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ORIGINAL RESEARCH

The Use of Peer Teaching in the Online Clinical PBL: The Medical Students' Perspectives

Gustavo Salata Romão [1], Sheyla Ribeiro Rocha [2], Milton Faria Junior [1], Marina de Toledo Durand [1], Reinaldo Bulgarelli Bestetti [1]

[1]Medical Course, University of Ribeirão Preto, Ribeirão Preto, São Paulo, Brazil; [2]Department of Medicine, Federal University of São Carlos, São Carlos, São Paulo, Brazil

Correspondence: Gustavo Salata Romão; Reinaldo Bulgarelli Bestetti, Email gsalata@uol.com.br; rbestetti44@gmail.com

Purpose: To evaluate medical students' perceptions about using peer teaching (PT) in the online Clinical PBL (C-PBL).

Materials and Methods: The C-PBL used in the Primary care Unit (PCU) of the medical course of the Ribeirao Preto University was adapted to the virtual environment. A PT session was included to enhance students' intrinsic motivation. This cross-sectional study applied a 14-item survey to evaluate the perceptions of 378 medical students from the first to the seventh semester about the use of PT in this context.

Results: According to participants' perceptions, the use of PT in the online C-PBL allowed the interactive participation of students and produced satisfactory knowledge acquisition. Preparing and presenting a slideshow and being taught by peers contributed significantly to their learning. The survey used to collect information presented a high internal consistency measured by Cronbach's alpha.

Conclusion: From the students' perspectives, the use of PT in the online C-PBL was satisfactory and improved learning for peer teachers and learners. This study contributes additional evidence suggesting that PT is an effective teaching strategy in online learning and can be associated with PBL. This finding has implications for curriculum development and the health system.

Keywords: peer teaching, clinical PBL, problem based learning, virtual learning, educational technology

Introduction

Peer Teaching (PT) can be defined as learning from a group of individuals of similar educational levels (horizontal PT) or from students more advanced in a given course (near-PT or vertical PT)[1,2] Its root can roughly be traced to the University of Bologna in the XIII century, where older students discussed with newer students in the afternoon the lectures delivered by the masters in the morning.[3] PT is a broad concept encompassing different learner group sizes, educational distances between teachers and learners, and formal and informal activities.[2] Several researchers have reported many reasons to use PT in medical education, including providing students education on their cognitive level, creating a positive and safer learning environment, enhancing intrinsic motivation through teaching, and preparing physicians for their future role as educators.[2,4–7] These results may be explained by cognitive and social congruence between peer teachers and learners, resulting in a successful learning experience.[4,8–10] According to the cognitive congruence theory, learning is more effective when the learner's and teacher's knowledge bases are similar than when the teacher is an expert.[8] Additionally, PT also benefits peer teachers because teaching preparation and execution require a more in-depth study than preparing for a written examination.[9]

In contrast, very little is known about the use of PT in online higher education.[11–14] PT has been shown to increase students' motivation for the subject at hand as well as creativity and communication skills; in addition, students prefer PT to traditional learning.[11] Similarly, Festl-Wietek et al[12] have studied the efficacy of online tutorials in a communication course. They enrolled 128 second-year medical students in a quantitative longitudinal study assessing interaction, verbal and non-verbal communication of tutors and students, and student learning success online. They observed that interaction

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and nonverbal and verbal communication occurred satisfactorily between students and tutors and that students' learning increased throughout the communication course.

Similarly, virtual classrooms were used to teach practical skills under the guidance of a tutor, replacing PT. Although the students' acceptability was great during life restrictions imposed by the Pandemic, many challenges appeared, and it became clear that virtual tutorials could not replace in-person PT.[13] Furthermore, Thom et al[14] assessed online PT's impact on the anatomy learning process before and during the COVID-19 pandemic. Compared with in-person teaching, students with online teaching scored lower than those who had in-person teaching. Collectively, these findings show that online PT's efficacy is still unclear.

In 2020, due to the COVID-19 Pandemic, the Medical Course of the University of Ribeirão Preto quickly adapted the PBL curriculum to the virtual environment. In the Primary Care Unit (PCU), a pre-clerkship curricular unit developed over the first seven semesters, the original Clinical PBL (C-PBL) focused on real primary care settings[15,16] was adapted to synchronous online tutorials using the Google Meet web conference platform. This change required some adaptations. In an attempt to increase student motivation and educational outcomes during the Pandemic, PT was introduced to the online C-PBL.

