The Case of the Crowded Sidewalks: Implementing and Assessing Problem-Based Learning in Higher Education

Vincent Genareo

Salisbury University

Corresponding author: VRGENAREO@salisbury.edu

Abstract

This paper provides a scenario of Dr Picksie, an urban engineering instructor in an institute of higher education. Frustrated with the lack of student engagement and authentic, interactive, collaborative pedagogy, he tries Problem-Based Learning (PBL). By following steps of implementing and assessing PBL, he successfully leads his class through their first PBL case, The Case of the Crowded Sidewalks, and gives students the confidence and knowledge to continue more complex PBL problems throughout the semester. Although fictitious, the instructor in this scenario represents a compilation of concerns, successes, confusions and frustrations voiced by faculty and students in higher education through the authors' professional development workshops, teaching, and research studies.

Keywords: Problem-Based Learning, PBL, instructional design, collaboration, problem solving, pedagogy

1

Introduction

Dr Picksie, an urban engineering instructor at a public university, learned about Problem-Based Learning (PBL) in a webinar last summer. Excited about its potential to develop students' problem solving strategies, collaborative abilities and content knowledge, he tried implementing PBL in his introductory class during the fall semester. He introduced an ill-defined problem to his students, which was complex and had multiple potential solutions (Hung et al, 2003). His students spent six class sessions researching the problem, developing research-informed solutions, creating an interactive website with their findings, and presenting to the class.

Unfortunately, the PBL process did not go as planned. His students, like many in higher education, were unprepared for this type of independent learning and critical thinking (Wiggins et al., 2016). In addition to performing research on a complex issue, they needed to work in groups and communicate effectively. All of these high-level skills made some students uncomfortable, confused and discouraged. If only the students had some experience with these activities prior to diving into such a complicated process. Dr Picksie eventually wanted to make his courses completely problem-based, so he needed to figure out a way to better prepare students early this semester to be thinkers, researchers, collaborators and problem solvers.

Problem-Based Learning background

The concept of traditional higher education, involving lectures, notes and tests, is becoming less relevant as modern careers typically require more sophisticated levels of higher order and critical thinking (Darling-Hammond, 2010). There is more demand than ever for higher education to prepare students to analyze information and implement reasoning skills (Dubas & Toledo, 2016). Problem-based learning can help prepare for these. It was originally developed by Barrows (1980) to help medical students move away from rote memorization and engage with the content in meaningful ways. In PBL, students are presented with authentic, ill-structured problems that require research and critical analysis to fully understand and solve (Hung, 2006). Students then collaboratively research and solve problems under the guidance of the teacher (Barrows, 1986).

Problem-Based Learning is considered a student-centered, self-directed instructional strategy, in which students construct meaning of content based on their interactions with data and social negotiations (Hmelo-Silver, 2004; Savery & Duffy, 2001). It can

assist students in developing metacognition, or the ability to learn about themselves as learners and thinkers (Gijbels et al, 2005). As students propose hypotheses to solve problems, identify gaps in their knowledge, fill the gaps with research, and refine solutions, they can acquire complex cognitive processes that can be transferred to other contexts and courses (Barrows & Tamblyn, 1980; Hmelo-Silver et al, 2009). An additional benefit of PBL is its performance nature, because students often present their findings. It meets current calls for a greater number of evidence-based performance assessments in colleges and universities (Pereira et al, 2016).

There is a plethora of literature available about the potential benefits of PBL-based instruction across many subject areas (Williams & Paltridge, 2016). Although PBL can be managed in lecture courses (Wijnen et al, 2016), and can be assisted with technology (Fukuzawa & Boyd, 2016), a major obstacle is its implementation. It can be time consuming to plan, and more ambiguous in nature than instructors are comfortable with (Genareo et al, 2015a), particularly for new instructors unfamiliar with the process (Newble & Cannon, 2013; Onyon, 2012). There are also many forms and models of PBL (Wiggins et al., 2016). The following scenario follows the PBL implementation and assessment steps proposed by (Genareo and Lyons, 2015b) to facilitate an instructor's successful first experience with PBL in the classroom.

