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Problem-Based Learning in Blended Classrooms: An Approach in Covid 19 Emergency Situation

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Abstract

This study examined problem-based learning in blended learning classrooms for practicing mathematical problems in an emergency situation, such as Covid-19. For this purpose, a three-week program was framed in contrast to traditional teaching, aiming at enrichment and not remediation, for a group of fifty students' studying mathematics in a science program. The formative experiment research method was used for this study and practiced at public sector Higher Secondary School in Jehangira, district Swabi. The data were collected through a self-developed questionnaire verified by experts and were analyzed by using simple frequency distribution. Findings were mostly positive, indicating that students found problem-based learning productive in practicing mathematics, for example, solved samples helped them in answering similar problems, course work was completed timely, and use of smartphones with peers in groups helped them in better understanding the problems. The findings also revealed some concerns such as poor availability of network/internet services or non-affordability of having smart phone or internet packages, and parents' unwillingness for allowing smartphones and using the internet.

Keywords: problem-based learning model, PBL in mathematics, integrated designed pedagogies, problem solving skills.

Introduction

Problem-based learning (PBL) is a student-centered pedagogy which enables the students to learn with reference to a subject by working in groups to solve the open-ended problems (Teaching at Cornell Guide, 2024). When applied remotely via Zoom on any other online platform, PBL requires a contextual and collaborative approach in order to be successful in achieving greater self-directed learning, problem-solving skills, increased critical thinking abilities and improved academic achievement (Gunter & Alpat, 2017; Pyper, 2021; Seyhan, 2016; Yew & Goh, 2016; Yoon et al., 2014). Subjects such as biology, chemistry, physics or mathematics are taught at secondary level and research studies have been conducted on PBL in these classrooms and have shown positive results (Strobel & Van, 2009). PBL has been extensively adopted in the field of formal education and is a comprehensive approach to teaching. It has its roots in the constructivist theory of learning (Barrows, 2016; Donnelly & McSweeney, 2009; Yew & Goh, 2016). Savin-Baden and Major (2004) consider PBL as an amalgamation of various disciplines and branches of knowledge, enabling students to grow during their education.

In the current digital world, using technology in schools is highly encouraged (Aggarwal & Bal, 2020) and application software such as Wolfram Methematica, Maple, Graphmatica, MATLAB, Math Editors, and Geometry Pad are being used. Just like other developing countries, the schools of Pakistan have also faced academic recurrent issues since the country was hit by COVID-19 pandemic in mid-March, 2020. All educational institutions were closed in order to protect the children and stop the spreading of the pandemic. In this kind of situation, online learning can be quite supportive and can support traditional classroom settings when the schools reopen. This practice of mixed learning has been identified as the Blended Learning (BL) approach (Horn & Staker, 2011; Graham, 2013), indicating that BL approach is the blend of learning in face-to-face traditional classroom settings and learning online. The main advantage of BL approach is to replace the demerits with merits of each mode of learning in order to keep the academic advantage at a higher level. Thus, BL is a productive approach because of its positive effects on students' learning experiences such as supporting self-directed learning and offering

opportunity to educators and learners to exert, preserve, control and improve their knowledge (Ali et al., 2013; Asif et al., 2020; Gecer & Dag, 2012).

In fact, blended learning is a model which integrates problem-based learning activities in the classroom and ICT in pedagogy to create a student-centered learning environment (Montgomery, 2015). Literature reveals that many teachers of advanced countries have used PBL in a variety of disciplines at each level of education and gained the expertise in designing and using problems, and are content with this approach (Pyper, 2021). It is also concluded from previous studies' that the PBL model can be used for learning in various disciplines (Ali, 2019). The encouraging outcomes of research studies inspired me to test the PBL approach in BL environment in secondary grade classes (class 9 and 10) in Pakistan, when emergencies such as the COVID-19 pandemic or other similar situations need urgent management.

Context of the Study

Due to COVID-19, social distancing was imposed and this led to school closures in Pakistan just like the rest of the world's countries. The World Bank (2020) reported that educational institutions were closed in 192 countries, affecting schooling of 90% students approximately. According to this report, in terms of the global context, the majority of students belonged to middle income countries and hence they were facing greater losses. However, the losses of low-income countries in terms of education were devastating. In the same vein, Pakistan also could not escape from these clutches of educational losses. During the 3rd wave of the pandemic in November, 2020, schools were closed in the last week of November 2020 till mid-February 2021. This closure happened just ahead of annual examinations that were to take place in March, 2021. Hence, an intense need was felt for adopting such a pedagogy which could bridge the gap of the study losses during off days of schooling, particularly for students who had to take their Annual Board Examination 2021. Moreover, this research could also guide in the future, if any emergency situation arose.

Therefore, noticing the trend of a diverging society towards information and communication technology (ICT), where digitalization and socio-cultural learning occur simultaneously, a revised PBL pedagogy was integrated with BL due to the rich use of ICT. Another reason of utilizing PBL in BL was the global realization

of this being a comprehensive approach to teaching and learning in all discipline's education.

Significance of the Study

The results of this study will hopefully pave the way to use the PBL approach in a BL environment for grades and subjects at the secondary level, such as physics, chemistry, and biology. This approach will help in lessening the burden of course completion and make learning a pleasurable experience for students. The strategy will also empower the students to learn and practice the recorded lectures according to their need and choice, enabling them to get assistance for the completion of their home work as well.

Objectives of the Study

The objectives of the study are:

1. To explore the practices of PBL approach.
2. To ascertain the advantages of using the PBL model in BL.
3. To identify the main challenges in the use of PBL through BL approach.

Research Questions

These objectives will be achieved by posing following questions from students:

i. How helpful was it for students when they were provided exemplified problems, prior to solving the actual problems?

ii. How helpful was it for students' course work?

iii. What are students' perceptions about using PBL pedagogy in BL environment?

iv. How did this practice assist in enhancing students' learning?

v. What were the difficulties faced by students in utilizing PBL through BL?

