UNIVERSITI TEKNOLOGI MARA

Voice of Academia

Academic Series of Universiti Teknologi MARA Kedah

VoA 2024

Volume 20 Issue 1

ISSN: : 1985-5079

DR NUR SYAZWANIE BINTI MANSOR,
ACADEMY OF LANGUAGE STUDIES,
UNIVERSITI TEKNOLOGI MARA (UiTM)KEDAH BRANCH, MALAYSIA

JUWAIRIAH OSMAN,
UNIVERSITI MALAYA , MALAYSIA

MOHD ZAKI RAMLI,
PROOFREADER UNITED, MALAYSIA

MUHAMMAD AIMAN ABDUL HALIM,
ACADEMY OF LANGUAGE STUDIES,
UNIVERSITI TEKNOLOGI MARA (UiTM)PENANG BRANCH, MALAYSIA

NORLIZAWATI MD TAHIR,
ACADEMY OF LANGUAGE STUDIES,
UNIVERSITI TEKNOLOGI MARA (UiTM)KEDAH BRANCH, MALAYSIA

SAMSIAH BINTI BIDIN,
ACADEMY OF LANGUAGE STUDIES,
UNIVERSITI TEKNOLOGI MARA (UiTM)KEDAH BRANCH, MALAYSIA

YANG SALEHA ABD GHANI,
ACADEMY OF LANGUAGE STUDIES,
UNIVERSITI TEKNOLOGI MARA (UiTM)PERLIS BRANCH, MALAYSIA

e-ISSN: 2682-7840

© Voice of Academia is jointly published by the Universiti Teknologi MARA Caawangan Kedah, Malaysia and Penerbit UiTM (UiTM Press), Universiti Teknologi MARA Malaysia, Shah Alam, Selangor.

TABLE of CONTENTS

Voice of Academia
Academic Series of Universiti Teknologi MARA Kedah

Voice of Academia Volume 20 Issue (1) 2024

Voice of Academia

e-ISSN: 2682-7840

COMPETITION-BASED LEARNING AND PROJECT-BASED LEARNING TO PROMOTE UNDERGRADUATE STUDENTS' MOTIVATION AND PERFORMANCE IN MATHEMATICS

Tammie Christy Saibin[1]*, Ung Ling Ling[2], Janvin Janteng[3] & Norfazillah Matmali[4]

[1,2,3&4] *College of Computing, Informatics and Mathematics Universiti Teknologi MARA (UiTM), Sabah Branch, Kota Kinabalu Campus, MALAYSIA*

ARTICLE INFO

Article history:

Received April 2023
Accepted Nov 2023
Published Jan 2024

Keywords:

Competition-Based, Project-Based, Open and Distance Learning (ODL), Learning Approach, Mathematics Education / Instruction

Corresponding Author:
tammi023@uitm.edu.my

ABSTRACT

A combination of two well-known learning models, project-based learning (PBL) and competition-based learning (CBL) maximises the advantages while avoiding the disadvantages of competition in Mathematics instruction. Thus, this study aims to improve the teaching and learning quality and enhance the learning outcomes of Mathematics instruction. To that end, the research hypotheses investigate the influence of the CBL-PBL approach on students' learning based on their engagement and educators' perspectives of the approach. A questionnaire was employed and distributed to 36 students and 2 lecturers who were using and implementing the CBL-PBL approach to achieve the research objectives. Non-parametric statistics tests were used to analyse the results. A significant relationship was found between the CBL-PBL approach and students' learning outcome based on their learning engagement, collaboration, authentic learning, disciplinary subject learning, and interactiveness. The results suggest that the CBL-PBL approach can maximise the students' learning outcomes by bridging academic theories and real-world practices through competition. Thus, the CBL-PBL approach is recommended for educational use with proper planning.

1. Introduction

As an emergency response to contain the Covid-19 pandemic, the governments of many countries have issued closures of national borders. Many sectors and people were affected irrespective of nationality, income, or gender. Education was no exception. The education systems of many countries were forced to make a sudden transition – from conventional face-to-face learning to online learning, which was highly dependent on broadband access and computers.

The Covid-19 pandemic also has an inevitable impact on higher education. Although higher education institutions quickly replaced face-to-face lectures with online learning, their students were still affected, particularly in accessing the internet and computers. In addition, the shutdown of international borders in response to the lockdown affected international students, particularly with regards to their safety and legal status.

The closures of universities and conversion to digital learning raise the question about the value offered by university education. According to Schleicher (2020), for universities to remain relevant, they need to reinvent their learning environment. Utilising digitalization and building an environment that suits student-teacher and student-student relationships can maximise the quality of online education.

The COVID-19 pandemic had an impact on three constructs of student learning: learning behavioural (students' frequency of participating in class discussions, meeting with instructors, and studying with peers outside the classroom); cognitive (students' sense of belonging and self-efficacy); and emotional (students' attitudes toward science, perceived value of the course, and stress) (Mseleku, 2020; Wester et al., 2021). To overcome these issues, scholars have developed a variety of learning techniques and learning models. Project-based learning (PBL) and competitions are two well-known models among others. Issa et al. (2014) proposed a new learning model that combines PBL and competitions. This model incorporates the advantages of competitions and PBL while avoiding the disadvantages of competitions by administering a set of constraints to prevent the model from being violated. This model has been used and proven by Saibin et al. (2021) as a successful learning technique based on students' perceptions.

Panwar et al. (2020) incorporated project-based learning within a competitive framework. The objective of the project was to create an online pedagogy for the Robotics and Embedded Systems subject using the Problem-Based Learning (PBL) approach. This objective was successfully accomplished, and as a result, the students demonstrated improved performance in the subject. Based on the feedback provided by the students, they gained the ability to function effectively within a cooperative and collaborative environment, so enhancing their aptitude for cooperation and subsequently enhancing their intra-personal and inter-personal proficiencies.

