

Best Practices Learned from Online Problem-based Learning Help Prepare Students for Global Health Care Challenges of the Future

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Abstract

Background

Problem-based learning (PBL) offers a unique model of remote learning that resembles important facets of students' future medical careers. The purpose of this study was to determine if online PBL was successful and to identify creative innovations and best practices of online learning in order to better prepare medical students for health care careers in the future.

Methods

The impact of implementing virtually delivered PBL sessions on student experience and performance in comparison to in-person PBL sessions was evaluated. A 4-point Likert scale question was used to investigate the effect of the transition to online PBL on the students' PBL process experience. Student PBL process grades were measured on a scale of 5–10, where 5 is “needs substantial improvement” and 10 is “meets expectations”. PBL session grades were compared in one session before and one session after the transition to online PBL using a paired t-test. Data are presented as number of responses per category (percentage), or as a mean +/- standard deviation.

Results

Based on our experiences, we identified a successful transition to online PBL with no meaningful impact on students' performance. We also identified several challenges to online PBL and how students demonstrated creative solutions to overcome these challenges. As a result of our experience, we identified several key factors as best practices of implementing online PBL to ensure a smooth transition from in-person sessions for both faculty and students, including extensive preparation, participation of support staff, availability of adequate internet services and equipment, and input from instructional technology and design personnel.

Conclusion

Successful student performance and experience, along with best practices learned from implementing virtual PBL, provide valuable tools for improving teaching and critical insight into the challenges faced, when preparing students for global health care changes in the future.

Introduction:

Historically, online learning has offered a worthy oasis in times of unforeseen catastrophe (Dhawan, 2020). The University of Camerino in Italy, the University of Canterbury in Australia and the Southern University in New Orleans all crumpled to the ground by violent earthquakes or hurricanes, turned to

online learning in the face of adversity (Dhawan, 2020). The current COVID-19 crisis has similarly forced many schools to close their doors and quickly adapt to online learning (Li and Lanani, 2020). Platforms such as Webex, Zoom and Panopto have been rapidly woven into the educational fabric to deliver a combination of prerecorded lectures, live review sessions and online workshops. Simultaneously, other global challenges in health care exist, including rising costs, changing patient demographics, and evolving consumer expectations. Technology-enabled patient engagement and care strategies are enhancing patient independence regarding their health care decisions and have the potential to change a physician's role in health care delivery (Burrill, 2000). The transition to alternative employment models, including virtual medicine, has already begun and is only expected to accelerate over the next decade (Burrill, 2000). Learning the skills needed to effectively integrate into this changing landscape will be invaluable to future health care providers.

Problem-based learning (PBL), traditionally executed in small in-person groups, offers a unique model of learning that resembles important facets of students' future medical careers and is the one of the most important developments in the university education of the professions (Boud and Feletti, 1977). The first PBL program originated at McMaster University School of Medicine in North America in 1969 and spread across the world. Interestingly, PBL was the brainchild of several medical professors in response to a global change during the sixties (Servant-Miklos, 2019). In 2015, Savory wonderfully described PBL as "an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem".

PBL at the New York University Long Island School of Medicine uses real life clinical scenarios/vignettes to help learners critically identify, analyze and synthesize information and concepts relevant to the students learning needs, with a substantial emphasis on basic science concepts. During PBL, students are divided into groups of 8 students and one facilitator per group. There are at least two PBL sessions per case. In the first session, the students deconstruct and analyze the presented case information, in order to identify their knowledge gaps. These gaps are then researched by the students from credible, peer-reviewed resources and discussed in the second PBL session, to synthesize the information of the case and furnish their original knowledge gaps.