Literature Review

The literature review for the current research offers an analysis of studies carried out on the PBL model and its goals for secondary level education. The literature review also covers the advantages and impact of BL on teaching and learning practices of secondary school teachers and students. Use of technology in education has opened new ways in the teaching and learning process and technology-integrated pedagogies have a positive impact and facilitate teaching and learning practices (Al-Ansi et al., 2021; Al-zboon et al., 2021; Zamir & Ali, 2023). This development has paved the way to transform teaching of mathematics by enabling teachers to use ICT aids for developing students' problem-solving and critical thinking approach from the very early age, adding clarity of concepts regarding different geometrical shapes and figures (Das, 2019; Das, 2021; Eleftheriadi et al., 2021; Zamir & Ali, 2023).

PBL in Secondary Education

PBL is a procedure that is practiced to enhance knowledge and understanding in order to recognize and solve the problem by following the principles of: i) self-directed learning; ii) learning in group while teacher facilitates; iii) allowing groups to participate equally; iv) promoting motivation, teamwork spirit, problem-solving skills and engagement within the given task and v) using other resources and materials such as additional content relevant to the task (Ali, 2019). In addition, the five goals of PBL are i) To construct a broad and flexile base of knowledge; ii) To develop the skills of problem-solving; iii) To enhance the self-directed and life-long learning abilities; iv) To encourage collaboration; and v) To be motivated to learn inherently (Pyper, 2021). Thus it is concluded from the literature that PBL is a student centered educational model with objectives to improve students' problem-solving skills by using self-regulatory learning as a long term habit and developing skills to work in a team. The students are assigned problems to explore/create knowledge by adopting a certain process whereas the teacher is merely a facilitator/moderator (Ajmal et al., 2017; Pyper, 2021).

PBL is one of the most innovative aspects of pedagogy implemented in education due to its effectiveness in facilitating students' problem-solving and self-directed learning (Hung et al., 2008; Pyper, 2021), specifically as reported in medical education (Barrows & Tamblyn, 1980; Schmidt, 1983). It has also gained

popularity across other disciplines in higher education and K–12 education settings (Barrows, 2000; DeLuca et al., 2015; Gallagher et al., 1992; Hmelo et al., 2003; Hmelo- Silver, 2004; Williams & Hmelo, 1998; Torp and Sage, 2002). The adoption of PBL in K–12 education emerged gradually during 1990s (Hung et al., 2008) and has been used globally in a diverse educational settings, including vocational schools (Boud and Feletti, 1991; Gijselaers et al., 1995; Wilkerson & Gijselaers, 1996) According to Mouse et al. (2005), PBL has been frequently integrated into disciplines of biology, biochemistry, calculus, chemistry, economics, physics, art history, educational psychology, leadership education, criminal justice, nutrition and diets, and in a variety of domains of post-secondary education. Whereas, Barrows and Kelson (1993) developed PBL pedagogy and teacher training curricula for teaching high-school core subjects. A range of results have been reported about utilizing PBL in K–12 education (Hung et al., 2008) and shown an effective turn over in array of content area such as mathematics (Cognition and Technology Group at Vanderbilt, 1993), science (Kolodner et al., 2003; Linn et al., 1999), literature (Jacobsen and Spiro, 1994), history (Wieseman and Cadwell, 2005), and microeconomics (Maxwell et al., 2005). Interestingly, Delisle (1997) and Fogarty (1997) reported that PBL had been implemented effectively in urban, suburban schools and communities. Similarly Hung et al. (2008) state that PBL can be utilized in gifted elementary, middle and high-schools (Dods, 1997; Gallagher, 1997; Gallagher et al., 1995; Stepien & Gallagher, 1993; Stepien et al., 1993), as well as for low-income students (Stepien & Gallagher, 1993).

The above literature study reveals that using the PBL model cannot be restricted to a specific level or discipline. In a broad sense, the PBL model is used for students' authentic learning, adopting problem solving pedagogy, so that they may use achieved knowledge to nurture their skills (independence, and develop the confidence in themselves; and resultantly students gain the key concepts to practice the critical thinking skills to solve their problems in problem oriented situations (Nurzaman, 2017; Yew & Goh, 2016). However, the entire process is dependent upon the efficacy of both teachers and students (Ali, 2019). Although PBL is considered to be a student-centered model, it does not spare the teacher either from his/her responsibilities, for example, if teachers cannot facilitate group discussions or assist students in problem solving, then challenges may occur in use of PBL (Pyper, 2021). In the same vein, when students fail to work in groups and generate solutions to a problem, PBL cannot be implemented effectively (Ali,

2019). But Hmelo-Silver (2004), presents several other aspects of PBL that are the demands of the 21st century education system, for example, learning 21st century skills and understanding how liberal education can contribute for the betterment of the workforce.