Based on past literature, the CBL-PBL approach may help promote students' motivation and produce more meaning in learning (Saad & Zainudin, 2022). In addition, this approach makes long-lasting connections with real-world applications. It supports the lecturers in delivering the subject contents more effectively. Therefore, our framework focuses on educational goals. The proposed intervention aims to improve the teaching and learning process and enhance learning outcomes. The present study has been undertaken to achieve the following objectives:

a) To study lecturers' perceptions about the implementation of the CBL-PBL approach in Mathematics instruction.

b) To investigate the determinants of CBL-PBL on students' Mathematics instruction

To guide the research, the following research questions were constructed:

1. What are lecturers' perceptions of the CBL- PBL approach in Mathematics instruction?
2. What are the determinants of CBL-PBL on students' Mathematics learning?

This study is essential for mathematics educators and learners who are having difficulties with ODL learning. It is expected that educators, faculty, and students are likely to benefit from its implementation, analysis, and conclusions. This study serves as a practical guide for future Mathematics learning to learners and the faculty, by presenting the determinants in promoting Mathematics instruction within the ODL environment. Nevertheless, this exposure allows the faculty to determine whether this approach improves the quality of mathematics-based education or whether changes should be made to address the difficulties associated with learning the subject. In any case, the findings of this study can help to enhance the methodology of teaching Mathematics in schools.

2. Literature Review

2.1 Project-Based Learning (PBL)

Project-based learning (PBL) has grown in popularity and has been investigated in a variety of situations at different educational levels, from elementary education to higher education. The purpose of problem-based learning is to engage students in the investigation of real-world issues whose solutions have the potential to be implemented and used in the real world (Hussein, 2021). Chen and Yang (2019) demonstrated that PBL has a few advantages, compared to traditional teaching methods. PBL provides students with three unique experiences: (1) a sense of freedom to express opinions, ask questions, and engage in discussion with colleagues; (2) the feeling of being able to influence the course of the learning process; and (3) the feeling of doing something that can be applied in the real world (along with contributing to the team's work).

Furthermore, according to common opinion, PBL stems from John Dewey's educational philosophy of "learning by doing" (Alam, 2021). Educators meticulously arrange activities that mimic real-world conditions so that students may engage in extended open learning and inquiry to facilitate meaningful learning. Facilitators, educators provide students with the required guidance and assistance. When students engage in a project, they use real-world resources and abilities to solve a series of interconnected challenges within a predetermined time range (Ummah et al., 2019; Viro et al., 2020). This style of inquiry-based learning emphasises ideas and principles from a variety of fields and encourages students to produce and promote their work results. With this definition, it is evident that PBL encourages students to use inquiry-based learning in real-world contexts and motivates the creation of final products based on student knowledge. In addition, Chen, and Yang (2019) reported that PBL learning increases student engagement in defining tasks/problems, exchanging ideas, making queries, obtaining and analysing data, and sharing outcomes with peers. While collaborating to address the driving issue, students get a deeper understanding of the pertinent concepts.

Besides, PBL improves mathematics communication skills, critical-thinking abilities, learning outcomes, process skills, problem-solving, creative thinking, and concept knowledge, according to previous studies on its usage as a learning paradigm (Ratnasari et al., 2018). According to Helle et al. (2006), autonomy improves students' capacity to generate new information by allowing them to use their prior knowledge and experience, which accelerate the generation of new knowledge. The final need is authenticity, which requires that the endeavour to be practical and not academic. Therefore, PBL should contain real-world issues where the emphasis is on realistic problems and where solutions may be applied. Meanwhile, Almulla (2020) recognised that the PBL technique has a substantial relationship with collaborative learning, disciplinary subject learning, iterative learning, and authentic learning, which in turn lead to student engagement. In addition, PBL also increases student involvement by facilitating the sharing and discussion of knowledge and information.

Collaborative learning is between the teachers-students and students-students interaction. In teachers-students interaction, teachers do not provide knowledge; they negotiate it in cooperation with students (Almulla, 2020). Students-student interaction develops essential skills for teamwork and communication. Disciplinary subject learning refers to the process of embedding academic content within context of a project in a certain subject area. According to Almulla (2000), this approach has been proven to improve students' performance in terms of IT skills, integration of technology into science and cooperative skills. Iterative learning involves students going through multiple rounds of planning, implementation, feedback, reflection to enhance the quality of their work. In the PBL approach, the teachers not only assess the students' perception of content but their ability to use the feedback for reflection (Grossman et al., 2019). Authentic learning involves students to generate new ideas, develop one another's thinking, and assess their own and their peers' thoughts (Moje, 2015). Students become active participants in their learning journey, developing skills and knowledge that they can carry forward into their personal and professional lives. Student engagement in learning believe that students are competent simulators (Lampert et al., 2013) that participate actively in the learning process and offers the best learning opportunities compared to the direct learning method (Bilbao et al., 2018).

2.2 Competition-based Learning (CBL)

The competition-based learning (CBL) contributes significantly to the learning processes. In this regard, teams should be established such that its members may embrace the potential of team-based learning's mutual effort. Specifically, competitions in games may be used to sustain students' desire to study over an extended length of time. Students might be engaged in the learning process to improve the efficiency of learning. Students play active roles in the learning process. Active learning now comes into view. Competition-based learning is supported by active learning. To achieve success in contests, students take proactive steps to acquire knowledge before their peers (Çulha, 2021).