We propose that online PBL offers a unique model of remote learning to study virtual challenges that will be faced during global changes in health care education in the future. Such unique factors include:

1. *Small groups.* PBL normally consist of a group of 8–10 students (Wood, 2003). These groups are akin to the multidisciplinary teams of students' future medical teams.
2. *Student focused.* PBL is a learner-centered approach, whereby students are responsible for their own learning needs. Learner motivation increases when responsibility for the solution to the problem and the process rests with the learner (Savery and Duffy, 1995) and as student ownership for learning increases (Savery, 1999). When the expected outcomes are clearly defined then there is less need or incentive for the learner to set their own parameters. In the real or virtual world, it is recognized that

the ability to both define the problem and develop a solution (or range of possible solutions) is important. Mastery of this learner-centered approach offers a level of independence and confidence in solving medical/patient problems they will face in the future.

3. *Facilitator is present as guide only, and not as a content expert.* “As the responsibility for learning shifts toward students, the role of the instructor also shifts, from the conventional authority who dispenses final-form knowledge to an expert guide, who motivates and facilitates the process of learning, while promoting the individual development of learning skills.” (Allchin, 2013).
4. *Patient centered case.* While the objective of PBL is to hone in on the basic sciences in the first year of medical school, the case is a vignette based around a real-life patient. Students must not only bring their research and discussion back to the basic science but always do so in the context of the patient. Such patient-centered learning objectives align with their future careers as physicians offering patient-centered care.
5. *Active participants.* As PBL is a student-centered approach, students are actively involved in addressing their own learning needs. They need to develop communications skills to drive cooperative identification, analyses and synthesis of their knowledge gaps. Such communication and teamwork skills are vital to the success of their future medical careers.

We contend that the five main factors outlined above make PBL a unique model of learning as it both mirrors many of the day-to-day activities of their future medical careers and helps promote many of the skills needed for success within this profession. More so, we believe that online PBL is an applicable model to study virtual challenges that will be faced during global changes in health care education in the future.

In this study, we evaluated the impact of implementing virtually delivered PBL sessions on student experience and performance in comparison to in-person PBL sessions. We analyzed perceived challenges and the techniques used to overcome them, as well as the benefits realized during the online process. We present here several best practices learned from our experience, which we believe will help prepare medical students for future global changes in health care delivery.

Methods:

PBL session process grades and student PBL course feedback were collected as part of an IRB-approved medical education student registry. The entire class (n = 24) was surveyed and their grades and evaluations of online PBL were quantitatively and qualitatively analyzed.

Evaluation of Student Perspective

A 4-point Likert scale question was used to investigate the effect of the transition to online PBL on the students' PBL process experience. Two open ended questions were used to investigate the major themes of the challenges perceived by students and how they overcame them, and the added benefits realized. Student written comments were counted and classified under major themes.

Evaluation of Student Performance

Student PBL process grades were measured on a scale of 5–10, where 5 is “needs substantial improvement” and 10 is “meets expectations”. PBL session grades were compared in one session before and one session after the transition to online PBL using a paired t-test. Data are presented as number of responses per category (percentage), or as a mean +/- standard deviation. Significance is set at $p = 0.05$.

Best Practices

Based on our experiences, we identified and recorded best practices of implementing online PBL to ensure a smooth transition from in-person sessions for both faculty and students.

Results And Discussion:

Health, disease and pandemics are not limited by border and continents. The current pandemic, however, reminds us that neither is global health sciences education. While online education may present with some challenges, it also presents many wonderful opportunities.

Student Perspective and Performance of Online PBL

Overall, we have observed the successful and rapid transition from in-person PBL sessions to online PBL learning during an unexpected pandemic (Fig. 1; 85.7% strongly agree). The major challenge students identified was online interaction (Fig. 2; 50%). However, this was quickly overcome by using the chat feature and online cues (Table 1) and did not affect student’s PBL process experience. In fact, students reported that the chat feature was a major benefit (Fig. 3; 41%) that gave the quieter members of the group a platform to enhance their communication and aided their online interaction. Other benefits included a paperless forum and generation of innovative ways, such as quizzes, to approach their case summaries. Interestingly, these methodologies have since become a mainstay feature in their PBL in-person and online PBL learning sessions alike. Student PBL process grades, e.g., collaboration, proper referencing, and reflection, were similar before and after online PBL delivery (9.99[0.02] and 9.97[0.05], respectively, $p = 0.03$), though the scores were statistically higher before the transition to PBL. However, the difference in scores was not meaningful with respect to successfully meeting expectations in process skills during PBL sessions.