Application of PBL

The PBL process described by Maastricht University comprises four learning principles: constructive, contextual, collaborative, and self-directed learning (CCCS). Constructivist learning theory considers learning as an active process where knowledge is acquired from experiences and interactions. The learners are encouraged to think about what they already know and learn to integrate new information with their prior knowledge, in order to understand the topics and gain new knowledge rather than simply memorize things (Donnelly & McSweeney, 2009). Collaborative learning encourages learning through discussion, exchanging ideas and providing feedback to understand the subject matter comprehensively; while self-directed learning enables the learners to well manage themselves by planning, monitoring and evaluating. Servant-Miklos (2019) describes the 7 steps contained in the Maastricht University PBL program. These are:

Step 1: Terms and concepts clarification not readily comprehensible
Step 2: Problem definition
Step 3: Problem Analysis
Step 4: Making an inventory of the explanations on the basis of step no 3, proceeding systematically
Step 5: Formulating learning-objectives
Step 6: Collecting supplementary information outside the group
Step 7: Synthesizing and checking the newly acquired information

Using PBL Model in BL Environment

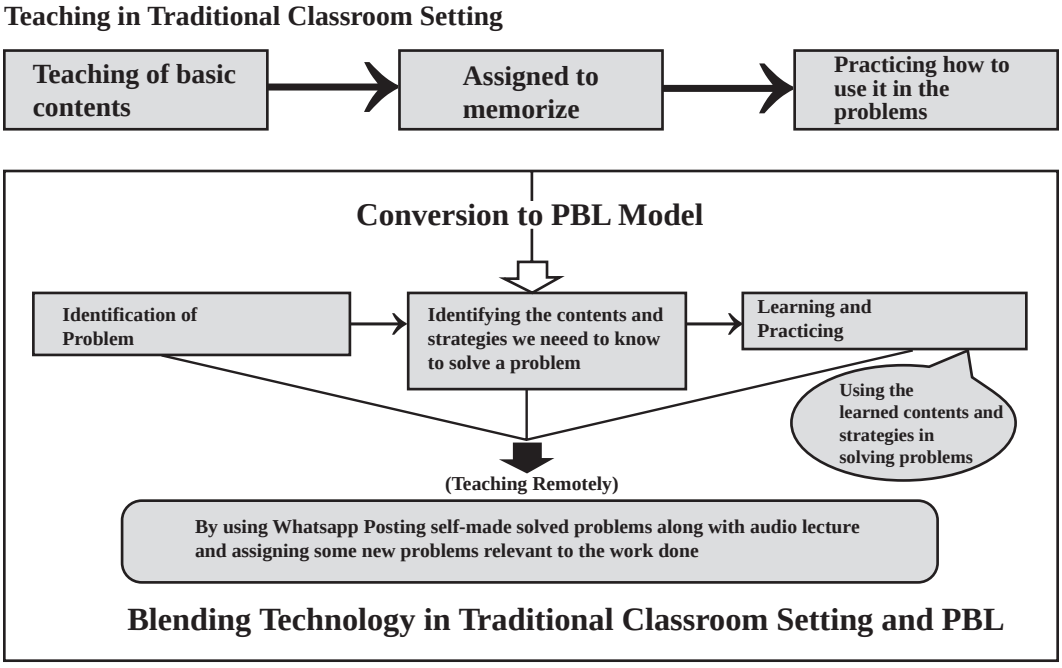
Majority researchers agree that technological devices such as tabs, smart phones, laptops, Internet and white interaction boards should be used in a virtual BL environment. Besides, pedagogy should also be related to technology, in virtual as well as face to face class instruction (Graham, 2013; Garrison, 2013). More precisely, a learning environment is referred to as a BL approach when various teaching and learning techniques are used for teaching or learning purposes. In other words,

BL is a formal educational approach that endows learning opportunities, partially online and partially face to face, controlling time, pace and path. Thus learning situations where several delivery methods of teaching via virtual and traditional modes are combined and applied is known as BL/hybrid learning. Montgomery (2015) describes BL as a model that integrates problem-based learning activities with traditional classroom environments and allows use of ICT instructions to create a student-centered learning environment. This exhibits BL as a combination of instructions that utilize two or more methods, supplementary to each other, for teaching or learning the same contents with incorporation of technology (Graham, 2013). Hence BL utilizes two or more methods, supplementary to each other, for teaching or learning the same contents with incorporation of technology into the same learning system (Graham, 2013). Ajmal et al. (2017) applied the PBL approach experimentally and findings from their study showed that PBL is an effective approach in pre-service teacher education in Pakistan. In another study, Royani and Agustina (2019) used the Polya's Step for grade seven mathematics, using the PBL approach and obtained positive results. Positive results of using the PBL approach in mathematics is evidenced even at the primary level education, when real life examples were used for motivating youngsters to grasp the objectives for using critical thinking and problem-solving skills effectively. There are various research studies in different fields such as in the allied and medical sciences, medical and dental and teacher education (Ajmal et al., 2017) that have applied PBL approach and gained positive results.

From the literature review, firstly it is concluded that although the PBL approach has been used in school-based education, it is not used as frequently at graduate level in higher education. Secondly, the PBL approach, though used, had very little technology incorporated in it. This encouraged research in the area PBL, applying ICT at Secondary level classes (grade 9 and 10). The following self-developed BL model shows the diagrammatic representation of how a PBL approach (Ali, 2019) can be used remotely by using technology.

Figure 1

Using of PBL in BL Environment



Methodology

Procedure

The formative experimental paradigm (Reinking & Bradley, 2004) was used to address the research questions clearly, as this study was more directly correlated to practice than to other types of research and was more likely to appeal to practitioners. Keeping in view the four learning principles of PBL: constructive, contextual, collaborative, and self-directed learning, 7 steps (Servant-Miklos, 2019) were followed in application of PBL pedagogy. No new PBL model was developed and the model developed by Maastricht University was used for this study.

In this research, the participants were 9th grade science group students of a government secondary School in Jehangira, district Swabi Khyber PakhtunKhwa (KPK), Pakistan. Few targeted units of grade 9 Mathematics were taught with the help of PBL approach by using WhatsApp application during closure of schools due to the second wave of COVID-19 pandemic. The school closure duration

was from the last week of November 2020 to mid-February 2021. For course work teaching, "An Accelerated Academic Calendar (AAC)", (See Table 1) was followed, proposed by "National Command and Operation Centre (NCOC) Elementary & Secondary Education Department, Peshawar KPK (DCTE, 2020). Working hours of the week (from Monday to Saturday) were distributed to grades from 6th to 10th. Under this management, Thursday of each week was assigned to grade 9 for school attendance. Hence PBL approach was used to deliver chapter 5, 6 and 7 from the AAC proposed course work, in the rest of the 5 off days of the week (Saturday, Monday, Tuesday, and Wednesday). The WhatsApp application was used by smartphones for delivering course contents, interacting with students, and delivering audio lectures on a daily basis. The delivered course contents were then checked and assessed on the weekly designated attendance working day (each Thursday).