According to Sung (2022), competition may help students improve their learning performance via interaction throughout the learning process. A competitive learning strategy entails that students attain learning goals via competition and its outcomes. Competitions amongst student groups both encourage and assist them in achieving the competition's objectives. In addition, participation in the competition encourages students to engage in group discussions and seek solutions from the literature, therefore enhancing their problem-solving and critical thinking skills. Past research has shown that competition makes students feel more energised and optimistic while addressing difficult tasks in real-world settings (Burguillo, 2010). Admiraal et al. (2011) discovered that students were influenced by the scoring and reward system of a game and subsequently competed with their classmates throughout the gaming process. The more pupils participated in the competition, the more information they gained.

More competition-based systems have arisen recently, usually coupled with motivation and active learning (Chen, 2018; Diep & Hieu, 2021). Frequently, competitions bring out the best in individuals and motivate students to do better in the classroom. They promote enhanced motivation (Vasilica et al., 2022), self-esteem (Hong et al., 2018), and academic performance (Radzi et al., 2020). When cooperation is used, students assume more responsibility in competitions than in conventional learning (Pang et al., 2019). However, the implementation of competitive-based learning should be undertaken with care (Chen, 2018). For instance, lecturers need to ensure that curriculum-based teaching and learning objectives are met.

2.3 Online and Distance Learning

The conventional face-to-face learning has been replaced by online (distance) learning, resulting in diverse effects on the academic performance, physical and mental health of students. Higher education plays a vital role in technological innovation and societal growth, which are crucial to study and enhance online learning in the 21st century. The learning environment may be one of the most important determinants of academic achievement in online education. Academic performance reduction is more plainly associated with studying at home or in a dorm. Several coping mechanisms, which are crucial for higher education and the promotion of a civilised and sustainable society, are proposed to enhance online learning in the post-pandemic period (Li & Che, 2022).

In addition, educational challenges in the present crisis include the need to rapidly transition to digital learning and instruction, to aid with students and instructors who study or instruct from home, and to ensure that students gain practical skills (Daniel, 2020). Access disparities to digital and other resources tend to exacerbate these difficulties. Therefore, instructors have been required to quickly locate or learn how to create remote, digital tools and resources (Hughes et al., 2020). Finding an appropriate and attractive interactive setting or incorporating teaching tactics into the course is a more advanced approach than a regular class or lecture.

Intrinsically, the system should include an appropriate learning model to enhance the learning result. Through interactive, adaptable, diverse, and stimulating activities, the ODL learning approach encourages students to discover and investigate things independently (Mamun et al., 2020). According to Hugus (n.d), features of effective online course design include a deliberate design of course components, authentic learning, engagement, and collaboration. An engaging online course is authentic and relevant when it connects student experiences to real-world application.

3. Methodology

This empirical investigation aims to analyse the effectiveness of employing the CBL-PBL learning model in studying mathematics, from the perspectives of lecturers and students. To achieve the aim, the researchers adapted a proposed model by Almulla (2020). The model highlights five major features that lead to student learning: learning engagement, collaborative learning, disciplinary subject learning, interactive learning, and authentic learning. This study has proposed 11 hypotheses to gauge students' perceptions of how CBL-PBL can affect students in Mathematics instruction.

The intervention is termed as Calculus Project Online Presentation Competition (CAPOPCOM), which was employed in August 2020. To assess the intervention, five significant elements of the CBL-PBL that promote students' Mathematics learning are highlighted: collaborative learning (COL), disciplinary subject learning (DL), interactive learning (IR), engagement in learning (EG) and authentic learning (AL).

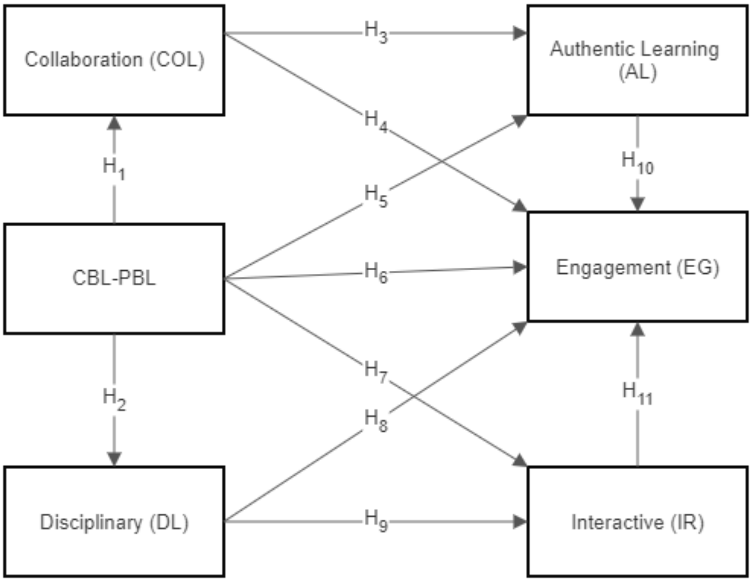

Figure 1: Research model and hypotheses by Almulla (2020)

Many learning environments include collaboration features that permit students to work together to learn and grow. Interaction between learners and between educators is critical to ensure meaningful learning. Collaboration encourages pupils to learn, engage as a group, and reinforce knowledge of the subject matter (Ling-Ling et al., 2021). The collaboration features comprise feedback, discussion, sharing and revision processes. These activities are crucial in establishing learners' knowledge repositories (materials, technologies, and contents), especially in the ODL environment (Sharma & Saini, 2022; Wihlborg et al., 2018). Utilising these features, the researchers opine that the projects can be conducted in students' own space and then shared during the virtual time. Therefore, the current research hypotheses include:

H1: There is a significant relationship between CBL-PBL and COL.
H3: There is a significant relationship between COL and EG.
H4: There is a significant relationship between COL and IR.

