

# Developing 21st Century Skills through Problem-Based Learning in Online Environments

CHRIS D CRAIG

**\*Corresponding author**

CHRIS D CRAIG

Southern Queensland Learning and Teaching Support  
Toowoomba, Australia

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## Introduction

More than just literacy and numeracy abilities are necessary to thrive in the modern world (Bourn, 2018; Care et al., 2016; Lai & Viering, 2012). Indeed, according to Care et al. (2016), essential 21st-century talents include creativity, communication, critical thinking, and problem-solving.

Problem-Based Learning (PBL), which was first created for medical education (Servant-Miklos, 2019), offers an opportunity to hone the critical abilities listed above. The core knowledge for implementing PBL in online learning environments is provided in this chapter. I provide perspectives based on the original McMaster Philosophy and its application in the fully online education studies programmes at Ontario Tech University.

## LEARNING BASED ON PROBLEMS (PBL)

PBL is a turning point in modern education, demonstrating to educators that formal education can be more than just memorising information (Servant-Miklos, 2019).

A team of creative thinkers at McMaster University took advantage of the chance to update the medical programme and created a special programme that is now a cornerstone of education around the world. The McMaster Philosophy grew through dynamic frameworks into what is known as PBL, building on concepts like system-based courses (Servant-Miklos, 2019). PBL prioritises learning above solving problems (Walsh, 2005). Instead, while interacting with their peers, issues encourage students to use their creative and critical thinking skills.

Students are then urged to acquire self-awareness and skills that enable knowledge to be used in flexible and real-world contexts (Neufeld & Barrows, 1974).

PBL is defined as “the learning that arises from the process of

working toward the understanding or resolution of a problem” by Barrows and Tamblyn (1980). (p. 1).

PBL calls for scaffolding and is analogous to learning to ride a bike. A person learning to ride a bicycle on two wheels typically begins with some additional supports, which are gradually removed to increase the rider’s need for balance. In PBL, a teacher initially supports the process while guiding it, but gradually gives the student more responsibility to achieve learning objectives, necessitating a higher level of self-efficacy.

## Learning collaboratively

Although PBL can support individual learning circumstances, it is typically a team endeavour (Pease & Kuhn, 2011). Beyond academic studies, working in a team or group is beneficial. Additional advantages of using collaborative learning (Burke, 2011).

The four main abilities linked to PBL are as follows:

- **Originality.**

While problem-solving is inherently creative, it may be made more creative by reflecting on each group member’s unique insights.

Additionally, investigating the issue can need for using knowledge in ways different from those in which it was first acquired.

- **Interaction.**

Communication is necessary to formulate a cogent response. In PBL, communication has several facets, and various tactics will be visible in various groups.

- **Critical analysis.**

With the support of critical reflection (e.g., what is known and what isn’t, who will carry out particular tasks, why an answer is relevant), collaborative learning enables students to apply findings.

- **Resolving issues.**

Students must consider the issue in depth and work through conflicting viewpoints to arrive at a response or solution.

## OVERALL DIRECTIVES

A single project or assignment, a whole course, or both may be required to put PBL into reality. The procedure in all scenarios accommodates a wide range of abilities, from technical to interpersonal.

Because of the independent and adaptable nature of student workflow, both students and teachers must be adaptive (Hillman, 2003).

## FOCUS

Educators may develop a single case study or problem at the start of a course or a number of problems during the course of the course. When presenting a single issue, it should be narrow enough to make sense in the context of the course while remaining broad enough to allow for a range of solutions that will necessitate deep thought.

The emphasis of various problems throughout a course may be on different skill sets (such as creating learning outcomes, exercises, and assessments).

If a collection of problems is scaffolded, you can start out with a number of related questions, or you can have students come up with “what comes next?” questions. For instance, a group of students may determine that a problem is too wide to understand in the allotted time, therefore they may decide to narrow their focus.

## OVERVIEW OF THE CONCEPT

The recommendations that follow serve as a flexible framework for implementing PBL in online learning settings.

### What exactly is the issue?

There are various ways to communicate a topic, including statements that offer various perspectives on a circumstance or a case study that fosters skill development in subject-related scenarios (Belt, 2018).

#### • forming a team.

Although self-selected groups may be more advantageous for students, they can also indicate higher

socialising as opposed to concentrating on the work at hand, For a fully immersive PBL experience with greater learning potential, try randomly assigning the groups or doing it yourself (Burke, 2011). Randomizing breakout sessions is a feature of many online conference platforms, which can facilitate the procedure.

