can complete the problem settings and the knowledge related to the subject areas of SDGs, COVID-19, and the App, as well as the application of relevant emerging technologies, such as the Internet of Things in daily life, etc., where students could explore and learn network-related knowledge by solving problems.

*Students’ Feedback:*

S0101: The teacher uploaded relevant teaching plan data, pictures, videos, and online resource links to the Line course group, so that we can refer to them and study, or directly discuss and communicate in the group.

S0603: Unexpectedly, the data on the Internet is so rich, we can find all kinds of detailed data, there are online textbooks, pictures, videos, research papers, and other materials, which can allow us to carry out extended learning and integrated learning. We really needed to use network resources effectively.

The 5th week was the face-to-face teaching course. This course planned to teach the unit of “Creative Thinking Tools-Nine-square Grid”, with COVID-19 and SDGs as practice themes, where students could learn the application of nine-square grid creative thinking, as shown in Fig. 2. This course was designed with SDGs, COVID-19, and other real problem situations to improve students’ participation. Students were allowed to discuss and learn in class, and the Line course group was also adopted to guide students to use the nine-square grid to think, discuss, and search for information from various learning resources, and carry out creative ideas for emerging technologies, innovative operation models, and prototype design implementations, as well as other technological applications to solve problems and achieve sustainable development goals.

*Students’ Feedback:*

S0301: The teacher taught us the steps to use the nine-square grid, and let us learn through creative thinking tools and teamwork. We first thought about the impact of COVID-19 when it occurred, for example, airplanes were grounded, restaurants were closed, daily meals were cooked by ourselves or ordered on Foodpanda, and the rise of video function applications. We brainstormed and collected resources on the Internet to discuss and exchange together. Student works (a)

S0703: It was not easy to fill all nine-square grids. Fortunately, our team members were excellent. Together, we listed the relevant precau-

tions of COVID-19 in a complete list, including wearing a mask, taking body temperature, alcohol disinfection, maintaining a social distance of 1.5 Meters, fasting bats, 14 days of quarantine when returning from a foreign country, and other rich materials, and used them as the direction for creative thinking in the group. Student works (b)

(4) Independent Learning

The 6th to 8th weeks were an advanced online learning course for App Inventor 2, including subprogram exercises, animation, and mobile phone sensor applications, as well as data access and image recognition, in order that students could learn advanced App design applications. Furthermore, this course encouraged students to use group cooperative learning methods, which used online learning resources and Line group functions to guide students to independently plan individual learning plans to enhance knowledge learning, including SDGs, the basic concepts and applications of the App, emerging technology applications, and relevant COVID-19 knowledge. In the course, the Line group functions were utilized to plan driving questions, and create study lists and online quizzes, in order to promote students' communication skills, teamwork, problem solving capabilities, independent learning, and information sharing, and train team members to understand and respect each other.

Students' Feedback:

S0202: According to the online course planning and the deadline for the delivery of homework, I made a personal learning plan according to my learning progress, so that I can better understand time management, teamwork, and independent learning, and the use of teaching resources.

S0505: As a team leader, I always reminded my classmates to complete the online courses, convene group discussions, and record and host team learning activities, so that I could complete the classwork and final report as scheduled.

(5) Group Discussion

This course was implemented as a hybrid PBL method, and group discussions were mainly planned for online and Line group discussions. Moreover, as this course is a college course, the source of students is mostly from different departments, thus, the grouping method was heterogeneous and cross-departmental. The groups consisted of 3-6 members, which is in line with the characteristics of the cross-field integration of this course. In terms of group operations, three students were group leaders and deputy group leaders, and the rest were group members. In response to the impact of COVID-19, online collaborative learning was mainly adopted, including the division of labor and cooperation for data

(a) Students think about responses to the COVID-19 pandemic by following the steps in the nine-square division



(b) Students are grouped to brainstorm on the response measures to prevent COVID-19 infection



Fig. 2. Students Learning with Nine-square Grid Creative Thinking Tool.

collection, integration and induction, discussion and analysis, creative thinking, problem solving, and hands-on App design.