The theory of PBL is learning by doing, whereby learners are exposed to real-world challenges via a project (Hawamdeh & Adamu, 2021). To address a real-world issue, an individual cannot merely

rely on one area of skills but needs to apply different skill sets such as critical thinking, creativity, teamwork, communication, and technology skills. PBL via CBL is a learning model that can cultivate learners' lifelong development, as highlighted in Alt and Raichel (2022) and Aufa et al. (2021). Hence, the following hypotheses are formulated:

H2: There is a significant relationship between CBL-PBL and DL.
H8: There is a significant relationship between DL and EG.
H9: There is a significant relationship between DL and IR.

CBL-PBL substitutes assistive learning, faculty mentoring, discussion, and on-site experience for traditional classrooms. It supports in-depth learning for individual students within an ODL environment (Almulla, 2020). Hence, students' knowledge grows as more sharing/discussions are made. The questions in the competition are project-based and designed to inspire critical thinking. Students attempt to think about the various parts of the project rather than simply following what is taught in lectures. Students investigate the how, where, and why aspects of the challenges presented. It encourages learners to think creatively for real-world problem-solving. Accordingly, the hypotheses are put forward as follows:

H5: There is a significant relationship between CBL-PBL and AL.
H10: There is a significant relationship between AL and EG.

CBL-PBL is a strategy that bridges academic theories and real-world practice. Hence, it requires students to present their project problems, processes, methods, and results; defend their solutions when faced with peer review and constructive criticism. Accordingly, this empowers students' engagement. The engagement experience is directly related to the learning objectives (Almulla, 2020). Credit is given not only for completing hours of instruction but also for learning. Students, for example, reflect on what they learnt from the engaging experience and how it relates to the subject of the course. The CBL-PBL strategy also helps to instil civic development and responsibility in students (Ensmann et al., 2021), through discussion and sharing sessions. Hence, the hypothesis is formulated as:

H6: There is a significant relationship between CBL-PBL and EG.

CBL-PBL provides a platform for learners to interact by encouraging students to offer constructive comments to one another. The activities can be broadcast on a video-based social learning platform to engage students in weekly reflections. Students can use a basic video recording to communicate their problems and answers, ask course members questions, and discuss the next steps while they work on their assignments. Using CBL-PBL in remote learning allows teachers to create meaningful content. It also allows students to collaborate and connect with one another even when they are not in the same space. Hence, the hypothesis is formulated as:

H11: There is a significant relationship between IR and EG.

Table 1 presents a description of the construct items.

Table 1
Description of study constructs and items

Construct	Item	Description	Source
Collaboration	Col1	CAPOPCOM supported me as a student in collaborating with other students.	(Grossman et al., 2019; Ung et al., 2022)
	Col2	CAPOPCOM supported me in deciding and making choices on the project.	
	Col3	The CBL-PBL learning approach also emphasises 21st-century skills such as collaboration & interaction skills.	
CBL-PBL	CBL-PBL1	CAPOPCOM enabled me to share resources with other students.	(Grossman et al., 2019)
	CBL-PBL2	CAPOPCOM enabled me to share experiences in handling the project with other students.	
	CBL-PBL3	I find it easier to understand MAT183 (Calculus) with the CAPOPCOM learning approach.	
	CBL-PBL4	I like to learn MAT183 (Calculus) via CAPOPCOM.	
	CBL-PBL5	I think CAPOPCOM was an extremely effective way to learn MAT183 (Calculus).	
Authentic Learning (AL)	AL1	CAPOPCOM provided a meaningful and valuable learning environment for understanding MAT183 (Calculus).	(Grossman et al., 2019; Moje, 2015)
	AL2	CAPOPCOM compelled me to generate new ideas, share those ideas, develop one another's thinking, and assess my and other students' academic thoughts.	
	AL3	In CAPOPCOM, I integrated and applied knowledge from different lesson units to address the project questions.	
Disciplinary (DL)	DL1	I integrated technology (e.g., ICT tools) and applied MAT183 knowledge to my study area.	(Grossman et al., 2019)
	DL2	CAPOPCOM provided me with a platform to apply MAT183 (Calculus) knowledge to solve "real-world" issues in the project.	
	DL3	CAPOPCOM developed various abilities, including critical thinking, collaboration and problem-solving.	
Engagement	EG1	CAPOPCOM has increased my motivation to learn about new subjects or topics.	(Al-Rahmi et al., 2019; Grossman et al., 2019)
	EG2	I have participated actively in idea sharing and discussion.	
	EG3	CAPOPCOM has increased my desire to seek out new knowledge on my own that is relevant to my studies.	
	EG4	CAPOPCOM has increased my resourcefulness in finding helpful information to solve mathematics problems.	

Interactive (IR)	IR1	In CAPOPCOM, my friends and I actively engaged in giving, receiving, and using peer feedback to share information on the project.	(Grossman et al., 2019)
	IR2	In CAPOPCOM, the process of sharing, feedback and discussion is a continuous cycle throughout the semester.	
	IR3	Discussing and sharing in CAPOPCOM is crucial in generating ideas and reflection.	

Sampling Setting and Analysis

The CBL-PBL approach has been implemented in Calculus Project Online Presentation Competition (CAPOPCOM) since August 2020 in the Calculus course. Calculus is a course for undergraduate students in Applied Sciences at the Faculty of Applied Sciences in UiTM Sabah Branch. Therefore, the population of this study is all students who registered for the Calculus course in the current semester. They were taken as participants for CAPOPCOM. There were 36 students and two lecturers involved in CAPOPCOM for the March 2021 – August 2021 semester. The Calculus course syllabus is divided into three parts with five topics:

1. The first part introduces Functions and discusses Limits and Continuity.

2. The second part starts with Differentiation and techniques to solve Differentiation. This part is extended to include the application of Differentiation in four areas: related rates, sketching graphs, maximisation and minimisation problems, and the Mean Value Theorem.