#### • Establish a student cap.

Keeping groups between three and five is advised because larger groups can limit learners' opportunities to contribute and pairings may not foster different thinking (Burke, 2011).

#### • Good Issues

The issue raised should be pertinent to the subject at hand and fairly depict many potential outcomes (Hillman, 2003).

#### • Genuine.

Student interest and perceptions of relevance might be improved by considering how a scenario might have real-

life ramifications (Fogarty, 1997) Similar to that, it can assist students in comprehending situations seen in their field of study (Gibbs et al., 1994).

#### Poorly organised and unclear.

Real-life difficulties, including your suggested concerns, don't adhere to a specific set of rules (Fogarty, 1997).

Learning objectives should be distinctly stated. Before starting, students must decide what their

#### • Disperse energy.

Give educators and students the same amount of power (Childs & van Oost-veen, 2016). The procedure allows for critical reflection, which is crucial for both teachers and students to learn and develop.

• Establish ground rules for the PBL (such as a learning contract) or adhere to those provided at the start of the course.

Even a mini-PBL can be used to develop ground rules (see Activity 1 in this chapter).

#### • Keep a long view.

According to Yew and Goh (2016), PBL is a highly excellent educational method for fostering long-term memory.

Potentially painful

Continuing from the bicycle example from earlier:

There may be some road-rash if traditional learning tools, such as specific guidelines, are removed.

According to Stommel (2018), students are accustomed to performance evaluations and quantitative instruction. For some people, altering a

#### • Education is a social construction.

According to Lave and Wenger (1991), learning takes place through social processes, where knowledge is built upon insights gained from one's social and physical environment.

Small-group work can provide a comparable feeling.

Process that is formative PBL-based work may not easily lend itself to summative or final evaluation rubrics or guidelines because it is intended to help students' formative development (Neufeld & Barrows, 1974).

## KEY ROLES

• An educator is anybody in charge of directing content to meet learning objectives. Examples of educators in this context include a teacher, professor, clinician, or teaching assistant. This position—often referred to as a tutor—requires flexibility and assistance with task orientation and learner cohesiveness.

As a result, an educator doesn't take over conversations, reveal solutions, or disregard conflicts.

- A learner or student. I refer to both students and learners interchangeably throughout this chapter. If I were to make a distinction, I may say that a student is someone who is enrolled in formal education, whereas learners include people who are always learning in both formal and informal settings.

- Group a small group of students or learners linked with the goal of cooperatively exploring a common issue.

### PROCESS OF PBL

The PBL process is broken down into the seven dynamic processes listed below (Neufeld & Barrows, 1974; Walsh, 2005):

#### 1. Determine the issue.

Not a diagnosis, rather problem investigation is the learning objective. Encourage students to begin by using the Five Ws of problem-solving.

#### 2. Examine earlier insights.

Finding a range of knowledge is helpful for problem identification and critical thinking. For a deeper comprehension at this step, it is essential to clarify information and determine meaning through individual and group reflection.

#### 3. Come up with a theory.

Learners develop ideas about traits and mechanisms related to the nature of the problem by building on prior insights.

#### 4. Recognize problems.

After establishing some of the knowns, students should determine the unknowns, such as any gaps in their own knowledge or in their ability to solve the problem.

In this stage, students may also identify any gaps in their understanding of the issue at hand.

#### 5. Self-education

Frequently, rather than exploring fresh perspectives of the previously unknown, learners will withdraw to regions where they already feel comfortable.

This phase may involve taking some time on your own to consider any emotional, physical, or social gaps that might prevent you from being aware.

#### 6. Think things out again:

Reconvening, the groups discuss new information regarding the issues and their potential for finding a solution. In this stage, the tutor may serve as a facilitator to assist students in synthesising and developing 7. Concluding. In this stage, the groups consolidate their reaction or solution. Self- and peer-review or assessment will probably be useful to educators in summarising the learning experience.

### Digital technology and PBL:

Students have unique potential to improve the efficacy of

pen-and-paper PBL because to digital technologies. Unlike breakout sessions, which offer students individualised learning spaces to encourage individual learning and communication skills, a lecture hall is typically noisy and obviously crowded and recognise Recognizing that synchronous activities like breakouts aren't always practical for various student groups, cloud-based documents like Google Docs provide fantastic chances for asynchronous communication.