The teacher guided the students to first complete the data collection and online discussion of SDGs, COVID-19, and related industry issues, and encouraged students to recall and share their previous knowledge and life-related experiences, in order to facilitate group discussion and thinking, and raise derivative questions. Then, each group proposed their problem-related assumptions and mechanisms to determine the theme of learning. Furthermore, students were encouraged to find relevant materials and learn new knowledge, based on the division of labor, to find innovative solutions to group problems. In this way, the students' abilities to apply new knowledge to solve problems were improved, and the results of teamwork learning were displayed.

In terms of integrating SDGs into the course learning, the teachers introduced the implications of the 17 indicators of SDGs in the course to arouse the students' interest in social issues and set the students' development of an innovative design for sustainable and common prosperity of the world, as shown in Table 4. With the connection of SDGs, the students' vision and international outlook were expanded. The group of students thought about the theme of the App together, took their own majors as the starting point, and searched for innovative solutions for social problems. The connotations of gender equality, intelligent, and friendly environments, improvement of education quality, sustainable production and other indicators were combined to show the students' intention and action in caring about local innovative and sustainable development. In this way, the students' spirit of sustainable development could be cultivated and their social responsibility could be fulfilled.

*Students' Feedback:*

S0101: Due to the impact of COVID-19, there are

not many opportunities for students to meet and discuss. We had to use the line group function to conduct group interactive discussions, SDGs knowledge sharing, and COVID-19 opinion exchange to successfully complete the assignment.

S0604: Fortunately, there is a Line group. In addition to group discussions, we could also ask the teacher immediately if we had questions, and have real-time interaction and communication with the teacher; besides, the teacher often reminded us to complete the online course and study list discussions, which can be considered as an alternative after-school tutoring mechanism.

*(6) Present Problem Solution Results*

According to this course plan, students were asked to understand the impact and shock COVID-19 had on their lives and the importance of SDGs indicators. Then, students were guided to use the nine-square grid creative thinking tool to put forward creative ideas, and draw the idea map for the problems they wanted to solve, and then, explain the design concept of the innovative App and the corresponding SDGs indicators to be achieved. Furthermore, according to the design concept, students applied the App and programming knowledge for App Inventor 2, as learned in the online course, to design their App Simulation works. Finally, in the result exhibition, each group made a presentation to share their design concept and creation process.

*Students' Feedback:*

S0401: The design of this group is the "Smart Manual Accounting App". In response to the impact of COVID-19, people's daily consumption patterns have changed from offline consumption to online/network consumption. Therefore, we designed this App to record online consumption details and collect statis-

**Table 4.** Student App Project and SDGS Association Table

No.	Topic	SDGs
1	Female defense – GPS satellite positioning App	05 GENDER EQUALITY 11 SUSTAINABLE CITIES AND COMMUNITIES
2	Elderly Care App	11 SUSTAINABLE CITIES AND COMMUNITIES 03 GOOD HEALTH AND WELL-BEING
3	Automobile driver's license question bank App	04 QUALITY EDUCATION 08 DECENT WORK AND ECONOMIC GROWTH
4	Smart journal App	12 RESPONSIBLE CONSUMPTION AND PRODUCTION 08 DECENT WORK AND ECONOMIC GROWTH
5	Local Agricultural Products Cooperative Platform App	10 REDUCED INEQUALITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION
6	Environmental Protection Education App	04 QUALITY EDUCATION 14 LIFE BELOW WATER 15 LIFE ON LAND



tics to achieve the function of bookkeeping and financial management. Furthermore, we added an intelligent warning function to reduce unnecessary expenditures. In addition, we hope this “Smart Manual Accounting App” can replace paper accounting to achieve environmental protection to love the earth, which is in line with SDG12: Ensure sustainable consumption and production patterns.

S0501: We referred to SDG12 to ensure sustainable consumption and production patterns, and wanted to design a “Local Agricultural Product Sales Platform App” to provide sales channels, agricultural product information, and promotional activities for special local agricultural products, in order to solve the problem of local farmers’ inability to obtain reasonable agricultural prices to improve the production environment and update their facilities due to the low price exploitation by intermediaries, resulting in a vicious cycle of production mode. In addition, under the influence of COVID-19, it can provide a safe consumption mode for the online purchase of fruits.