3. The last part is devoted to Integration, the reverse differentiation process. Same as the second part, where it introduces Integration and techniques to solve Integration. Then, this part is extended to include the application of integration, where it focuses on the area under the graph and the volume of solid revolution.

This course is fully online, and the assessment is divided into quizzes 10%, assignment 10%, project 10%, tests 20%, and the final assessment 50%. The rules and regulations of the competition are explained in Saibin et al. (2021). The CBL-PBL approach has been implemented in project assessment and focused only on the second part of the syllabus which is Application of Differentiation. This is mainly because it is a compulsory topic in the course syllabus. The following is the administration of the CBL-PBL intervention:

1. Participants were Diploma in Science students who took the Calculus course in their fourth semester

2. Project requirements and specifications are defined by the course syllabus, in which participants were required to solve a real-world problem related to the topics they learned in the Calculus course

3. The participants strictly adhered to the competition rules set by the organiser

4. The winners received cash prizes and e-certificates as rewards

5. The competition judges were made up of lecturers

After the competition had ended, a survey form was distributed to the participants. The survey comprised closed-ended questions, with five-point Likert-type items (1-strongly disagree, 2-disagree, 3-not sure, 4-agree, 5-strongly agree) was administered to the participating lecturers and students at the end of the semester. The survey items themselves were adapted from various sources, and these sources are detailed in Table 1. The survey aims to gauge lecturers' and students' perceptions of the intervention. Cronbach's Alpha coefficients were used to ensure the construct items' reliability. The collected data were analysed using the SPSS 27.0 software and relative frequency relative means, standard deviations and non-parametric correlations were tabulated.

4. Results

A total of two lecturers and 36 students participated in the survey. All the students were doing a Diploma in Applied Science. The respondents comprised 28 female students (78%) and 8 male students (22%).

Table 2
Descriptive statistics of student respondents

Demographics	Value	Percentage
Gender	Female	78%
	Male	22%

RQ1: How do lecturers perceive CBL-PBL?

In addressing RQ1, Table 3 presents lecturers' perspectives of the intervention. There were two lecturers involved in the teaching and learning of Calculus. The table shows that both lecturers were optimistic about the implementation of the CBL-PBL approach in Mathematics instruction.

Table 3
Lecturers' perceptions towards CAPOPCOM

Statement	Mean
I feel that CAPOPCOM was mostly successful in improving students' engagement.	5
I find the implementation of CAPOPCOM very challenging but accomplishable.	5
I feel that CAPOPCOM successfully improved students' understanding of Calculus.	5
I feel that CAPOPCOM has succeeded in improving students' interest in Calculus.	4.5
I think that CAPOPCOM was an extremely effective way to teach Calculus.	4.5
And overall, I immensely liked implementing CAPOPCOM in teaching Calculus.	5

Open-ended questions were asked to gauge in-depth perceptions of the lecturers towards the intervention. When asked, "What do you like the most about CAPOPCOM?" Both lecturers highlighted the significance of using videos in presenting the project's outcomes. One lecturer stated that CAPOPOCOM had engaged the students in utilising technological tools to deliver the solutions more creatively. While the other lecturer said, "CAPOPCOM has improved teamwork among peers." RQ2: What are the significant influences of CBL-PBL on students' learning engagement?

The overall means and the standard deviations are presented in Table 4. The findings showed that the mean values for all the dimensions were high, indicating a positive response to the constructs that were measured in this research. Reliability tests were executed. The results revealed that the Cronbach's Alpha coefficients for construct items were relatively high: Collaboration (0.885), CBL-PBL (0.787), Authentic Learning (0.952), Disciplinary Learning (0.952), Engagement (0.888) and Interactive (0.779). The Cronbach's a values which were higher than 0.70 indicate high internal consistency reliability for the scales.

Table 4
The descriptive statistics of the constructs

Question	Mean	Standard Deviation	Minimum	Maximum
COL1	4.14	0.351	4	5
COL2	4.19	0.401	4	5
COL3	4.25	0.439	4	5
CBL-PBL1	4.08	0.280	4	5
CBL-PBL2	4.03	0.167	4	5
CBL-PBL3	4.06	0.232	4	5
CBL-PBL4	4.08	0.280	4	5
CBL-PBL5	4.08	0.280	4	5
AL1	4.14	0.351	4	5
AL2	4.11	0.398	3	5
AL3	4.08	0.368	3	5
DL1	4.14	0.351	4	5
DL2	4.11	0.398	3	5
DL3	4.08	0.368	3	5
EG1	4.11	0.319	4	5
EG2	4.08	0.280	4	5
EG3	4.14	0.351	4	5
IR1	4.19	0.401	4	5
IR2	4.14	0.351	4	5
IR3	4.25	0.439	4	5

Table 5 indicates that there was a significant, positive, and moderately strong correlation on H1 (Kendall |τb|= 0.434, p=.006; Spearman r(df) =0.454, p=.005), H2 (Kendall |τb|= 0.423, p=.009; Spearman r(df) = 0.432, p=.009) and H5. (Kendall |τb|= 0.439, p=.009; Spearman r(df) = 0.445, p=.007). It is shown in the table that there was a significant, positive and strong correlation on H4 (Kendall |τb|= 0.569, p=.000; Spearman r(df) = 0.598, p=.000), H6, (Kendall |τb|= 0.517, p=.001; Spearman r(df) = 0.532, p=.001) H7 (Kendall |τb|= 0.529, p=.001; Spearman r(df) = 0.559, p=.000) and H11 (Kendall |τb| = 0.559, p=.000; Spearman r(df) = 0.579, p=.000). There was a negative correlation on H3 (Kendall |τb|= 0.112, p=.486; Spearman r(df) = 0.114, p=.558), H8 (Kendall |τb|= 0.259, p=.110; Spearman r(df) = 0.2688, p=.114), H9 (Kendall |τb|= 0.270, p=.089; Spearman r(df) = 0.297, p=.079) and H10 (Kendall |τb|= 0.260, p=.113; Spearman r(df) = 0.266, p=.116) hypothesis, hence not supported.