Considering the dearth of studies regarding online PT, this investigation aimed to evaluate medical students' perceptions about using the PT in the online C-PBL.

Methods
Research Design
This single-group post-test study is part of the Ribeirão Preto University Institutional project that evaluates the use of C-PBL in the PCU of the Medical School. An online survey was used to elicit information from medical students on their perceptions regarding the use of peer teaching in the online C-PBL in 2020.

Setting
The study was conducted in Brazil at the Ribeirão Preto University Medical Course and included students from the first to the seventh semesters of the 6-year medical curriculum. The pre-clerkship curriculum consists of three integrated parallel curricular units (primary care, tutoring, and medical skills) developed in a "spiral" where clinical conditions can be revisited at different complexity levels.[17] In 2017, a C-PBL based on real patient encounters in primary care clinical settings was introduced in the PCU.[16] In this C-PBL model, medical students participate in primary care teams, performing clinical consultations under the supervision of experienced clinical doctors and accompanying health agents during home visits. The clinical consultations and home visits are recorded and discussed in two tutoring sessions 15 days apart in small groups of 8 to 10 students under the guidance of trained tutors with experience in primary care (Table 1). After that, the group elaborates a patient care planning, which will be discussed with the primary care team. This care planning might contemplate biopsychosocial aspects of healthcare. In PCU, students can integrate knowledge, skills, and attitudes acquired in other curricular units to collect and interpret clinical data and elaborate patient care planning that is aligned with the health needs of patients and their families. According to our previous findings using the DREEM (The Dundee Ready Educational Environment Measure) questionnaire,[18] medical students found this C-PBL model feasible and well-accepted.[15]

The Educational Intervention
During the COVID-19 Pandemic, the C-PBL was adapted to four online synchronous tutorials using the Google Meet web-conference platform while the activities in the primary care facilities were suspended. To increase student motivation, we made some changes to the original C-PBL. In the opening session, consultations and home visit records were replaced by clinical cases focused on common clinical conditions in primary care settings. Tutors provided the cases, and the learning objectives were subdivided among the students. In the reporting phase, a peer teaching (PT) session was included to increase students' intrinsic motivation. In this step, each student prepares a 5 to 10-minute PowerPoint presentation covering the content of the learning objective for which he or she was assigned. At the end of the session, students debate the new knowledge, aiming to elaborate a simulated care plan as they were supposed to do if they were attending a real patient (Table 1).

Table 1 Summary of the Original C-PBL and the Adapted Online C-PBL Using Peer-Teaching in the Primary Care Unit

Encounters	Original C-PBL	Online C-PBL Associated with a PT Session
Week 1: Elaborating Clinical Case Report	-Tutor allocates patient to led student in the Primary Care Facility -Student performs the task (patient consultation or home visit) and produces a written case report	-Tutor elaborates a clinical case report focused on common clinical conditions in primary care settings
Week 2: Tutorial 1 (Opening session)	-Tutor acts as a facilitator -Student presents the case to the group -Group discussion to generate hypotheses to explain clinical presentation. -Students collectively agree on what they need to study and define learning goals. -The learning goals were subdivided among the students. -In self-directed learning, students must use textbooks and online resources to answer learning goals	-Tutor acts as a facilitator -Tutor presents the clinical case report -Group discussion to generate hypotheses to explain clinical presentation. -Students collectively agree on what they need to study and define learning goals. -The learning goals were subdivided among the students. -In self-directed learning, students must use textbooks and online resources to answer learning goals -Students must also prepare a 5–10 min PowerPoint presentation covering the content of their respective learning goals
Week 3: Tutorial 2 (Reporting phase)	-Tutor acts as a facilitator -Students share and debate the new information about the learning goals -Tutor leads discussion and ensures students have covered all appropriate aspects -Whole group produces a care planning focused on patient care needs -Tutor and students assess the activity	-Tutor acts as a facilitator -Each student performs a PowerPoint presentation covering the content of the learning goal for which he or she was assigned. -The tutor provides feedback to each student at the end of their presentation -Students share and debate the new information about the learning goals -Tutor leads discussion and ensures students have covered all appropriate aspects -Whole group produces a simulated care planning focused on patient care needs -Tutor and students assess the activity
Week 4: Primary Care Teamwork	Each student discusses the patient care planning elaborated by the group with the primary care team	-This encounter could not be held during the pandemic due to health restrictions for in-person activities

Abbreviations: C-PBL, Clinical problem-based learning; PT, Peer teaching.