#### (7) Teaching Summary Evaluation

In response to the impact of COVID-19, this course planned diversified evaluation methods, including study feedback forms for each unit, student evaluation forms for each unit, result release evaluation, questionnaire survey, etc. Using these evaluation methods, the completion of the online courses by the entire group of students, the actual participation performance of the Line group, and the feedback content of the study list were scored by the teacher. When the group members discussed in accordance with the PBL method, they had good communication skills and respected each other, for which they were given extra points. In this way, the teacher could grasp the learning status of the students and adjust the teaching difficulty level to enhance students’ learning effectiveness.

#### Students’ Feedback:

S0103: Before learning each unit of the online course, the teacher posted the unit study list in the Line group, so that we could understand the key points of the course in advance; as

students completed the online course, we would discuss in the group and complete the study list together.

S0401: There are assessment questions in each unit of the online course to check whether we understand the content of the course; the teacher also encouraged us to discuss in the Line group and share our learning experience.

S0202: In order to prepare the final results report, the students in this group stayed up late to divide the work, and finally, completed the works and the content of the presentation. During the presentation, we learned about the design concepts, innovation, practicality, and feasibility of other groups. It also enabled us to learn the creativity of other groups and achieve the effect of communication between groups.

#### 5.2 Analysis of the Learning Effectiveness of the Hybrid PBL Course

After the course was over, this study conducted a questionnaire survey of the 30 students that took the course, the single sample t-test analysis was conducted, and the statistical analysis results are shown in Table 5. The “Hybrid PBL Course Learning Effectiveness Questionnaire” covered the 3 dimensions of learning content and skills, teamwork, and task achievement. The average score of each dimension ranged from 4.46 points to 4.53 points, and the t value ranged from 13.98 to 14.35, which all reached significant differences. Among them, the “task achievement” dimension had the highest score, with an average mean of 4.53 (SD = 0.601) and a t value of 13.98; followed by the “teamwork” dimension, with an average mean of 4.49 (SD = 0.567) and a t value of 14.35. Finally, the “learning content and skills” dimension had an average mean of 4.46 (SD = 0.568) and a t value of 14.10. These results show that, after teaching this course according to the PBL method, most students expressed positive affirmation in terms of learning content and skills, teamwork, and task achievement.

The performance of students in the various dimensions was further explored, as shown in Table 6. In terms of “learning content and skills”, the average mean of each item ranged from 4.23

**Table 5.** Analysis of main dimensions of the learning effectiveness of the hybrid PBL course

Dimensions	Average mean	Standard deviation	t
learning content and skills	4.46	0.568	14.10***
teamwork	4.49	0.567	14.35***
task achievement	4.53	0.601	13.98***

\*\*\* p-value < 0.001.

**Table 6.** Single-sample T-test Analysis for Learning Effectiveness of Hybrid PBL Courses

Dimension	Item	Average mean	Standard deviation	t
Learning content and skills	I understand the basic concepts and curriculum design of the hybrid PBL teaching in this course	4.37	0.718	10.42***
	The hybrid PBL teaching method can enhance my understanding of the course content and theme-related knowledge	4.47	0.629	12.78***
	The hybrid PBL teaching method can help me link theme-related knowledge with previous knowledge	4.50	0.682	12.04***
	The hybrid PBL teaching method can motivate me to learn actively and increase my motivation	4.47	0.730	11.00***
	This course can help me effectively use the diversified information on the Internet to solve problems	4.53	0.571	14.70***
	This course can improve my ability to integrate theory and practice	4.23	0.774	8.73***
	This course can improve my skills in using online resources and independent learning	4.53	0.629	13.36***
	This course can improve my critical thinking ability	4.40	0.770	9.96***
	The process of discussing the theme of the course can improve my ability to examine problem skills	4.50	0.682	12.04***
	In the process of discussing the theme of the course, the teacher will guide students online to think about problem solutions	4.63	0.615	14.55***
Teamwork	Through this course, I can understand that teamwork is very important for the training and development of organizational skills	4.63	0.615	14.55***
	According to the theme of the course, team members can coordinate with each other, jointly decide the direction of discussion, and carry out division of labor	4.33	0.711	10.27***
	The hybrid PBL teaching method can improve my ability to collaborate and communicate with other online teams	4.50	0.682	12.04***
	In the process of discussing the subject of the course, I can share and discuss the data collected on the Internet in groups	4.57	0.568	15.10***
	In the course of discussing the subject of the course, the group members can express different opinions in the online discussion	4.40	0.770	9.96***
Task achievement	My team members and I can fully discuss and reach a consensus on the work content of the course theme	4.53	0.682	12.32***
	In the online division of the team, I can actively participate and complete the assigned tasks.	4.57	0.679	12.64***
	In the online course study, I can properly plan and manage my work progress to improve my learning effectiveness	4.53	0.682	12.32***
	The hybrid PBL teaching method can improve my problem-solving ability	4.50	0.777	10.58***