Student-reported successful transition to online PBL is important for global health care since there is an increased use and interest in telehealth (Jonas, 2019), especially in response to the global COVID-19 pandemic. Many physicians may be hesitant to use telehealth due to lack of training or unfamiliarity with the platform, however, exposure and training in telehealth during medical school can increase future plans to practice telehealth (Jonas, 2019). We contend that exposure to online learning during medical school drives students' comfort and familiarity with online platforms and overcoming challenges thereof for their future practices. PBL, in particular, offers a unique learning experience, many facets of which mirror the day-to-day operations of their future careers. Online PBL, thereby exposes students to the

virtual world of such activities and hence aids a smooth and successful transition to telehealth in the future.

Additionally, students implemented innovative ways to overcome limitations presented by the online platform, resulting in novel and enduring methodology during PBL. This is encouraging since global health care will require the use of technology to connect providers with patients and promote international collaborations. Synchronous interactive online sessions have already proven to be successful at promoting real-time virtual discussions and successful acquisition of course content (Oz, 2005). These discussions can be verbal, via chat box, or a combination of both. However, it is important to recognize that use of the chat feature must be monitored by either the students themselves or a facilitator, in order to successfully incorporate comments into the ongoing discussion (Zuo, 2021). Similarly, we found the chat box feature was beneficial to the quieter students and allowed students to naturally monitor their colleague's communication activity as outlined in the benefits below.

While students were surveyed and measured regarding their performance during online PBL, we also identified observations at the program level. We identified several challenges and opportunities of online PBL. Such challenges e.g., social and technical, can be felt at both the local and global level and require additional funding to overcome.

Best Practices for Online PBL

There were several factors that contributed to the smooth implementation of online PBL. We highlight five of the best practices that we found during our experience below.

1. Preparation-

Choice of virtual platform. Three platforms were initially chosen, with Webex selected to be the primary platform. As the whole world was moving to online, Zoom and call-in conference room numbers were also employed as backups in case the system collapsed. Having a backup system in place eased anxieties of faculty and students alike, while moving to a foreign world of online learning. Fortunately, Webex proved to be a robust system and neither of the backup systems were needed to date.

Guideline documents. A step-by-step guide of the in-person process of PBL was written down and it was then applied to the possibilities of an online platform. It was brainstormed and cross-referenced with the facilitator team, support staff, administration and IT/Instructional design staff. Having a guideline document for online PBL delivery not only eased the anxieties of faculty and students alike, but it was also the perfect brainstorming platform of the possibilities of online learning. IT also created a user guide for the platform (Webex) itself (logging in, muting, backup platforms.)

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learning. Fortunately, Webex proved to be a robust system and neither of the backup systems were needed to date.

IT team/Instructional Design (ID) Team- Having an excellent IT/ID team was vital in setting up of the initial virtual platform. This included brainstorming for best platform and best backup systems. It also included continued monitoring of the platform chosen and IT/ID support where needed.

2. Support staff- Having an excellent support staff was also essential to the successful implementation of the new virtual platform. They set up the triweekly PBL sessions via Webex and sent all necessary persons the invites. One support staff member also hosts each group and is available to provide support and guidance where necessary. For example, having support staff help students take the presenter ball, share the screen, etc., was extremely important for smooth presentations during each session. One host one group: An important lesson learned was that only one person can set up a Webex meeting at a time. Three different members of staff were needed to set up the three group meetings needed for each session. Once discovered, the error was immediately rectified by another staff member by creating a new invite and resending the link to the affected group.
3. Internet connection- A good internet connection is the backbone to the successful implementation of an online learning system. Although the school had a great system in place, medical education was now reliant on internet connection in the homes of students and faculty and the availability of such a connection in their residences across the world. Akin to the physicians and patients in telehealth visits and applicable to all global health sciences education. When students had slow connections from home, they were asked to turn off their camera. This usually improved audio and allowed continuation of their participation in the session.
4. Equipment- A workable laptop or device. The school offered students a loan of the school's in-house iPads, if needed. Such backup was not needed by the students to date.