The three chapters 5, 6, and 7 of 9th class mathematics were meant to be taught as per NCOC course plan, (see table 3.1 for the course contents).

Course Contents Selection

Table 1

Grade-9 Mathematics Course Content Designed by NCOC

Unit Name	Topics	Selected Course	Guidelines for Teachers
Unit 5. Factorization	5.1 Factorization 5.2 Remainder Theorem 5.3 Factorization of a Cubic Polynomial	Ex 5.1(Q.1, 3, 5, 8, 9). Ex 5.2(Q.1 , 3, 5, 6, 8, 10) Ex 5.3 (Q.1, 2, 3, 5, 10, 11) Ex 5.4 (Q. 1, 3, 5, 6, 9) Ex 5.5 (Q. 1, 2, 3, 7) Ex 5.6 (Q. 1, 2, 4)	i. Explain the concept of factorization, remainder theorem, factor theorem, and cubic polynomial using factor theorem ii. Selected Course contents are compulsory to teach the students. iii. Assig examples/questions of relevant concepts/topics as homework task
Unit 6. Algebraic Manipulation	6.1 Highest Common Factor and Least Common Multiple 6.2 Basic Operations on Algebraic Expression 6.3 Square Root of Algebraic Expressions	Ex 6.1(Q.1, 2, 3, 5, 6, 7, 8) Ex 6.2 (Q. 1, 2) Ex 6.3 (Q. 1, 2, 3)	Explain the concept of H.C.F, L.C.M and relevant topics with the help of real life examples, if possible. ii. Selected course contents are compulsory to teach the students. iii. Assign examples/ questions of relevant concepts/ topics as homework task
Unit 7. Linear Equation and Inequalities	7.1 Linear Equation 7.2 Equations Involve Absolute Value 7.3 Linear Inequalities 7.4 Solution of Linear Inequalities with Rational Coefficient	Ex 7.1(Q. 1, 2, 3, 4, 5, 8) Ex 7.2 (Q. 1, 4, 7, 8) Ex 7.3 (Q. 1, 3, 7, 9) Ex 7.4 (Q. 2, 3)	Explain the concept of linear equations, linear inequalities and relevant topics. ii. Selected course contents are compulsory to teach the students. iii. Assign examples/ questions of relevant concepts/ topics as homework task

Data Collection and Analysis

After completion of this course work, an open ended questionnaire was delivered for assessing the effectiveness of PBL approach through BL. The collected data was analyzed objective-wise by using simple frequency distribution of descriptive statistics.

Students Involved in Study

Total strength of grade 9 science students was 50, and on average, 48 of them participated in this research study. The statistics and management of students for the course delivery was considered as per policy of the school management (See Table 2). There were altogether 4 weeks (December-3 to December-23), during which students' home-work was assessed and further home-work was assigned for

the upcoming week. As per Government policy, following SOPs due to Covid-19 pandemic, 4 days of the week were assigned to other classes (6th, 7th, 8th, and 10th) on the basis of one day for one grade strategy. According to this policy, Thursday was specified to grade 9 allocating 4 days in total to grade 9th for attending traditional classes (See Table 2) from December-3 to December-23. After that the schools were fully closed officially from December-24, 2020 to 31-Dec-2020, which got eventually prolonged to January-17, 2021 due to an increase in corona virus cases nationally. The tabulated form of the whole statistics of class 9 attendances and course work (online and in the classroom) are given in the table below.

Table 2

School Days and Attendances of Class 9 During School Closure Due to Pandemic

Schooling Days	Total class strength	Present students	Absent students	Students (H-work done)	Students (H-work not done)	Students Struck off
Dec-03, 2020	50	39	11	37	2	-
Dec-10, 2020	50	35	15	35	0	-
Dec-17, 2020	48	35	13	34	1	2
Dec-23, 2020	48	36	12	36	0	-
Average	49	36.25	12.25	35.50	0.75	0.5
%age		73.97	25.00	72.44	01.53	01.02

Group Formation

35 out of 50 students attended school more regularly and punctually than those who were irregular in attending the school. All together 22/50 students had smart phones and could use WhatsApp proficiently. The other remaining 28 students were split into groups. The uneven number of students in each group was due to their residence being near to each other, in order to form a group with the student having smart phones. The following (Table 3) displays the grouping details.

Table 3

Students' Grouping in December

Number of Groups	Students per Group	Total Students
3	7	21
2	5	10
4	3	12
7	1	07

Designing BL Approach

The following table explains the phases of mathematics course contents that were taught through BL by using the PBL approach.

Table 4

Design and Phases of 9th Class Mathematics Course During School Closure Due to Pandemic

Chapter	Traditional Classroom Teaching	Using PBL Approach in Teaching	Contents Delivered Online
Class 9 (Maths Science Group) 5, 6 and & 7	The course work introduced, home-work assigned, and facilitated for collaborative work in exploring teaching strategies. Checked, assessed and discussed the work done online.	Forming groups, practicing the strategies to be used in problem solving with predetermined goals, enabling students to know and work with problems that are important to learn and motivating them towards higher achievement. Each student in the group identifies the thing he/she wanted to learn prior to the next class. (This cycle continued). Students help peers if they experienced any difficulty in problem solving till they achieve their goals.	1) The self-solved problems were posted in the group to enforce the students self-learning (Shifting the process to student-centered learning). Then an audio recording, explaining the method and procedure to solve the problems was posted, to facilitate and provide guidelines to keep them on track. Also, teachers allocated time to students for questions and answers, to discuss the issues they faced during problem solving. 2) If they felt a need for f2f interaction, then the teachers arranged for that. Also, further problems relevant to the solved-problems were assigned for practice and to cover the course work.