Having the ability to share documents also eliminates the requirement for designated note-takers because everyone in the group may examine the issue and reflect simultaneously with their peers on the same page. Likely, students will choose to communicate ideas or engage in debate via digital messaging services like text messages, Facebook, or TikTok.

The availability of high-quality information to students that might not otherwise be available in traditional libraries or lecture rooms is also increased through digital library hubs, Google Scholar. Diverse delivery modalities are also supported by the incorporation of digital tools.

One instance is using case studies that depict real-life or simulated occurrences using video or multi-timedia (van Oostveen et al., 2019). Teachers can provide video case studies that depict real-world issues.

In the activities section, I expand on the idea of having students create a video-based case study that they can then present to their peers. With cameras being a standard, the process of creating videos has become much more timely and accessible. a cellphone accessory, Additionally, current developments can elevate video-based case studies, giving specialists in a variety of subjects, including physics and English as a foreign language, the chance to participate in immersive encounters through augmented and virtual reality (Chen et al., 2021; Fidan & Tuncel, 2019; Jivram et al., 2021).

### Breakout sessions on the internet:

A key component of the collaborative PBL process is breakout sessions. Students can participate in peer learning groups that are small, face-to-face, and online using tools like Google Meet, Microsoft Teams, or Zoom. Three recommendations for productive group sessions are listed below (Burgess et al., 2020; Thrall et al., 2016; Ulfa et al., 2021):

#### 1. Control but don't command:

By moving between breakout rooms, responding to direct inquiries, providing clarification, and igniting conversation, you can keep up your teaching presence. Give your students the reins to steer and lead the discussion.

#### 2. prompt feedback:

Your capacity to respond and offer timely criticism can boost participation and lessen the likelihood of pupils wandering off task. 3. Student self- and peer-assessment promotes student self-efficacy (Liu et al., 2018; Mao & Peck, 2013) and offers insights into learning.

To help students grasp expectations and stay informed, think about routinely gathering and reflecting on student insights.

Potential Obstacles

**Implementing PBL in online settings might provide four common difficulties, including:**

### 1. Requirements for technology:

Students who participate in online learning may have varying access, whether it be totally or partially online (for instance, due to family technology use, geographic location, or financial resources).

### 2. The tutor or professor goes too far:

In PBL scenarios, students must take the initiative, therefore educators must be active players rather than the leaders (Walsh, 2005).

### 3. Less useful for quick learning:

While PBL has numerous benefits, short-term learning is not probably one of them. Over the course of a course, PBL fosters the development of creativity, communication, critical thinking, and problem-solving.

### 4. Variations in how things are done:

Yew and Goh (2016) found a variety of PBL tactics in several academic domains after reviewing prior studies. I suggest giving these suggestions some thought and modifying them to fit your needs.

### STARTING POINTS :

- Canva is a drag-and-drop multimedia editing software that enables anyone, regardless of technology proficiency, to create aesthetically appealing presentations, movies, infographics, and more.
- LabXChange is a free platform that offers collaborative STEM labs for low-stakes (as in, things don't go boom in real life) experimentation and problem-solving. There are limitations with the free edition and multiple plans to match your needs. Social media platforms include a variety of material kinds (such as text-only or multimedia information) as well as chances for introspection on and sharing of current issues.

### IMPLEMENTING 21ST-CENTURY SKILLS IN ONLINE ENVIRONMENTS THROUGH PROBLEM-BASED LEARNING 178:

- Real-time collaboration and feedback are possible with synchronised document platforms like Google Workspace and Microsoft 365, which are frequently provided by the school board or other organisation.
- Opportunities to gather unusual circumstances or case studies on a variety of topics are offered through TedTalks and TedEd.

- If you're having trouble coming up with questions, turn to The Knowledge Compass.

- Thinkrolls is a paid app that encourages the growth of critical thinking abilities in children ages three to eight.

### ACTIVITIES

Establishing a Rubric, An Introduction to PBL, Activity 1 Overview

By co-creating the rules for the term, we as teachers may fully immerse students in a PBL experience through a small-scale activity in the first and second classes.

For a PBL curriculum that is entirely online, the ground rules serve as a learning contract or rubric that will direct peer and self assessment.

An added benefit of using a common goal as an icebreaker at the beginning of a course is that students get more involved.

### Description

By answering the question, What aspects will you need to consider to make this work?, you will be required to fill in the details for this task in the spirit of PBL.

(for instance, period, topic, or technological platform).