Ultimately, it was the successful implementation of online PBL delivery using the factors mentioned and lessons learned that aided students' and faculty's smooth virtual experiences and increased their comfort level and acceptance of the virtual platform.

Global Applications of Online PBL

Based on student perspective, performance, and identified best practices, we formulated a list of challenges and benefits with global applications in mind.

Global Challenges

1. *Affects development of group bonding*- Online communication removes several in-person communication cues e.g., gestures, all team member verbally agreeing in unison, light banter before and after class etc. that normally allows for group bonding. Fortunately, when the pandemic hit New York in Spring 2019, the medical students already had 8 months' worth of fulltime daily in-person sessions to form bonds. The class that began in July of 2020, had a reduced number of hours of in-

person experience (all lectures remote, small group activities in-person which were socially distanced). Interestingly, this class appeared to take longer to form bonds.

2. *Communication*- The major challenge students identified was online interaction; knowing when to speak, difficulty in active dialogue. However, this was quickly overcome by using the chat feature and online cues. More so, students unanimously agreed that it did not affect their PBL process experience.
3. *Internet infrastructure*- Online platforms are reliant on internet connection in the homes of participants and at the mercy of the availability of such a connection in their residences across the world. A good internet connection is critical to the success of online learning or telehealth visits. Remote areas, low-income countries, impoverished areas, etc. would need financial help to build or repair the necessary infrastructure for successful online platforms. Within the United States, the Federal Communications Commission (FCC) states that 21 million Americans still lack broadband access (Federal Communications Commission, 2019), while Microsoft places this number as over as 160 million (Microsoft, 2019).
4. *Equipment*- All participants require a workable laptop or device. Globally, economically challenged countries would be at a disadvantage. Locally, persons with lower incomes would also be at a disadvantage. Again, funding is needed at the local and global level to support online health care platforms.

While such online learning may present with some challenges, we also identified the many wonderful opportunities it offers.

Global Benefits/Opportunities

1. *Flexibility of activity*- Remote PBL can be mirrored anywhere in the world like telehealth. Students and facilitator do not necessarily have to be in the same country.
2. *Flexibility of Scheduling*- Remote PBL can be scheduled for anytime within in the working day; not confined to a morning or afternoon schedule. It is not at the mercy of potential transport or inclement weather problems for commute to work or school. While students and facilitator do not have to be in the same country, careful scheduling should be considered due to potential differences in disparate time zones.
3. *Acquisition of new skill sets*- Online learning cues/language. While students found communication via virtual platforms challenging in the beginning, they quickly overcame these by adapting to a new set of online communication cues. For example, students continually monitored the activities of their online colleagues, e.g., when someone unmuted, it indicated they would like to speak.
4. *Provide a voice for quieter members*- Online PBL offers a platform that allows quieter students to interact more thoroughly via chat function. It allows them to engage more and be a continued voice in the team. Students both reported, and self-reported that this was one of the biggest benefits of online PBL. Globally, additional opportunities for all members of multidisciplinary teams to participate, would further aid well informed decisions.

5. *Experience, adaptation and resilience for future-* Online PBL offered students their first experience of future telehealth, their first successful response of adaptation to a global crisis, and their first acknowledgement of successful resilience to a global crisis.

Conclusion:

In summary, we identified and implemented best practices for smooth and successful online PBL delivery in the medical school setting. Serendipitously, the need for a quick transition from in-person PBL to online PBL has highlighted important benefits for medical students including promoting comfort and familiarity with the online platform. The pandemic has allowed remote learning to take center stage and equip medical students with virtual experiences and skills that are essential to their adaptation to any future global change or new pandemic that requires telehealth, or online platforms for continued patient care.