Findings

The results were analyzed on the basis of the objectives as under:

1. To explore the practices of PBL approach

i) How helpful was it for students when they were provided exemplified problems, prior to solving the actual problems?

The results (Table 5) shows the views of 48 students using PBL-Model; 28 students found this model useful whereas 11 students raised concerns.

> "It is not useful always for each and every problem, as we have faced some different points and steps in solving other problem."

Similarly, two other students stated that they could not solve all the problems by using the same method they had adopted for exemplified problems.

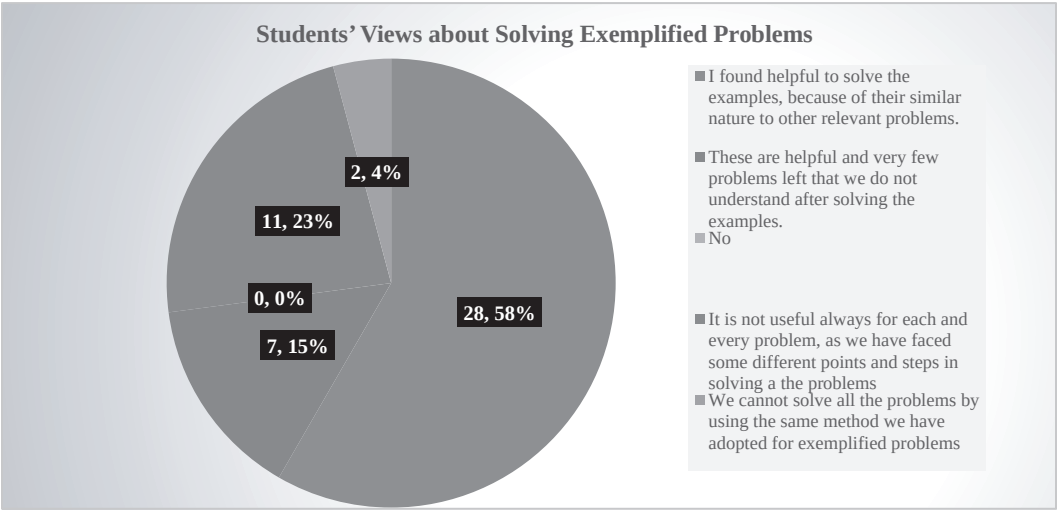
Table 5

Students' Views about Solving Exemplified Problems

Students Find Exemplified Problems Useful		Students do not Find Exemplified Problem Useful	Students Showed Concerns Alongside Solving Exemplified Problems	
Statements	**No. of Students**	**No. of students**	**Statements showing Concerns**	**No. of Students**
i. I found it helpful to solve the examples, because of their similar nature to other relevant problems.	28 (58%)	0	i. It is not useful always for each and every problem, as we have faced some different points and steps in solving problems ii. We cannot solve all the problems by using the same method we have adopted for exemplified problems	11(23%)
ii. These are helpful and very few problems are left that we do not understand after solving the examples.	7 (15%)			2(4%)
Total	35(73%)	0		13(27%)

Figure 1

A Pictorial Presentation of Students' % age Views About Solving Exemplified Problems



2. Helpfulness for Coursework

ii) How helpful was it for students' course work?

Out of 48 (Table 6), 39 students opined that PBL helped in finishing course work, whereas, though the other 9 students also gave statements in favour, they showed concern that they were not able to solve all the sums (3 students) which is why they could not finish on time; additionally, 2 students opined that it could help only if they were able to solve the exemplified problem; while 4 students aligned course completion with understating exemplified problems.

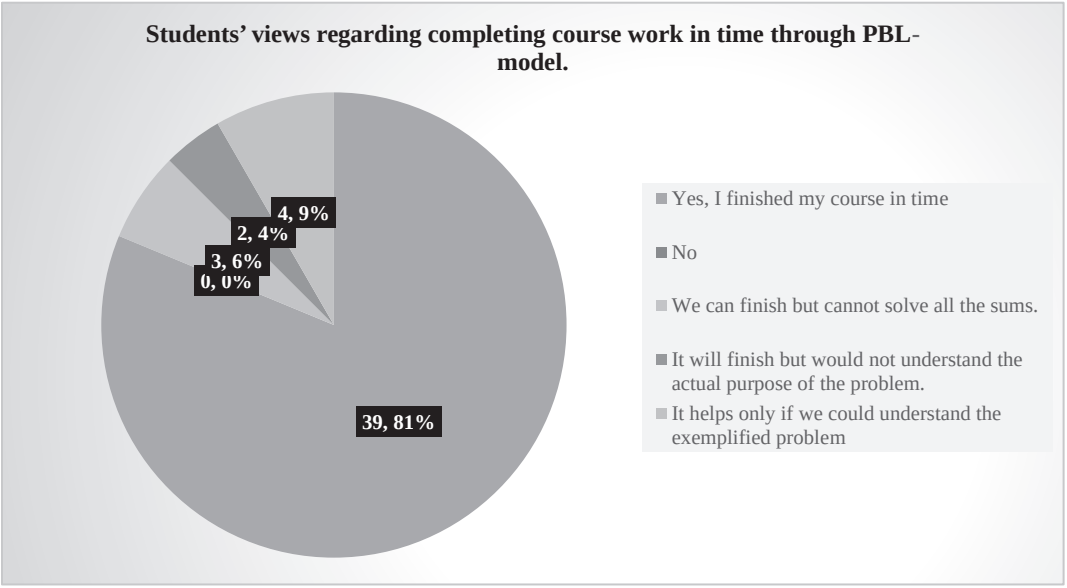
Table 6

Students' Views Regarding Completing Course Work in Time Through PBL-Model

Students Find Exemplified Problems Useful in completing course work		**Students do not Find Exemplified Problem Useful in completing Course work**	**Students Showed Concerns regarding completing course work alongside solving Exemplified Problems**	
Statements	**No. of Students**	**No. of Students**	**Statements showing Concerns**	**No. of Students**
Yes, I finished my course in time	39 (81%)	0	i. We can finish but cannot solve all the sums.	3(6%)
			ii. It will finish but we would not understand the actual purpose of the problem.	2(2%)
			iii. It helps only if we could understand the exemplified problem.	4(8%)
	39(81%)			9(18%)