The general procedure is as follows:

### First Step

1. Outline the learning objectives and how they relate to the discipline.
2. Collect group opinions
3. Create a rough timetable for the class (Note: I like this concept since it includes modelling the anticipated attention to detail), but be prepared to modify it as the class goes on.
4. Describe the issue.  
You may utilise a sequence of questions such, "Considering the learning outcomes, what do you expect from yourselves? What do your peers expect from you? What do we anticipate from our tutor, instructor, TA, or education assistant?"
5. Establish early self-efficacy.  
Inform the students that they must locate the course outline in the learning management system (LMS) and jot down or type the questions for later reflection.
6. Give technical information, such as your breakout session connection information.  
The specifics shouldn't be included in the activity but should aid in student performance.

7. Assign students to groups.  
By selecting breakout rooms at random, divide students into groups of

8. Tour the space and ask questions.

9. Conclude the breakout discussion.

10. Be prepared for uncertainty because it's likely that students won't know how to create a rubric.

11. Initiate a discussion regarding the data that students believe they require in order to provide more accurate answers.

Alternately, ask them to consider what they believe they know. It might be helpful to use a Jamboard in this situation.

12. Restart the breakout sessions with fresh randomised groupings so that students interact with different people.

13. Regroup and write the thoughts from each group on the Jamboard.

14. Offer examples of rubrics and advice on how to create them as homework.

## Second Step

1. Talk about the kids' fresh perspectives on rubrics.

Example 2.

the previous Jamboard, please.

3. Start breakout sessions with randomized students.

4. Revise previous insights. Students develop a rubric based on the last session and their new insights in this step.

5. End breakouts.

6. Pitch. Each group shares their rubric and outlines why they think it's a good idea.

7. Vote. Students vote on what they believe is a challenging but reasonable set of expectations for the term.

8. Collect the responses and add them to the course outline or learning shell.

## Future Steps

- Have students evaluate their own participation in an activity using the criteria as a guide.
- Use the rubric for self and peer evaluation at least once before the course is over (for example, during the midterm).

## Potential Obstacles

- Some students can feel left out if they miss the first class.
- If students do not participate, this process may last longer than expected.
- The components of the jointly formed rubric might not lead to challenging expectations.

Resources Rubrics are useful assessment tools, according to the Centre for Teaching Excellence at the University of Waterloo. Rubrics are also tools for making learning objectives and evaluation criteria clear for both teachers and students, according to the CBE—Life Sciences Education.

How to utilise breakout rooms with Zoom, Microsoft Teams, and Google Meet.

## PROBLEM-BASED LEARNING OBJECTS: ACTIVITY 2 (PBLOS)

### Overview

Shareable digital multimedia modules known as “problem-based learning objects” (PBLOs) are transmitted through a variety of platforms, including spreadsheets, websites, and presentation software.

Essentially, PBLOs are made up of video case studies and related materials that offer a vague situation in an effort to elicit thought and conversation.

Students gather, create, and share information in order to find solutions that are appropriate for the challenge at hand.

In synchronous or asynchronous learning environments, educators might utilise the objects to offer case studies that focus on solving problems.

The latter has served as a foundational experience for BA students in Ontario Tech's education programme for more than ten years.

A platform for collaborative online learning, PBLOs are built on the Fully Online Learning Communities (FOLC) framework. The framework encourages cooperation, co-creation of a digital area, and social and cognitive presence (Blayone et al., 2017).

The development and deployment of PBLOs will benefit from a dynamic reflection between the stages and steps, despite the fact that we have shared a streamlined process here.

### Description

Groups of students will learn how to position themselves for autonomous study that emphasises genuine, collaborative, and multidisciplinary work in this two-stage activity. There are three development phases in a PBLO's first stage.

#### 1.1 Examination.

A topic and scenario are developed from an actual learning experience. The example should be pertinent to the students and should cast doubt on any preconceived notions they may have, encouraging more autonomous learning.

#### 1.2 Conversation.

The goal of educator-based PBLOs is to promote student discourse.

The dialogue that follows can encourage critical reflection to direct prospective adjustments. For learner-based PBLOs, the objects are created through numerous group meetings (weekly, for example, if the PBLOs last for an entire term).

sivity, test one's own assumptions, and investigate original concepts.

### 1.3 Production

Consider the scenario's objective and how to create a circumstance that piques interest before moving on to Stage 2.

Being upfront and presenting a problem without expressing bias is difficult Second stage: execution

The creation of the four-part item is the main emphasis of stage two.