Participants

All medical students from the first to the seventh semester at Ribeirão Preto University in 2020 were eligible to participate and invited by WhatsApp®. The inclusion criterion was to be enrolled in the PCU and sign the consent form.

Data Collection

The research team designed the online survey based on a literature review and the study objectives. It was applied online by the Google Forms Platform and consisted of 14-item using a five-point Likert scale and a text box for free comments.

Data Analysis

The online survey items were analyzed using the R version 4.2. statistical software. Descriptive statistics were used to indicate the students' perceptions.

Ethical Considerations

The Institutional Ethical Committee approved this study (Reference no. 67795717.9.0000.5498). All medical students from the first to the seventh semester at Ribeirão Preto University in 2020 were eligible to participate. They receive a message by WhatsApp®, inviting them to participate. Ones who agreed clicked on the link to the consent form. It was clear that they could choose whether or not to participate, and it would not affect their grades. The participants' informed

consent also included the publication of anonymized responses. After that, they could fill out the anonymous questionnaire.

Results

Casuistic

Of the 560 medical students enrolled from the first to the seventh semester, 378 (67.5%) answered the questionnaire. The participants' age ranged between 17 and 38 years (22±3 years), with 67.5% being female. There was a homogeneous distribution of participants between the different medical course stages (Table 2).

Likert Questionnaire

The Likert questionnaire results are summarized in Table 3. According to participants' perceptions, the Online C-PBL associated with a PT session allowed the interactive participation of students, produced satisfactory knowledge acquisition, and did not impair learning in the PCU during the Pandemic. They agreed that preparing and presenting a slideshow

Table 2 Distribution of Participants Between the Different Medical Course Stages

Stages (Semester)	Number of Participants	Proportion
First	57	15.1%
Second	57	15.1%
Third	65	17.2%
Fourth	58	15.3%
Fifth	47	12.4%
Sixth	39	10.3%
Seventh	55	14.6%
TOTAL	378	100.0%

Table 3 Topics of a 5-Point Likert Questionnaire Applied to Medical Students Who Joined the Online C-PBL Associated with a PT Session to Evaluate Their Perceptions. Values are Presented as the Number of Responses (with Percentage in Parentheses)

The Online C-PBL and PT session…	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
… allowed the interactive participation of students.	269 (71.2)	93 (24.6)	6 (1.6)	8 (2.1)	2 (0.5)
… produced satisfactory knowledge acquisition.	166 (43.9)	119 (31.5)	35 (9.3)	34 (9)	24 (6.3)
… motivated them to self-directed study	184 (48.7)	83 (22)	42 (11.1)	35 (9.3)	34 (9)
… did not impair learning in the PCU during the Pandemic	125 (33.1)	105 (27.8)	42 (11,1)	79 (20.9)	27 (7.1)
The slideshow preparation and presentation contributed significantly to my learning	259 (68.5)	67 (17.7)	30 (7.9)	16 (4.2)	6 (1.6)
The peers' presentations contributed significantly to my learning	190 (50.3)	97 (25.7)	47 (12.4)	32 (8.5)	12 (3.2)
The clinical cases presented in the opening session were realistic and motivating	239 (63.2)	95 (25.1)	28 (7,4)	15 (4)	1 (0,3)
The opening discussion was productive and fruitful	213 (56.3)	111 (29.4)	24 (6.3)	24 (6.3)	6 (1.6)
The learning objectives were consistent with their knowledge gaps	223 (59)	129 (34.1)	11 (2.9)	13 (3.4)	2 (0.5)
The simulated healthcare plan elaboration enables the application of the acquired knowledge in a clinical context	186 (49.2)	103 (27.2)	45 (11.9)	34 (9)	10 (2.6)
Tutors were sufficiently prepared to guide the activity	219 (57.9)	97 (25.7)	26 (6.9)	26 (6.9)	10 (2.6)
The tutors' feedback was structured and encouraged the acquisition of new skills	159 (42.1)	112 (29.6)	54 (14.3)	33 (8.7)	20 (5.3)
Students received clearly and understandably instructions about the activity	246 (65.1)	90 (23.8)	17 (4.5)	17 (4.5)	8 (2.1)
I participate satisfactorily in the activity using my hardware and internet connection	243 (64.3)	98 (25.9)	10 (2.6)	24 (6.3)	3 (0.8)