Phases of the PBL process

Dr Picksie took great care in the PBL planning and implementation this semester. He planned his PBL in six phases. First, he identified learning outcomes in his course that would fit with PBL and then planned his assessments. He wanted to ensure that his students got all of the information they needed early on, including the expectations and grading rubrics. Then, he designed the problem scenario that would lead students to develop the skills and knowledge he intended. Next, he introduced PBL to his class and they performed research on and developed solutions for the problems they identified. They developed a product and performance to demonstrate their learning. He assessed their work formatively, but did a final assessment of their product and presentation during the third class session.

Learning outcomes

The first step of PBL, as with all instructional planning processes, was for Dr Picksie to identify learning outcomes from his course that would be addressed. Since this course was one of several sections that were taught in his department, he was unable to write

new learning objectives without consulting all instructors and the director of undergraduate studies. However, he knew that PBL best fits with process-oriented objectives, such as collaborating, researching, analyzing, applying knowledge and writing. Generally, objectives that begin with verbs such as, "list," "describe," "define" or "explain" may not fit PBL, since they are often more efficiently assessed through written assignments, quizzes or tests. One of his objectives seemed to offer promise for PBL: *The students will conduct research using scholarly work, websites and data to develop a strategic plan for institutional change.*

Next, Dr Picksie designed formative and summative assessments. Typically, instructors who use PBL, or tutors, as they are often referred to (Williams & Paltridge, 2016), use a variety of formative assessments. These can include resource checks, writing drafts, students' learning self-reflections, or self- or peer-evaluations. He knew that peer evaluations can be an especially valuable learning tool for students (Yousef et al., 2015). Since this PBL would only be three class sessions long, he chose to have students turn in reflections at the end of the first two classes, on which students wrote a page regarding what they were learning, brief summaries of the research they had found, and what they still needed to research.

Dr Picksie also needed to develop a summative assessment. Given the short timespan, he elected to have the groups create a one-page handout with a brief introduction to their problem, a short background section of the research they found, a solution, and resources. They needed to include a systematic description of the solution, the research that informed the solution, the potential obstacles in implementation, and its economic, environmental, cultural and resource implications. He decided it best to give the groups 10 minutes to present their handout to the class, and allow the class five minutes for questions, grading both the brochure and presentation with a rubric.

Scenario design

In PBL, students are presented with a scenario that has an embedded problem for which students can discuss, research, and propose solutions. Dr Picksie knew that the scenario needed to be motivating and interesting. Since PBL is student-driven, the students' interest must be piqued enough to want to investigate and research. The scenario should also be authentic, or related to the real world of the students and the discipline (Marra, Johassen, Palmer, & Luft, 2014). He also knew that scenarios that generated some level of controversy were more intriguing and would produce more lively discussion among students.

As he thought about his discipline, urban engineering, Dr Picksie realized there are countless engineering problems that could be researched and solved by the students. As an introduction to PBL, and because of the short timeframe, he felt it would be best if the problem was ill-defined, but not too complex. He needed to make sure it could address his course learning objectives, help students develop content knowledge in his subject and was relatable to their lives and interests. Resultantly, he developed *The Case of the Crowded Sidewalks.*

The scenario he created needed to have a recognizable problem within, but did not state the problem outright. Since it was imbedded within a contextualized scenario, the students would need to figure out what the problem was on their own, initially using only the given information. The case he created read:

> The sidewalks around your campus get *really* crowded during some times of the day. Your job is to propose a solution to the crowding that takes into account all potential physical, economic, and environmental implications of the solution. In your groups, think about what's *causing* the crowding. Brainstorm ideas and come up with an initial problem statement (single sentence) that tells us what the problem is. Then, come up with a hypothesis for what you think the best solution to this problem is, at this point. You will be researching the problem more, so keep in mind that your solution hypothesis, and even your problem, may very well change as you learn more. Don't forget our engineering concepts we have discussed so far, and use your textbook as a starting point.

He printed copies of his case for each student in his class so they could read it, process it, and then discuss it within small groups.

Introduce PBL to the class

Problem-Based Learning requires that students work collaboratively (Savery & Duffy, 2001). Prior to class, Dr Picksie put his students in groups of five. Since Dr Picksie did not yet know his students well, he grouped them randomly. Typically, one or more students (out of the 15 students enrolled this semester) would likely drop the class early in the semester. Even if two students in a group dropped during this PBL introduction, there would still be three students remaining, which was enough to complete it. Because he only had three groups, he could also devote more time in class to facilitating brainstorming, asking questions, and recommending research areas.