Table 5
Kendall and Spearman coefficients for hypotheses

Hypothesis	Description	Kendall's tau_b Sig. (2-tailed)	Spearman's rho Sig. (2-tailed)	Result
H_1	CBL-PBL→COL	.434** .006	.454** .005	Supported
H_2	CBL-PBL→DL	.423** .009	.432** .009	Supported
H_3	COL→AL	.112 .486	.114 .558	Not supported
H_4	COL→EG	.569** .000	.598** .000	Supported
H_5	CBL-PBL→AL	.439** .009	.445** .007	Supported
H_6	CBL-PBL→EG	.517** .001	.532** .001	Supported
H_7	CBL-PBL→IR	.529** .001	.559** .000	Supported
H_8	DL→EG	.259 .110	.268 .114	Not supported
H_9	DL→IR	.270 .089	.297 .079	Not supported
H_{10}	AL→EG	.260 .113	.266 .116	Not supported
H_{11}	IR→EG	.559** .000	.579** .000	Supported

5. Discussion

The study's results present strong evidence to support the claim that the intervention of Competition-Based Learning (CBL) and Project-Based Learning (PBL) has a beneficial impact on several facets of students' educational journey. The analysis provides evidence that this intervention has a considerable positive impact on various aspects of students' educational experience, including collaboration, disciplinary learning, authentic learning, engagement, and interactiveness.

The research findings support the hypothesis proposed by other researchers, confirming that CBL-PBL interventions significantly enhance learning effectiveness. The agreement between CBL-PBL techniques and established theories and findings highlights the potential of these approaches in fostering a learning environment that promotes multidimensional growth.

A significant finding pertains to the favourable association between interactive learning and student involvement. The utilization of CBL-PBL techniques inherently fosters active involvement and increased levels of engagement among students. By engaging in practical exercises and fostering group cooperation, students are encouraged to actively participate in the educational journey, enhancing the learning experience's overall immersive nature.

The study elucidates a good correlation between collaboration and engagement while simultaneously emphasizing that cooperation does not substantially influence authentic learning. As supported by prior studies (Chen et al., 2018), this result could be ascribed to difficulties associated with the infrastructure. Additionally, comprehensive studies are necessary to comprehensively understand the intricacies related to this component. These investigations will provide insights into potential obstacles and provide strategies to enhance the genuine learning experience.

The study reveals no significant impact of disciplinary subject learning on engagement and interactive learning. This observation is consistent with previous research, such as the study by Issa et al. (2014), which argues that the various elements of CBL may unintentionally shift students' attention away from the actual learning process. There is a suggestion that the competitiveness among students for achieving success in projects may overshadow the primary learning objectives. The significance of careful preparation and diligent supervision by educators during the execution of CBL-PBL initiatives is emphasized in the works of Gutiérrez-Braojos et al. (2019) and Zhongming et al. (2020).

In summary, the study offers a comprehensive viewpoint on the effects of Competition-Based Learning and Project-Based Learning on the motivation and academic achievement of undergraduate students in mathematics. The results highlight the beneficial impact of various instructional methods on fostering cooperation, enhancing student engagement, and facilitating interactive learning. Nevertheless, going deeper into the complex relationship between real learning, disciplinary subject learning, and the approaches employed to fully understand their interplay is crucial. This research contributes to the current literature and highlights the importance of careful planning and support when incorporating CBL-PBL tactics into educational settings.

6. Conclusion

This study examined lecturers' perspectives and the impact of implementing the CBL-PBL learning model on improving university education standards in Mathematics. The lecturers expressed their positive responses to the intervention. CBL-PBL had been identified as the main driver in influencing students' learning engagement, collaboration, authentic learning, disciplinary subject learning and interactiveness. The deployment of the CBL-PBL learning model must be planned meticulously as the negative impact may side-track the students' learning goals. A proper guideline should be in place to ensure that the right motivation is nurtured in employing the same intervention.

Although the current study provided useful insights on CBL-PBL integration for undergraduate Mathematics instruction, some limitations should be addressed. The respondents' sample of the intervention experiment was limited to students from Diploma in Applied Sciences. Thus, the sampling of the study could be extended if a more comprehensive selection of students was included, by recruiting participants from other Mathematics courses and other undergraduate programs. This can help to raise the external validity of the study.

Second, the study did not employ any control group as a basis of comparison to the experimental group. This was decided because there was enough evidence in the literature that the intervention employed is associated with the same outcomes. However, for strong internal validity, it is recommended to include a control group in future.

Acknowledgments

We thank the anonymous reviewers for their useful suggestions.