Declarations

Ethics Approval and Consent to participate: Use of the medical student registry was approved in written form by the NYU Langone Institutional Review Board. Students in the medical registry gave written consent to participate. Consent for this study was obtained by satisfactory fulfillment of the quality improvement checklist which then designated this research as exempt. The Research and Scholarship Committee at NYU LISOM subsequently gave written consent. *Consent for Publication:* N/A

Authors Contributions: OO was a major contributor in writing and editing the manuscript. LK performed the statistical analyses in addition to writing and editing the manuscript. GA and SS both edited manuscript concepts and made valuable editing suggestions. LR designed the manuscript concept as well as being major contributor to the writing and overall production of the manuscript. All authors read and approved the final manuscript.

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Abbreviations

Problem-based learning (PBL); Information Technology (IT); Instructional Design (ID), Institutional Review Board (IRB), New York University (NYU), New York University Long Island School of Medicine (NYU LISOM)

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Table

Table 1. Student Quotes

Challenges	Overcame	Benefits
“there were times in which active dialogue between members was difficult due to the lack of in-person interaction”	“Nonetheless, we overcame this by implementing a specific order of presentation along with a fluid conversational environment”	“Because the software only allows one person to effectively speak at once, tele-learning allowed the talkers to be more attentive to the quieter group members and I think it brought their ideas out more than if we were in-person”
“Not having in-person cues to know when to speak / if others are about to say something.”	“..there are cues online that we learned to watch for (aka when someone unmutes themselves they're thinking of speaking)”	“I found that I am able to speak up more in my group”
“ Knowing when to speak relative to other groupmates”	“--> utilizing chat box ”	“ Chat allows quiet people to talk.”
“Some challenges with concept mapping ”	“..but we moved to a quiz which was great”	“Encouraged our group to be creative/try new methods of learning and reviewing material”
“Our group had trouble with time management.”	“We overcame this by discussing this during our feedback time and we all made an extra effort to watch the clock throughout the session.”	“ Efficient, reduced paper waste, and overall, very smooth! Brought out some of the quieter people too (esp. through chat function) which was a nice added bonus/surprise”