\*\*\* p-value < 0.001.

points to 4.63 points, and the t values ranged from 9.96 to 14.70, which all reached significant differences. Among them, the item “Teachers will guide students to think about problem-solving methods in the process of discussing the subject of the course” had the highest score, with an average mean of 4.63 (SD = 0.615) and a t value of 14.55. The second highest score was for “This course can help me to effectively use diversified network information to solve problems” and “This course can improve my skills in using online resources and independent learning”, where the average mean of both was 4.53 (SD was 0.571 and 0.629, respectively), and the t values were 14.70 and 13.36, respectively.

In terms of “participation degree”, the average mean of each item ranged from 4.33 points to 4.63

points, and the t-value ranged from 9.96 to 15.10, which all reached significant difference. Among them, “Through this course, I can understand that the effect of teamwork is very important on the training and performance of organizational ability” scored the highest, with an average mean of 4.63 (SD = 0.615) and a t value of 14.55. The second high was “In the course of discussing the subject of the course, I can share and discuss the data collected on the Internet in groups”, where the average mean was 4.57 (SD = 0.568), and the t value was 15.10. Next was the “Hybrid PBL teaching method can improve my ability to collaborate and communicate with others in the online teams”, where the average mean was 4.50 (SD = 0.682) and the t value was 12.04.

In terms of “task achievement”, the average

mean of each item was between 4.50 points and 4.57 points, and the t-value was between 10.58 and 12.64, which all reached significant difference. Among them, the item of “In the online labor division of the team, I can actively participate and have actually completed the assigned tasks” had the highest score, with an average mean of 4.57 (SD = 0.679), and a t value of 12.64. The second highest included “My team members and I can fully discuss and reach consensus on the work content of the course theme” and “In the online course study, I can properly plan and manage my work progress to improve my learning effectiveness”, with the average mean of 4.53 (SD = 0.682) and the t value of 12.32.

### 5.3 Comprehensive Discussion

Based on the above analysis, Dr. Don Woods once said: “Inspiring students is an important first step in teaching.” Therefore, this course was implemented as a hybrid PBL method, and diversified teaching strategies and activity designs were adopted to improve students’ learning interest and motivation in the App Inventor 2 online course. Furthermore, the course focused on the improvement of students’ online teamwork, communication, problem-thinking, inquiry, and resolution capabilities in the Line group of students.

From the feedback of the students’ learning and the on-site observations from the teachers, it could be seen that the students in this study were more active in their learning than previous students in the same course, and the discussion in the LINE group was more passionate and had a more profound and extensive discussion content. The results showed that the students could gradually complete the tasks and construct the learning knowledge according to the seven-stage plan of PBL, and reached a consensus on the need to work together online in order to complete the group project.

In the course, diversified learning activities, such as COVID-19, SDGs, and a nine-square grid, were planned to allow students to view problems in a new way and link interdisciplinary and subject learning [3]. Through teamwork, the students shared ideas, problems, and solutions, and students were encouraged to try new methods to solve problems and complete tasks, in order that talents, professional knowledge, and intelligence could play the maximum role [24].

## 6. COVID-19 Reflection on Hybrid PBL Practice

The relevant teaching and care suggestions after 9 weeks of experimental teaching observations are explained, as follows.

### 6.1 Implement a “Student-Centered” Hybrid PBL Teaching Method and Learning Care

This study found that teachers are no longer the only source of knowledge for students. Students can collect many kinds of learning resources through the Internet, including pictures, videos, materials, textbooks, and courses. Therefore, teachers can change their identities and become a “facilitator on the side” [25], provide grouped students with some theme-related current affairs cases or pictures, let students share their observations and discuss the relationship between themes and current affairs cases in groups to learn specific themes, train students to take responsibility for the learning effects for themselves and the team, as well as learn self-responsibility, and then, cultivate students’ abilities in “team spirit” and “independent learning”.