Funding Details

None

Authors Contributions

All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

Conflict of Interest

None

References

Admiraal, W., Huizenga, J., Akkerman, S., & Dam, G. T. (2011, May). The concept of flow in collaborative game-based learning. Computers in Human Behavior, 27(3), 1185–1194. https://doi.org/10.1016/j.chb.2010.12.013

Alam, A. (2021). What is the "Philosophy of Chemistry Education"? Viewing Philosophy behind Educational Ideas in Chemistry from John Dewey's Lens: The Curriculum and the Entitlement to Knowledge. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.377137

Almulla, M. A. (2020, July). The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. SAGE Open, 10(3), 215824402093870. https://doi.org/10.1177/2158244020938702

Al-Rahmi, W. M., Yahaya, N., Aldraiweesh, A. A., Alamri, M. M., Aljarboa, N. A., Alturki, U., & Aljeraiwi, A. A. (2019). Integrating Technology Acceptance Model with Innovation Diffusion Theory: An Empirical Investigation on Students' Intention to Use E-Learning Systems. IEEE Access, 7, 26797–26809. https://doi.org/10.1109/access.2019.2899368

Alt, D., & Raichel, N. (2020, December 6). Problem-based learning, self- and peer assessment in higher education: towards advancing lifelong learning skills. Research Papers in Education, 37(3), 370–394. https://doi.org/10.1080/02671522.2020.1849371

Aufa, M. N., Rusmansyah, R., Hasbie, M., Jaidie, A., & Yunita, A. (2021, July 7). The Effect of Using e module Model Problem Based Learning (PBL) Based on Wetland Environment on Critical Thinking Skills and Environmental Care Attitudes. Jurnal Penelitian Pendidikan IPA, 7(3), 401 407. https://doi.org/10.29303/jppipa.v7i3.732

Bilbao, J., Varela, C., Rebollar, C., Bravo, E., García, O. (2018) Selecting Assessments for Problem Based Learning. International Journal of Education and Learning Systems, 3, 129-133

Burguillo, J. C. (2010, September). Using game theory and Competition-based Learning to stimulate student motivation and performance. Computers &Amp; Education, 55(2), 566–575. https://doi.org/10.1016/j.compedu.2010.02.018

Chen, C. H. (2018, November 1). The impacts of peer competition-based science gameplay on conceptual knowledge, intrinsic motivation, and learning behavioral patterns. Educational Technology Research and Development, 67(1), 179–198. https://doi.org/10.1007/s11423-018-9635-5

Chen, C. H., & Yang, Y. C. (2019, February). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. Educational Research Review, 26, 71–81. https://doi.org/10.1016/j.edurev.2018.11.001

Chen, J., Wang, M., Kirschner, P. A., & Tsai, C. C. (2018, July 30). The Role of Collaboration, Computer Use, Learning Environments, and Supporting Strategies in CSCL: A Meta-Analysis. Review of Educational Research, 88(6), 799–843. https://doi.org/10.3102/0034654318791584

Culha, D. (2021). Competition-based learning of blockchain programming. Journal of Educational Technology & Online Learning, 4(1), 46–55.

Daniel, S. J. (2020, April 20). Education and the COVID-19 pandemic. PROSPECTS, 49(1–2), 91–96. https://doi.org/10.1007/s11125-020-09464-3

Diep, L. T. N., & Hiew, V. M. (2021, September 30). Examining Quality of English Language Learning of University Students in Vietnam: The Moderating Role of Competition Factor. Eurasian Journal of Educational Research, 2021(95). https://doi.org/10.14689/ejer.2021.95.4

Ensmann, S. Y., Eggers, P., Bing, B., & Li, L. (2021). Design of Learning Experience to Engage Learning in Instructional Design and Technology Graduate-Level Classes: Digital Game-Based Learning (DGBL) Cases. Learning: Design, Engagement and Definition, 147–166. https://doi.org/10.1007/978-3-030-85078-4_12

Grossman, P., Dean, C. G. P., Kavanagh, S. S., & Herrmann, Z. (2019). Preparing teachers for project based teaching. Phi Delta Kappan, 100(7), 43–48. https://doi.org/10.1177/0031721719841338

Gutiérrez-Braojos, C., Montejo-Gamez, J., Marin-Jimenez, A., & Campaña, J. (2019). Hybrid learning environment: Collaborative or competitive learning? Virtual Reality, 23(4), 411-423

Hawamdeh, M., & Adamu, I. (2021). Problem-Based Learning (PBL). Improving Scientific Communication for Lifelong Learners, 38–56. https://doi.org/10.4018/978-1-7998-4534-8.ch003

Helle, L., Tynjälä, P., & Olkinuora, E. (2006, March). Project-Based Learning in Post-Secondary Education – Theory, Practice and Rubber Sling Shots. Higher Education, 51(2), 287–314. https://doi.org/10.1007/s10734-004-6386-5

Hong, J., Tai, K., & Ye, J. (2018, December 17). Playing a Chinese remote-associated game: The correlation among flow, self-efficacy, collective self-esteem and competitive anxiety. British Journal of Educational Technology, 50(5), 2720–2735. https://doi.org/10.1111/bjet.12721

Hughes, M. C., Henry, B. W., & Kushnick, M. R. (2020, August 6). Teaching During the Pandemic? An Opportunity to Enhance Curriculum. Pedagogy in Health Promotion, 6(4), 235–238. https://doi.org/10.1177/2373379920950179

Hugus, E. (n.d.). Designing Learning Experiences for Developing Soft Skills in Online Education: A Basic Qualitative Study [PhD Dissertation]. Northern Arizona University.