Figure 2

A pictorial presentations of Students' %age views regarding finishing course work in time through PBL-model



3. To ascertain the advantages of using PBL approach in BL environment.

   iii) What are students' perceptions about using PBL pedagogy in BL environment?

Thirty students responded positively about using PBL through mobile phone applications. The only exceptional statements (Table 7) in this case are given below:

One student said, "There is a big difference between class teaching and mobile phone teaching. We can learn a lot by asking our teacher questions in a face to face situation. Another student had a similar opinion.

Only one student opined that this approach had confused him, especially listening to the lecture and trying to solve problems at the same time; 13 others could not use it effectively because they had no mobile phone as they could not afford to buy one, and neither did their parents allow them to use a cell phone.

Whereas 2 students stated, “I do not understand through WhatsApp.”

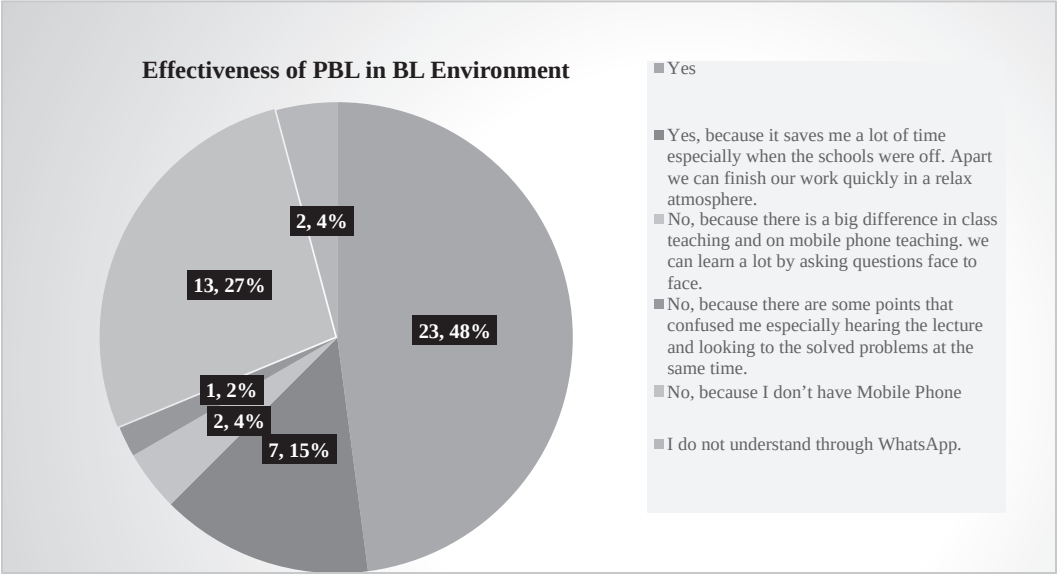
Table 7

Students' Opinions About Using PBL Pedagogy in BL Environment

Students Find Exemplified Problems Useful when used through WhatsApp		**Students do not Find Exemplified Problem Useful when used through WhatsApp**		**Students Showed Concerns Alongside Solving Exemplified Problems**	
Statements	**No. of Students**	**Statements**	**No. of Students**	**Statements showing Concerns**	**No. of Students**
Yes	23(48%)	i. No, because there is a big difference in class teaching and in mobile phone teaching. We can learn a lot by asking questions face to face.	2(4%)	i. No, because I don’t have mobile phone as I cannot afford to buy one. Also, as parents do not allow me.	13(27%)
		ii. No, because there are some points that confused me especially hearing the lecture and trying to solve problems at the same time.	1(2%)	ii. No, because I do not understand through WhatsApp.	2(4%)
Yes, because it saves me a lot of time, especially when the schools were off. Also, we can finish our work quickly in a relaxed atmosphere.	7(15%)				
	30(63%)		3(6%)		15(31%)

Figure 3

A Pictorial Presentation of Students' Statements About Using PBL Assistance in BL Environment



4. Enhancement of Learning

   iv. Did this practice assist in enhancing students' learning?

The results (table 8) show that thirty 35 students commented positively that using PBL in the BL environment has enhanced their learning, whereas, 13 others could not practice properly because of not having their own mobile phone. They overcame this deficiency to some extent by forming groups with those who possessed mobile phones.