The scale of this approach makes it ideal for development over a longer period of time, like a semester, but it may also be adjusted for shorter times.

#### 2.1 Case study with video.

Here, the intention is to arouse thought and persuade the audience to put themselves in the situation being portrayed. Use the closed captions to embed the video. The material contains.

A video-based case study with an authentic problem and room for viewer interpretation; a title/topic; 4-5 analytical questions to prompt and provide context for inquiry; a transcript; and a brief description of the video clip's environment.

#### 2.2 Background knowledge.

For the video case study on page 1, our objective is to offer more context and perspective. The content contains resources and supplemental materials for the video and video references.

#### Theoretical perspective.

By presenting material that encourages critical inquiry from numerous angles, this page or section aims to help readers see the original issue from a fresh viewpoint. Unorganized material that encourages critical thought about the issue (no more than 400 words) is included in the content, along with fresh sources and references that can be used to create unique insights.

2.4 The concluding page or section, or "synthesis," offers the chance to share, talk about, and argue about solutions and reflections.

Learners must exercise both creative and critical thinking in this situation.

- Repetition of 2.1 with synthesis questions in place of

analytical questions.

- The questions should be used by the students to facilitate group discussions on their observations and points of view.

#### Potential Obstacles

- Posing difficulties.

Traditional learning outcomes include succinct, structured information that leads to clear solutions.

Students may initially find it difficult to construct poorly constructed situations that provide more questions than solutions.

- Making of videos.

It's possible that students have never made a video of this kind, necessitating skill development that wasn't anticipated when the assignment was planned.

I suggested that Long before the deadline, you drop indications about the difficulty.

Resources • Problem-based learning objects as a step toward rethinking online teacher professional development

AEDT1110 PBLO PBL Scenario A; Problem-Based Learning Objects (PBLO) slideshow

#### ADVANCED RESOURCES

- Roland van Oostveen: Problem-Based Learning Online Teaching, the FOLC Model, and More [74 min.].

- Sample syllabi, evaluation forms, and sample problems are all available in the U of Delaware PBL Resources.

- Problem-Based Learning: A Guide for Librarians, Faculty, and Students (Digital Pedagogy)

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An overview is provided by the University of Toronto's research guides.

- Problem-Based Learning: The Wiley Handbook

#### References

1. Barrows, H. S. & Tamblyn, R. M. (1980). Problem-based learning: Rationale and definition. In, Problem-based learning: An approach to medical education. Springer.
2. Belt, S. (2015). Problem based learning (PBL)-A case study from environmental sciences. Planet, 4(1), 17-18. <https://doi.org/10.11120/plan.2001.00040017>