Dr Picksie came prepared with detailed handout packets for students, which included the printed scenario, his expectations for their writing and group work, a short rubric for the written product and presentation and a timeline of the three-day PBL process. In doing this, he was able to help keep them on track, minimize confusion, and offer tangible information for students to reference. After all, many of their other courses were large lecture courses and most students had never experienced this type of instruction in higher education.

Once his students came into class, Dr Picksie explained the purpose of the assignment, his expectations for their work and the PBL rubrics. After he displayed their groupings on the board, he asked students to move into their groups and allowed a few minutes for students to greet one another and exchange contact information. He then read through the scenario aloud as the students followed along at their tables.

The students nodded in agreement and laughed as they read about the crowded sidewalks. It was clearly something they experienced and also felt was a problem worth solving. He then asked if any students had ever watched medical dramas on television, and a majority raised their hands. Dr Picksie let his class know that in these shows, just like in this case, the crowded sidewalks were not the problem. The crowding was akin to the *symptom*, and their job was to find out the *disease* that was causing the crowding.

He then gave students time to brainstorm and provided them a handout to be completed and turned in at the end of class. The handout asked them to write the problem statement their group agreed upon and a hypothesis of what they thought the solution might be (or, the solution hypothesis). Then, they would write: 1) Everything they know about the topic, 2) What they still need to find out to fully understand the context, and 3) Student research responsibilities within the group. In doing this, he was helping them develop self-guided learning strategies and metacognition. Since they were allowed to collaborate, group members could share their previous knowledge about the topic and ideas about the types of information they would need to know to confirm, disprove, or modify their solution hypotheses. They also divided up the research topics among group members and wrote them down, turning in a copy for Dr Picksie and one for each group member.

After reading through the scenario, the group members discussed what they felt the problem to be and wrote it as a single sentence problem statement. They also developed an initial hypothesis to solve the problem. Group One initially wrote, "The

crowded sidewalks are an indicator that people did not follow the unspoken rules of walking on sidewalks," and the solution hypothesis was simple: paint lines on the sidewalks, like those on a street. They still needed to find out how lines are painted on streets, the effects it would have on bicyclists, and the ramifications of shutting down the sidewalks for painting. Dr Picksie asked them to think about the costs and benefits of doing so. Group One began discussing their points.

Group Two initially proposed that the problem was with course scheduling. They wrote, "The reason the sidewalks get crowded is because courses all get out at the same time during peak class times." Their initial solution hypothesis was to make all non-major, required courses online instead of lecture-format. They still needed to find out information about the logistics and economic factors involved in offering online courses, as well as the required technology and instructor training.

Group Three's problem statement was, "There are too many students on the sidewalks on campus because the enrollment rates are too high." Their solution hypothesis was for the university to raise their enrollment standards so fewer students would get accepted. They still needed to find out information about the current enrollment requirements, current enrollment rates, costs of admitting fewer students, and comparative data of similar universities.

During this brainstorming session, Dr Picksie helped facilitate some discussion amongst group members. He listened and asked many questions, particularly related to why they believed the hypothesis to be true and where they would find information they needed. Group Two was unsure where to find information about scheduling, so Dr Picksie recommended contacting the university's Office of the Registrar as a starting point. He also asked if they thought it would be helpful to look up enrollment information about courses to find out when the peak walking time occurred during the day.

Research

Dr Picksie next brought his class to the library. Since a librarian had spoken to his class, he was confident they were familiar with academic research, which proved only partially true. As he walked through the rows of computers, he noticed several students checking websites that had potentially inadequate data, and guided them to the library's searchable databases. He also suggested his students take diligent notes about the keywords and databases they searched, resources they found, and a summary of findings. Each student also printed a full copy of at least five relevant resources related

to their assigned topic area and produced a summary of their findings for their group meeting the next class session. At the end of the class session, they turned in a short reflection about their comfort in researching, the information they were learning, the research they had found thus far, and what they still needed to do to prepare for the next class session.

During the next class meeting time, he directed the groups to discuss the information they found, focusing on whether their data supported the problem and/or hypothesis they proposed. Students in Group One found that they simply could not find information that could verify the problem or solution they proposed about walking etiquette, since walking etiquette often varied by culture and institution. One group member found some interesting information about the width of sidewalks contributing to sidewalk crowding in metropolitan areas. Based on this, they changed their problem statement to reflect that the width of the sidewalks was too narrow, and proposed a solution to widen the sidewalks on campus.