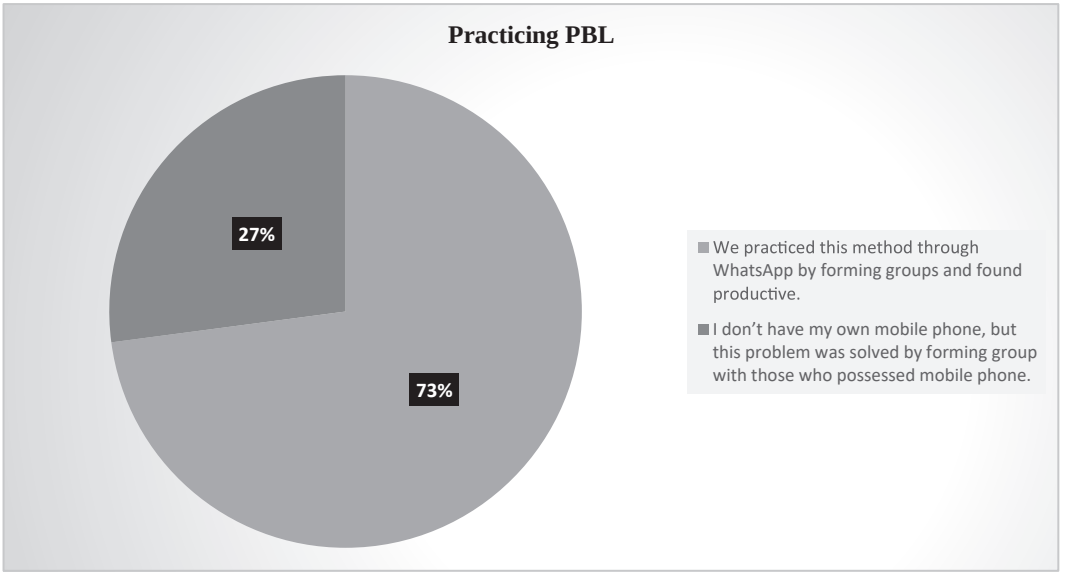
Table 8

Students' Statements about PBL Assistance in Enhancement of Learning

Responses of students about practicing problem-based method in BL	**Students Showed Concerns about practicing problem-based method**		
Statements	**No. of Students**	**Statements showing Concerns**	**No. of Students**
We practiced this method through WhatsApp by forming groups and found it productive.	35(73%)	I don't have my own mobile phone, but this problem was solved by forming a group with those who possessed mobile phones	13(27%)

Figure 4

Pictorial Presentations of Students' Statements about Practice of PBL in BL, Leading to Enhancement in Learning



5. To identify the main difficulties in use of PBL through BL

   v). What were the difficulties faced by students in utilizing PBL through BL?

Altogether 20 students had issues in practicing PBL when used with the help of technology. These were poor accessibility to network/internet, not having

mobile phones/smart phones either due to not being allowed by parents or non-affordability. Some students said that their cell phones were damaged and not in proper working order. The other issues that reported were, money shortage, living in far flung areas where people had connectivity issues due to bad network and few students were not able to use cell phones when their parents were not at home as they were using their parents' mobile phone.

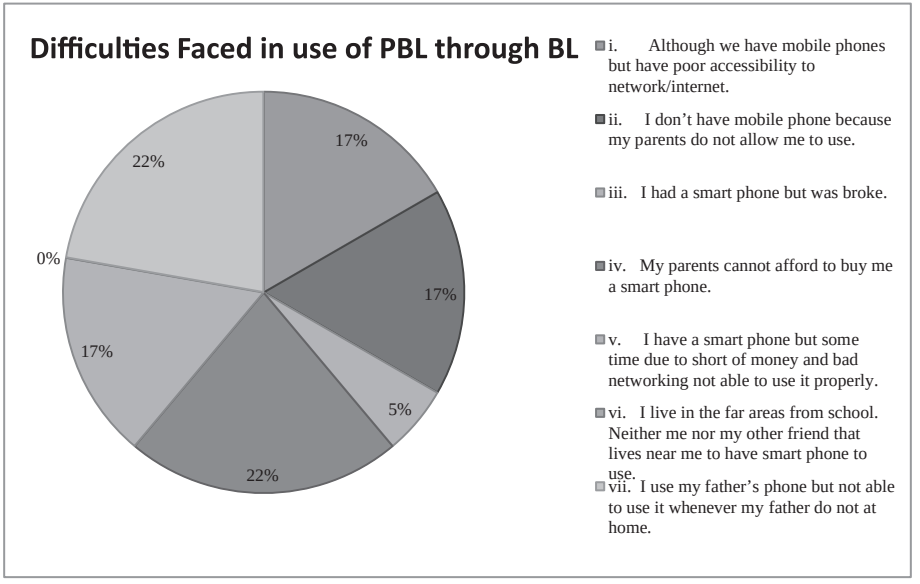
Table 9

Statements of those Students who Faced Difficulties in use of PBL through BL

Statements	No. of Students
i. Although we have mobile phones but there is poor accessibility to network/internet.	3
ii. I don't have mobile phone because my parents do not allow me to use.	3
iii. I had a smart phone but has broken	1
iv. My parents cannot afford to buy me a smart phone.	4
v. I have a smart phone but some time due to shortage of money and bad networking, I can't use it properly.	3
vi. I live in an area from school. Neither me nor my other friend that lives near me have a smart phone to use.	4
vii. I use my father's phone and cannot use it whenever my father is not at home.	2
	20(42%)

Figure 5

A Pictorial Presentation of Statements of those Students who Faced Difficulties in use of PBL through BL



Discussion

This research study was conducted for promoting PBL through BL approach in secondary grade classes (9th and 10th) in order to enhance teachers' as well as students' PBL efficacy in mathematics. In this study, findings from students' data demonstrate how course work was accomplished and learning developed by using PBL through BL approach. The learners worked with exemplified problems first and then moved on to solve similar problems which were helpful for them. This process was repeated for each unit of the coursework, with specific focus on enhancing learning. Though this was a beneficial process, towards the end of the course, some students identified a few issues they faced for incorporating BL in the PBL approach.