3. Blayone, T.J., van Oostveen, R., Barber, W., DiGiuseppe, M., & Childs, E. (2017). Democratizing digital learning: Theorizing the fully online learning community model. *International Journal of Educational Technology in Higher Education*, 14, Article 13. <https://doi.org/10.1186/s41239-017-0051-4>
4. Bourn, D. (2018). Understanding global skills for 21st Century professions. Palgrave Macmillan. <https://doi.org/10.1007/978-3-319-97655-6>
5. Burgess, A., van Diggele, C., Roberts, C., & Mellis, C. (2020). Team-based learning: design, facilitation and participation. *BMC Medical Education*, 20(2), 1-7. <https://doi.org/10.1186/s12909-020-02287-y>
6. Burke, A. (2011). Group work: How to use groups effectively. *Journal of Effective Teaching*, 11(2), 87-95. <https://files.eric.ed.gov/fulltext/EJ1092109.pdf>
7. Care, E., Anderson, K., & Kim, H. (2016). Visualizing the breadth of skills movement across education systems. Center for Universal Education at the Brookings Institution. <https://www.brookings.edu/research/visualizing-the-breadth-of-skills-movement-across-education-systems/>
8. Chen, C. H., Hung, H. T., & Yeh, H. C. (2021). Virtual reality in problem-based learning contexts: Effects on the problem-solving performance, vocabulary acquisition and motivation of English language learners. *Journal of Computer Assisted Learning*, 37(3), 851-860. <https://doi.org/10.1111/jcal.12528>
9. Childs, E., & vanOostveen, R. (2016). Moving beyond read, post, repeat in online courses: the integration of PBL methodologies into online learning courses and programs. In Canadian Society for the Study of Education Annual Conference.
10. Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem based learning: The effects on learning achievement and attitude in physics education. *Computers & Education*, 142, Article 103635. <https://doi.org/10.1016/j.compedu.2019.103635>
11. Fogarty, R. (1997). Problem-based learning and other curriculum models for the multiple intelligences classroom. Corwin. 183 CHRIS D CRAIG
12. Gibbs, G., Rust, C., Jenkins, A., & Jaques, D. (1994). Developing students' transferable skills. The Oxford Centre for Staff Development, Oxford Brookes University.
13. Hillman, W. (2003). Learning how to learn: Problem based learning. *Australian Journal of Teacher Education*, 28(2), 1-10. <https://doi.org/10.14221/ajte.2003v28n2.1>
14. Jivram, T., Kavia, S., Poulton, E., Hernandez, A. S., Woodham, L. A., & Poulton, T. (2021). The development of a virtual world problem-based learning tutorial and comparison with interactive text-based tutorials. *Frontiers in Digital Health*, 3, Article 611813. <https://doi.org/10.3389/fdgth.2021.611813>
15. Lai, E. R., & Viering, M. (2012). Assessing 21st Century skills: Integrating research findings. Pearson. [http://images.pearsonassessments.com/images/tmrs/Assessing\\_21st\\_Century\\_Skills\\_NCME.pdf](http://images.pearsonassessments.com/images/tmrs/Assessing_21st_Century_Skills_NCME.pdf)
16. Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511815355>
17. Liu, X., Li, L., & Zhang, Z. (2018). Small group discussion as a key component in online assessment training for enhanced student learning in web-based peer assessment. *Assessment & Evaluation in Higher Education*, 43(2), 207-222. <https://doi.org/10.1080/02602938.2017.1324018>
18. Mao, J., & Peck, K. (2013). Assessment strategies, self-regulated learning skills, and perceptions of assessment in online learning. *Quarterly Review of Distance Education*, 14(2), 75-95. <https://eric.ed.gov/?id=EJ1144843>
19. Neufeld, V. R., & Barrows, H. S. (1974). The "McMaster Philosophy": An approach to medical education. *Academic Medicine*, 49(11), 1040-50.
20. Pease, M. A., & Kuhn, D. (2011). Experimental analysis of the effective components of problem-based learning. *Science Education*, 95(1), 57-86. <https://doi.org/10.1111/jcal.12528>

org/10.1002/sce.20412

22. Servant-Miklos, V. F. (2019). Fifty years on: A retrospective on the world's first problem-based learning programme at McMaster University Medical School. *Health Professions Education*, 5(1), 3-12. <https://doi.org/10.1016/j.hpe.2018.04.002>
23. Stommel, J. (2018). How to ungrade. <https://www.jessestommel.com/how-to-ungrade/>
24. Ulfa, Y., Igarashi, Y., Takahata, K., Shishido, E., & Horiuchi, S. (2021). A comparison of team-based learning and lecture-based learning on clinical reasoning and classroom engagement: a cluster randomized controlled trial. *BMC Medical Education*, 21(1), 1-11. <https://doi.org/10.1186/s12909-021-02881-8>
25. Thrall, Coverdale, J. H., Benjamin, S., Wiggins, A., Lane, C. J., & Pato, M. T. (2016). A Randomized controlled trial of team-based learning versus lectures with break-out groups on knowledge retention. *Academic Psychiatry*, 40(5), 755-760. <https://doi.org/10.1007/s40596-016-0501-7> vanOostveen, R; Desjardins, F., Bullock, S., (2019). Professional development learning environments (PDLEs) embedded in a collaborative online learning environment (COLE): Moving towards a new conception of online professional learning. *Education and Information Technologies*, 24(2), 1863-1900. <https://doi.org/10.1007/s10639-018-9686-6>
26. Walsh, A. (2005). The tutor in problem based learning: A novice's guide. McMaster University. [https://health-sci.mcmaster.ca/docs/librariesprovider125/partners—resources-perks/novice-tutor-guide-2005.pdf?sfvrsn=824ab32a\\_2](https://health-sci.mcmaster.ca/docs/librariesprovider125/partners—resources-perks/novice-tutor-guide-2005.pdf?sfvrsn=824ab32a_2) PROBLEM-BASED LEARNING: DEVELOPING 21ST CENTURY SKILLS IN ONLINE ENVIRONMENTS 184Yew, E. H., & Goh, K. (2016). Problem-based learning: An overview of its process and impact on learning.
27. *Health Professions Education*, 2(2), 75-79. <https://doi.org/10.1016/j.hpe.2016.01.004>