Hussein, B. (2021, August 16). Addressing Collaboration Challenges in Project-Based Learning: The Student's Perspective. Education Sciences, 11(8), 434. https://doi.org/10.3390/educsci11080434

Issa, G., Hussain, S. M., & Al-Bahadili, H. (2014). Competition-Based Learning. International Journal of Information and Communication Technology Education, 10(1), 1–13. https://doi.org/10.4018/ijicte.2014010101

Lampert, M., Franke, M. L., Kazemi, E., Ghousseini, H., Turrou, A. C., Beasley, H., Cunard, A., & Crowe, K. (2013). Keeping It Complex: Using Rehearsals to Support Novice Teacher Learning of Ambitious Teaching. Journal of Teacher Education, 64(3), 226–243. https://doi.org/10.1177/0022487112473837

Li, J., & Che, W. (2022, August). Challenges and coping strategies of online learning for college students in the context of COVID-19: A survey of Chinese universities. Sustainable Cities and Society, 83, 103958. https://doi.org/10.1016/j.scs.2022.103958

Ling-Ling, U., Labadin, J., & Suraya Mohamad, F. (2021, September 21). Information System Framework for Training Teachers on Computational Thinking. SAR Journal - Science and Research, 119–127. https://doi.org/10.18421/sar43-04

Mamun, M. A. A., Lawrie, G., & Wright, T. (2020, January). Instructional design of scaffolded online learning modules for self-directed and inquiry-based learning environments. Computers & Education, 144, 103695. https://doi.org/10.1016/j.compedu.2019.103695

Moje, E. B. (2015, June 1). Doing and Teaching Disciplinary Literacy with Adolescent Learners: A Social and Cultural Enterprise. Harvard Educational Review, 85(2), 254–278. https://doi.org/10.17763/0017-8055.85.2.254

Mseleku, Z. (2020). A literature review of E-learning and E-teaching in the era of Covid-19 pandemic. SAGE, 57(52), 588-597.

Pang, Y. J., Hussin, H., Tay, C. C., & Syed Ahmad, S. S. (2019). Robotics Competition-Based Learning for 21st century STEM education. Journal of Human Capital Development, 12(1), 83–100.

Panwar, A., Chauhan, A., & Arya, K. Analyzing Learning Outcomes for a Massive Online Competition through a Project-Based Learning Engagement. (2020). 2020 IEEE Global Engineering Education Conference (EDUCON), Porto, Portugal, pp. 1246-1251. https://doi.org/10.1109/EDUCON45650.2020.9125379

Radzi, A. I. N., Awang Drahman, D. N., Joseph, C., Rahmat, M., & Suria, K. (2020, May 29). Competition-based Learning Strategy of the Online Introductory Accounting Quiz for Non accounting Majors. International Business Education Journal, 13(1), 83–94. https://doi.org/10.37134/ibej.vol13.1.7.2020

Ratnasari, N., Tadjudin, N., Syazali, M., Mujib, M., & Andriani, S. (2018, June 29). Project Based Learning (PjBL) Model on the Mathematical Representation Ability. Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah, 3(1), 47. https://doi.org/10.24042/tadris.v3i1.2535

Saad, A., & Zainudin, S. (2022). A review of Project-Based Learning (PBL) and Computational Thinking (CT) in teaching and learning. Learning and Motivation, 78, 101802

Saibin, T.C., Janteng, J., & Norfazillah, Matmali. (2021). Competition-based Learning Model: A Case Study in UiTM Sabah Branch. Presentation at Universiti Teknologi MARA, Sabah Branch, November 25, 2021.

Schleicher, A. (2020). The Impact of COVID-19 on Education: Insights from" Education at a Glance 2020". OECD Publishing

Sharma, S., & Saini, J. R. (2022, February 8). On the Role of Teachers' Acceptance, Continuance Intention and Self-Efficacy in the Use of Digital Technologies in Teaching Practices. Journal of Further and Higher Education, 46(6), 721–736. https://doi.org/10.1080/0309877x.2021.1998395

Sung, H. Y. (2022, June 17). A Competition-Based Problem-Posing Approach for Nursing Training. Healthcare, 10(6), 1132. https://doi.org/10.3390/healthcare10061132

Tibingana-Ahimbisibwe, B., Willis, S., Catherall, S., Butler, F., & Harrison, R. (2020, May 13). A systematic review of peer-assisted learning in fully online higher education distance learning programmes. Open Learning: The Journal of Open, Distance and e-Learning, 37(3), 251–272. https://doi.org/10.1080/02680513.2020.1758651

Ummah, S. K., In'am, A., & Azmi, R. D. (2019). Creating manipulatives: Improving students' creativity through Project-Based learning. Journal on Mathematics Education, 10(1), 93–102.

Ung, L. L., Labadin, J., & Mohamad, F. S. (2022, February). Computational thinking for teachers: Development of a localised E-learning system. Computers &Amp; Education, 177, 104379. https://doi.org/10.1016/j.compedu.2021.104379

Vasilica, I., Silva, R., Costa, P., Figueira, B., & Vaz, L. (2022, February 1). Games Based Learning Influence in Portuguese Referees Motivation to study Laws of the Game and Competition Rules: A Longitudinal Study. Sport Mont, 20(1), 51–57. https://doi.org/10.26773/smj.220209

Wester, E. R., Walsh, L. L., Arango-Caro, S., & Callis-Duehl, K. L. (2021). Student engagement declines in STEM undergraduates during COVID-19–driven remote learning. Journal of microbiology & biology education, 22(1), ev22i21. 2385.

Wihlborg, M., Friberg, E. E., Rose, K. M., & Eastham, L. (2018, February). Facilitating learning through an international virtual collaborative practice: A case study. Nurse Education Today, 61, 3–8. https://doi.org/10.1016/j.nedt.2017.10.007

Zhongming, Z., Linong, L., Xiaona, Y., Wangqiang, Z., & Wei, L. (2020). Bad Idea: Overly Focusing on Development and Acquisition Speed

UNIVERSITI
TEKNOLOGI
MARA

9 772682 784004

ISSN: : 1985-5079