The results also show that 73% of students found solving exemplified problems satisfactory because of similar methods they had to follow for solving other relevant problems. This shows that using the PBL approach has enhanced their knowledge and improved their learning skills (Ali, 2019; Pyper, 2021). A small ratio (15%) of 73% had some concerns, though they found PBL a useful approach for understanding the relevant problems. 27% students' thought that PBL was not useful for the problems because the problems given later were somewhat different from the solved examples. That could be a reason why four out of 27% were not able to solve all the problems by using exemplified problems. 81% of students were in favor of this approach because they could complete their course work on time. Thus the positive aspect of PBL reveals that it helps to construct a broad and flexible knowledge base which can ease the work of students so that they can complete their course work (Pyper, 2021). However, in the case of this research,18% could not complete their coursework because they thought the method was not helpful in solving all the problems (6% of 18%), and was not helping in understanding the problem properly (4% of 18%). Furthermore, 8% of the students felt that if they were able to comprehend the exemplified problems better, they would be able to solve the problems that followed with ease. However, most of the students, (63%), found exemplified problems useful when these were delivered by WhatsApp mobile application. This process saved their time and helped them to discuss and solve the actual problems in groups, while schools were closed. Moreover, their standpoint was that they could do so, without restriction of time, and this further proved the utility and effectiveness of using PBL approach when used in BL environment. The findings of this study are similar to the findings

of research studies conducted by Gecer and Gag (2012) and Asif et al. (2020). Furthermore, students found the PBL approach useful because this process enabled them to use it when and where they wanted to. However, there were 6% students who were not in favor of using the PBL approach through mobile phone, saying they could learn better in face-to-face classroom settings and that listening to the lecture and solving problems at the same time was confusing for them (2%).This shows that students had some issues in understanding, and this is what distinguishes learning, providing a zone of proximal development and student ownership of their own learning. Additionally, 27% showed concerns about not having mobile phones and a mere 4% stated that they did not know how to use whatsApp. All in all, the majority of students (73%) found practicing PBL through WhatsApp useful, whereas 27% showed grievances because of not possessing their own mobile phone. In addition, PBL implementation is meant to solve relevant problems that are similar to the problems students encounter in the meaningful space in which the problem exists. This is similar to PCL (Professional Collaborative Learning) and processes such as Instructional Rounds (IR) (DeLuca et al., 2015) in which such problems are explored that exist for the learners in their own working and living environment. However, students faced some hurdles while practicing PBL in a BL environment such as living in far outskirts in the farm houses and hence could not form a group; some also complained that they were using their parents' smartphone or their parents did not allow them to use the smartphone while they were away from home. There were some parents who were unable to purchase the smart phone due to low income. In some cases, despite the fact that students had smartphone facilities, they complained about the poor accessibility of the network/internet which supports the results of previous studies. For example, some researchers raise concerns about the complexities of blending pedagogies with technologies (Asif et al., 2020; Bonk & Graham, 2007; Dziuban et al., 2016; Garrison & Vaughan, 2013; Jean-François 2013; Kitchenham 2011; Picciano et al., 2014; Picciano & Dziuban, 2016). These concerns will continue to gain grip as researchers will continue to study the complexities of how BL interacts with cognitive, affective, and behavioral mechanisms of student behavior, and scrutinize its conversion potential for the educational environment.

Conclusion and Recommendations

This research study was conducted to use the PBL through BL approach for solving 9th grade science mathematical problems at secondary education level,

particularly in uncertain situations like COVID-19. The results of using PBL pedagogy in BL environment, exemplifying mathematical problems, were mostly satisfactory, for instance, providing some solved examples was helpful in attempting to solve other mathematical problems provided later. In addition, timely completion of coursework, improvement in learning skills and enhancement of knowledge for solving the actual problems with peers in groups helped the majority of the students who participated in this research. Barring some exceptions, students were excited with the approach of blended learning and were eager to move forward.

There was a mixed approach towards the use of PBL in the BL environment. There were some students who found it useful whereas some did not find it useful because they were unable to complete their homework/ course work in time, pointing out the disadvantages. Also, few learners preferred face-to-face learning in the PBL method arguing that it was difficult for them to concentrate, simultaneously on listening to the audio lecture and studying the solved examples. But the majority were in favor of using PBL in the BL environment stating that they understood well by listening to the audio recordings and simultaneously focusing on the solved problems.

Although there are some serious hurdles in the use of cell phones, such as poor availability of network/internet services or non-affordability of having smart phone or internet packages, and parents' unwillingness to let their children use smartphones or the internet. However, these issues can be resolved by teaming up with parents and convincing them by involving the head of the institute.

In the light of the above conclusion, it is strongly recommended that the concerned officials should motivate/convince the concerned authorities and finance providers to allocate funding or introduce schemes for the improvement of digital skills and technology at secondary level schools. Teachers, IT teachers in particular, must be motivated to apply the innovative pedagogies such as PBL by using BL approach so that, if any uncertain situation occurs, they may be able to dent the educational losses.

It is also recommended that parents should be convinced for provide smartphones/tablets to their children who study at secondary school level and allow them to use these devices for educational purposes. In this connection, strict

supervision is recommended so that there is no misuse of cell phones. The parents should also be motivated to interact with each other in order to assist their kids for better collaborations in this regard. The school management should help in provision of recorded lectures/audio recordings on secondary storage devices such as USB or Hard Disks to those who do not possess or cannot afford the smart phones/tablets.

Limitations of the Study

i. The availability/functionality of ICT and its equipment has remained vital (Tran et al., 2020) for practicing in a BL environment effectively and adequately. Therefore, proper application of PBL method in BL environment might not provide satisfactory results because of non-availability and poor accessibility to ICT in some places.

ii. The other limitation of the study was the financial constraints of the researcher.

iii. The sample size for this study (availability of suitable respondents due to COVID) caused difficulties for the researcher. Thus the results of this study are not generalizable or transferable.

iv. The sample size needs to be extended for generalizable results.

v. Another limitation was that due to the sudden occurrence of the Covid-19 pandemic, an entirely new research typology had to be designed which was apt for an emergency situation; as such, this could affect the authenticity of the data.

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