Abbreviations: C-PBL, Clinical problem-based learning; PT, Peer teaching; PCU, Primary Care Unit; %, percentage.

and being taught by peers contributed significantly to their learning, and formative assessment was adequate. For most participants, the clinical cases presented in the opening session were realistic and motivating, the opening discussion was productive and fruitful, and the learning objectives were consistent with their knowledge gaps and motivated them to self-directed study. In addition, tutors were sufficiently prepared to guide the activity and provide instruction about the activity and meaningful feedback.

When asked about the simulated healthcare plan elaboration, the majority (76.4%) commented that it enables knowledge application in a clinical context. The internal consistency of the questionnaire defined by Cronbach's alpha was 0.815.

Approximately 90% of those surveyed considered that their equipment and internet connection enabled proper access and use of the Google Meet Platform.

Discussion

This study aimed to assess the use of online PT in an online C-PBL under the medical students' perception during the COVID-19 pandemic. The current study found that this educational activity was effective and well-accepted for most respondents, who represent 67.5% of the total number of students enrolled in PCU. It is also encouraging to know that students are satisfied with their learning process and the organization of this activity.

During the Pandemic, keeping medical students motivated to learn and promote peer interaction in virtual environments was a concern.[19] Our rationale for implementing a PT session associated with an online C-PBL is based on previous research linking PT experiences with students' motivation and satisfaction.[4–7] However, studies linking PT to online C-PBL are not widely found in the literature. Then, this activity was an innovation and called for assessment.

According to our results, students agreed that the association between PT and C-PBL in online teaching was a successful strategy that allowed the interactive participation of students, produced satisfactory knowledge acquisition, motivated them to self-directed study, and did not impair clinical learning during the Pandemic. These results corroborate the findings of previous work in this field.[19–21] It may be explained by the fact that this online activity incorporated effective teaching principles such as social learning, feedback, interactivity, and real clinical cases to support clinical learning.[22]

On the question of the online PT, the results highlighted that the students approved this change to the original C-PBL. According to the PT framework described by Ten Cate and Durning, this online PT session can be classified as a formal small group encounter, with no educational distance between teachers and learners.[2,9] The introduction of PT as an explicit element in the medical curriculum has been recommended, considering its beneficial effects, such as creating a positive and safer learning environment, offering alternative methods for studying and long-term learning, and enhancing intrinsic motivation through teaching.[2,9]

Another critical finding about online PT was that students identified advantages in both roles. As learners, they pointed out that their peers' presentations contributed significantly to their learning. These findings mirror the previous studies that suggest that cognitive and social congruence between teachers and learners can result in a successful learning experience, optimizing knowledge acquisition.[4,8–10]

It is possible that the social and cognitive congruence between students facilitates learners' progression towards the zone of proximal development (ZPD) proposed by Vygotsky,[23] constituting better scaffolding than faculty facilitators. As noted by Topping, peers may identify the students' ZPD better than teachers, who may not realize the difficulties students face during their scholarship.[10] Therefore, according to the cognitive congruence theory, learning is more effective when the learner's and teacher's knowledge basis is similar than in situations where the teacher is an expert in the field.[8]

As teachers, the students also stressed the benefits of online PT to their own learning and the opportunity to develop other abilities, such as communication skills. They agreed that the slideshow preparation and presentation contributed significantly to their learning process, and the tutors' feedback encouraged the acquisition of new skills. It is plausible that being a peer-teacher promoted metacognitive learning skills during the slideshow's planning. To teach, they must deepen their knowledge, develop a comprehensive understanding of the subject, and elaborate and organize ideas.[9,24] They must also develop communication skills and share information clearly, using appropriate language.[4] It should also be considered that "to teach is to learn twice",[25] and several studies have shown that teaching can improve one's content

knowledge, communication skills, and intrinsic motivation.[26–29] Besides that, the self-determination theory proposes that when students perform a teacher role, their perceptions of autonomy and competence are enhanced and promote a quick intrinsic motivation to study, which does not always occur when students are only passive learners.[9,30]