Figures

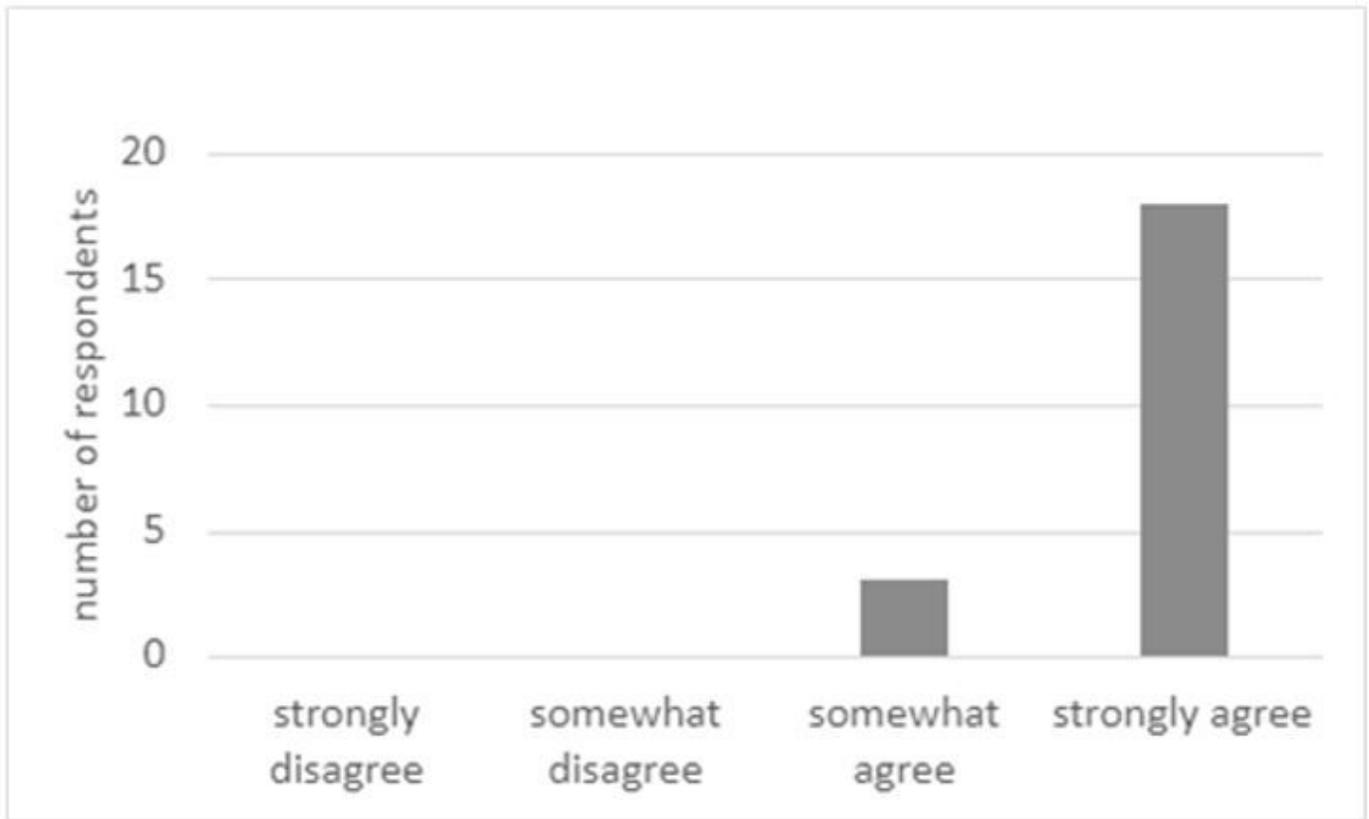


Figure 1

Response rate 87.5% n= 21: 100% of responders agreed that the transition to PBL online learning was smooth and did not affect their PBL process experience; 85.7% strongly agreed and 14.3% somewhat agreed.