In addition, as the pandemic is serious, students’ fear of possible infections, as well as concerns about family and personal health, have indirectly increased their psychological stress, and even caused physical symptoms, including depression, anxiety, and increased stress load [26]. Therefore, in addition to teaching responsibilities, teachers’ care for students is important to help students reduce the burden of psychological pressure, face the threat of infectious diseases with positive energy, and study with peace of mind.

### 6.2 Apply The Line Group Function to Ensure the Quality of Students’ Online Learning, Discussion, and Feedback

The impact of COVID-19 has revealed the importance of cultivating students’ online independent learning and cooperative learning abilities. However, as students are unaccustomed to online learning, it is risky to allow group students to study independently and discuss freely. Therefore, when implementing online course teaching, in addition to introducing the operational interface of the online course website, it is recommended to use the Line group function for assistance, in order that students can ask questions when they encounter difficulties in online learning, and use teachers’ feedback during real-time teaching to guide students in group discussions, which can help students stay focused on the online discussions [27]. Thus, after students have the ability to learn, discuss, and give back online, teachers can retreat to the role of tutors and observe the learning and discussion status of the group students, in order to evaluate the learning effectiveness of students’ writing ability, thinking ability, their ability to use information, and their ability to cooperate with peers.

### *6.3 Adopt Hybrid PBL Teaching To Improve The Ability Of Teachers And Students To Apply Computer Technology And Network Platform Learning*

With the advent of the trend of online learning, and under the impact of COVID-19, the importance of online learning is even more obvious, and computer technology and network platforms are necessary tools for online learning. Online learning shows that teachers must have a considerable degree of mastery of course network platforms, as well as the ability to ensure that the use of computer technology will not hinder students' learning. Therefore, to ensure that teachers and students can adapt to computer technology, use network platforms as a teaching and learning medium as soon as possible, and become familiar with online operation methods, it is recommended that teachers implement hybrid PBL teaching [28]. In this way, teachers and students can be equipped with the basic ability of troubleshooting to prepare for the full introduction of online learning in the future.

### *6.4 Cultivating the Correct Attitude and Basic Knowledge of Online Group Cooperative Learning in Students in the Post-Epidemic Era*

Although online courses cannot completely replace physical courses, many studies have confirmed that online teaching can assist students in improving their learning effectiveness. Due to the advent of the post-epidemic era, it has become the basic goal of school education to train students to have the ability to learn online independently. It is more important to know how to cultivate students to have the correct attitude and to acquire the basic knowledge and abilities through group cooperative learning online [29]. The hybrid PBL teaching model developed in this study could provide a reference for schools and teachers. The implementation of this course revealed that the implementation of online and physical courses could gradually guide students to get familiar with online learning and group discussion methods, including online communication, discussion, innovation sharing, online collaboration, resource integration, respect for diversity, openness and tolerance, and other abilities and attitudes. Furthermore, the students perceived that their participation in solving real life issues and meeting the SDGs targets could stimulate their interest in the curriculum, motivate peer discussion, increase social engagement, and provide their concerns and support for a sustainable environment. This hybrid PBL teaching mode could help cultivate students' ability to respond to the tremendous changes in the post-epidemic era and maintain

the correct attitudes and values of continuous learning, innovation, sharing, co-prosperity, and sustainability.

## **7. Comprehensive Discussion and Suggestions**

Based on the results and reflection of this study, this paper discussed, summarized, and put forward the following suggestions:

### *7.1 Discussion*

#### *(1) The Learning Effectiveness of Most Students in the Hybrid PBL Course was Positive and Significant*

As indicated by this study, most of the students taking this hybrid PBL course showed significant positive affirmation in the learning effectiveness of the dimensions of "learning content and skills", "teamwork", and "task achievement". The results show that most students can accept the hybrid PBL teaching method; especially the students with original weak performance in class, as they can repeatedly watch the content of the online course at home, repeat the exercises, and discuss and learn together with other students to effectively internalize knowledge and improve their learning effectiveness through hybrid PBL course learning [6, 30].