On the question of the online C-PBL, students agreed that the clinical cases were realistic and motivating, promoting a productive and fruitful discussion in the opening session, generating learning objectives consistent with their knowledge gaps, and enabling the application of the acquired knowledge in a clinical context. Therefore, it can be assumed that this online C-PBL encompasses key principles of student-centered education resulting in a constructive, collaborative, self-directed, and contextual learning process.[31] These results are consistent with those of other studies during the Pandemic, suggesting that synchronous learning mirrors face-to-face classes, had higher satisfaction ratings, and showed comparable outcomes to traditional education.[19,32,33] Similarly, a systematic review and meta-analysis by the Digital Health Education Collaboration conducted in 2017 had already found that online PBL is as effective as traditional PBL in improving knowledge outcomes and may be more effective than traditional PBL in enhancing skills.[34]

Another explanation for the excellent acceptance of the activity is the sufficient technical support and resources and the training program offered by the University. Most participants' equipment and internet connection enabled proper access (90%), tutors were sufficiently prepared to guide the sessions (83,6%), and students received instructions about the activity clearly and understandably (88,9%). According to the literature, the successful implementation of e-learning in medical education depends on access to adequate equipment and internet connection and to be skilled in using the technology as a learner or teacher. Institutional support is essential in this process.[35] Additionally, our group has previously demonstrated that subject-matter expertise tutor plays an important role and is essential to the learning process in PBL tutorial sessions.[36]

On the other hand, some students disclosed a negative view of e-learning. Few (18%, 69 out 378) disagree that the activity motivated them to self-directed study. They also pointed out the limitations of the lack of clinical practice (28%, 106 out 378) and problems using virtual learning (7,1%, 27 out 378). These results align with a systematic review of the effectiveness of virtual medical teaching during the COVID-19 pandemic. This review found that the significant weakness of e-learning is technical issues, followed by the loss of face-to-face teaching and a lack of direct patient care.[37] Another review also revealed that students worldwide expressed different levels of satisfaction with e-learning and pointed out that institutions should take students' views into account to improve e-learning opportunities.[32]

Some limitations of this study must be considered. First, the reproducibility and generalizability of these results depend on the context and satisfactory internet access, which is not always possible in some areas. Second, not all the skills expected of doctors can be acquired through distance learning, and even in areas with fewer resources, it will be necessary to expose medical students to the care of real patients who seek health services during training. Third, the results presented here refer only to the first level of Kirkpatrick's model for evaluating Educational Programs.[38] A more refined evaluation of this model requires assessments of cognitive gain (level two) or attitude changes (level three), which were not the object of this study.

Implications for Practice and Future Research

The findings of this study have some important implications for curriculum development and the health system. First, critical regulatory agencies of medical education have established teaching and communication as essential competencies of the medical professional.[6] PT can help develop these skills and promote self-confidence and long-term learning. Secondly, PT seems to be a cost-effective alternative for medical training, particularly in remote areas and in case of teacher scarcity.[6] Some of these difficulties can be circumvented by online PT associated with C-PBL, which enables interaction between peers from different geographic areas, allowing the sharing of practical knowledge, reducing regional deficiencies, and improving healthcare quality. Finally, considering this satisfactory experience, we believe this approach could enhance online learning in medical education and improve the quality of citizen assistance in primary care settings in underserved areas worldwide. Further studies, which take these variables into account, will need to be undertaken.

Conclusion

Our results showed that the proposed educational activity improved learning for peer teachers and learners. The sample was representative of the total students enrolled in the first seven semesters of the medical course at the University of Ribeirão Preto (67.5%), with a homogeneous participants' distribution between stages. The survey used to collect

information presented a high internal consistency measured by Cronbach's alpha. It can, therefore, be assumed that a formal synchronous online PT session in a small group associated with C-PBL encounters was a successful learning experience for learners and peer teachers. The results of our study are corroborated by other findings and supported by several learning theories.[1,2,9] It contributes additional evidence suggesting that PT is an effective teaching strategy in online learning and can be associated with PBL. Considering social and emotional gains associated with the PT experience, it is plausible that it may have supported students during the Pandemic.

Data Sharing Statement

The datasets generated during and analyzed during the current study are not publicly available because individual privacy could be compromised, but they are available from the corresponding author upon reasonable request.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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