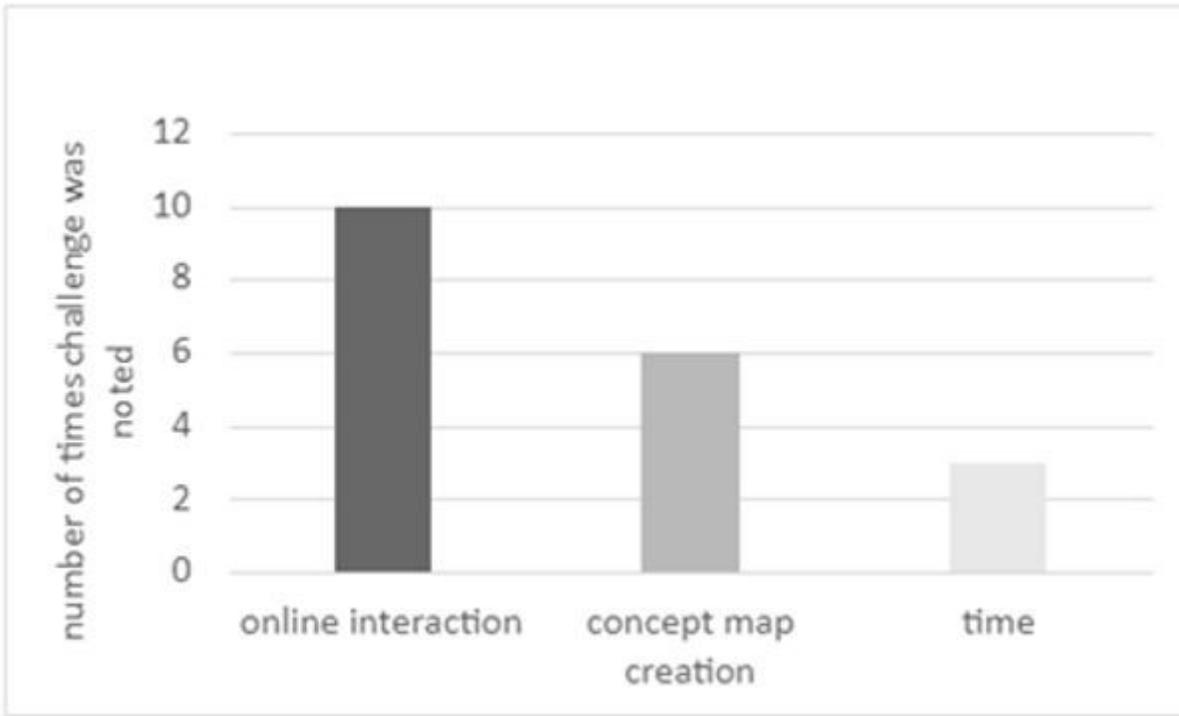


Figure 2

Response rate 83.3% n = 20: i) online interaction (50%): knowing when to speak, gauging group dynamics; ii) concept map creation (30%); and iii) time (15%).

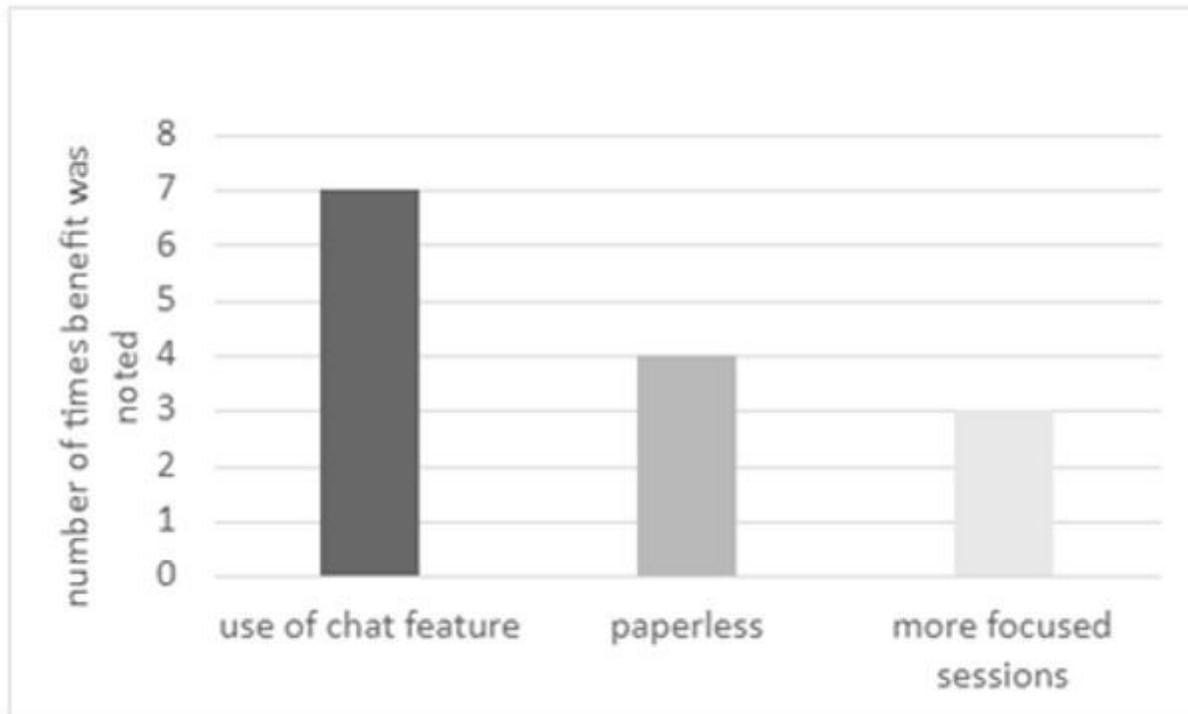


Figure 3

Response rate: 70.8% n= 17: i) use of the chat feature (41.2%): including subcategories, helped quieter members (n= 3), able to speak more (n= 2); ii) Paperless (23.5 %); and iii) More focused sessions (17.6%): e.g., one person speaks at a time, no side conversations that get lost in in-person PBL sessions.