#### *(2) The Line Function Application of the Hybrid PBL Course Can Increase the Interaction Between Teachers, Students and Peers*

The content of this hybrid PBL course was mainly based on online courses. In terms of student-student discussions and student-teacher interactions, this course was conducted as a Line group to facilitate students' learning and discussion in the classroom to extend to online implementation. With Line's real-time and multi-functional applications, students can deepen their understanding of the course content [29]. It can also provide students that seldom speak in class with the opportunity to ask questions and participate in discussions among students to strengthen their learning motivation.

#### *(3) The Implementation of Hybrid PBL Courses Helped Teachers to Innovate in Teaching Methods and Teaching Design*

When planning the hybrid PBL course for this study, it was necessary to consider which App Inventor 2 course content would allow students to independently read, digest, understand, and implement the online course. Furthermore, teachers should design teaching activities regarding SDGs

and COVID-19 to allow students to discuss, practice, and apply the knowledge to guide themselves to learn independently, train their reflection ability, improve their ability to collect information, and how to discuss learning with classmates. Therefore, the implementation of this hybrid PBL curriculum has enabled teachers to switch from the teacher-centered teaching method (what the teacher teaches) in the past to a student-centered teaching method (what students can do), which helps teachers to innovate teaching methods and teaching designs [3].

## 7.2 Suggestions

### *(1) Integrate Course Content and Current Affairs, Design a Hybrid PBL Course with Clear Learning Objectives*

The main axis of this hybrid PBL course is to allow students to actively and positively participate in learning, and not just transfer textbook knowledge. Therefore, when teachers develop hybrid PBL courses, they can integrate course content with current events to set course learning goals. Then, the subject direction of real problems can be combined to plan course activities and homework, meaning that student groups can collect data, sort and summarize the information, discuss the issues with each other, conduct in-depth analysis, and exchange learning experiences, which returns the responsibility and initiative of learning to students.

### *(2) Make Good Use of the Line Group Function to Assist Students in Independent Learning Online and Cultivate Their Time Management Ability*

Hybrid learning reduces the proportion of time for teachers' face-to-face teaching; however, it should be noted that students may become inattentive as a result. In response to the reduction in the proportion of face-to-face courses due to COVID-19, it is recommended to refer to this study, plan to establish a Line course group, and use the Line group as a platform for teacher-student interactions and peer discussions, such as online experience reports in the classroom, feedback and exchange, and discussions of questions. In this way, repeated practice will allow students to learn time management and become accustomed to "independent learning", thus, effectively linking online schoolwork with classroom learning.

### *(3) Promote Hybrid PBL and Create an Independent Learning Environment to Strengthen Teachers and Students' Adaptability*

This hybrid PBL course focuses on student-centered learning, benefits from the convenience of the

Internet, effectively integrates face-to-face teaching and online learning and creates a more autonomous and flexible learning environment for students. As a proportion of face-to-face teaching has been reduced in response to the impact of COVID-19, it is necessary to promote the use of hybrid PBL teaching by teachers, in order that students can get used to online independent learning to reduce the impact of learning inconvenience caused by the external environment.

## 8. Conclusions

While COVID-19 has affected individuals' life patterns and the balance between industrial supply and marketing, it has also accelerated the development and application of online teaching. The "Hybrid Problem-Based Learning Model" and the "SDGs App Creative Design Project" developed in this study provided students with a mixed learning environment of online learning and group discussion under the restriction of the pandemic, which received affirmation from most students. This study focused on students' living and learning situations during the pandemic, aiding them in understanding the impact of COVID-19 and the corresponding counter-measures with the nine-square division tool to improve students' awareness of pandemic prevention. Furthermore, the hybrid PBL project encouraged grouped students to pay attention to social issues and creatively designed apps to solve social problems, so as to implement SDGs and improve students' online communication, coordination, and teamwork abilities. Moreover, the result of this study can be provided as a reference for the development of hybrid teaching in the post-pandemic era.

### *Compliance with Ethical Standards*

*Disclosure of potential conflicts of interest:* The authors declare that they have no conflict of interest.

*Research involving Human Participants and/or Animals:* All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This chapter does not contain any studies with animals performed by any of the authors.

*Informed consent:* Additional informed consent was obtained from all individual participants for whom identifying information is included in this paper.

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