Students in Group Two brought back information they found about online courses, and quickly discovered that it simply was not feasible to implement all required courses online. One group member talked to a university technology assistant and the cost estimate of upgrading the technology and training faculty was in the millions of dollars. This cost was simply too high to be a feasible solution. They then changed their solution hypothesis to rescheduling some of the large courses, and went back to the library during class time to find further information.

After reading through all group members' findings, members of Group Three were confident in their problem statement and solution hypothesis, and worked to put the information they found together in a "background section" for their handout and presentation. Dr Picksie guided them to develop thematic sections with short, cited narratives, and gave advice on their academic writing. Groups Two and Three were able to finish their handout and plan their presentation during this class session.

Group One was able to find information that helped support and inform the students' problem statement and solution hypothesis, but they were unable to finish their handout in class. Dr Picksie set up a group wiki on the university's grading platform to allow them to communicate outside of class. However, they were more comfortable connecting by cellphone texts and social media, and used Google Docs to collaborate and create their handout remotely. At the end of the second class session, the students turned in a short reflection paper which asked them what they had accomplished during the day, what

information they found, how they were contributing to their group's success, and their confidence to present their handout by class sessions three.

Product/performance

During the third class session, the groups gave each member of the class their handouts and presented to them. The handout and presentation included an introduction to the problem, a background of information (including the research they found), their solution, and resources. Because this activity was meant to introduce students to the PBL process so they could be successful later with more complex PBL scenarios, Dr Picksie chose not to make the requirements as rigorous as he would later on. He knew that for a more involved PBL process with more thorough research, he would require them to include a section describing their research methodology. For future PBL scenarios, he felt it would be best for groups to also develop and consider multiple solutions, and then choose a best solution, describing the benefits and obstacles of each. But that was simply too much at this point; his students were still learning. Although Dr Picksie was pleasantly surprised that the groups collaborated well, found relevant research data and presented their information well, each group still missed valuable information that would have better informed their solutions.

Group One developed a solution that the sidewalks should be widened during the summer to accommodate the pedestrian traffic. They interviewed the director of Grounds and Landscaping at the university and produced a budget proposal based on a construction estimate for concrete and labor. This solution was infeasible, though, because the students failed to look into the historic trees that would need to be cut down to do this, and the fact that the sidewalks narrowly ran through two buildings at one point and could not be widened there.

Group Two proposed a solution that the large, required classes needed to be rescheduled so they would not be adjourning at the same time. The group found data about course enrollment during the peak times of the day, as well as some policy literature on scheduling classes in higher education. While this solution was a possibility, the group failed to talk to anyone at the registrar's office to look into this possibility, even after Dr Picksie suggested they do so. Additionally, they forgot to look into the number of available lecture halls on campus. As a result, while the solution seemed potentially effective, it was not informed by the real context of the university planning and its potential obstacles could not be ascertained.

Group Three developed a solution that enrollment rates needed to be more stringent because the crowded sidewalks were an indicator of an excess of students. They found data about enrollment and acceptance rates over the previous decade, enrollment rates at similar universities, and even interviewed some department chairs about their thoughts on the issue. However, Group Three group failed to take into account the economic factors of student enrollment, the mission of the university, and the state's vision for higher education in its public universities. Missing these important factors made their solution ill informed.

All three groups developed solutions that seemed to them possible, but none considered the full context of the case and implications for implementing their solutions. As an introductory activity into PBL, the instructor was able to lead a post-process discussion about these issues. He also provided a written summary of feedback for each group on their online learning platform that helped them realize the information they found was simply not enough to truly inform and verify their solutions.

Assessment

In the end, *The Case of the Crowded Sidewalks* gave students the opportunity to learn the steps that would be involved in more intensive PBL that Dr Picksie would be using throughout the semester. Dr Picksie required his students to turn in a written reflection on the first and second class sessions which asked them to consider what they were learning, the research they were finding, and had them summarize the resources they were using. Through doing this, he was able to keep track of their learning process and monitor students to ensure they were contributing to their group's success.

Dr Picksie was able to assess the product they created (the handout), the performance (their presentation), the content they found (the resource information), and their solutions (the solution feasibility). He used a rubric to assess that the product and presentation clearly communicated the background research, solutions and resources. He also evaluated the presentations to ensure that everyone participated meaningfully and communicated effectively. He assessed the solutions for feasibility and that they were informed by their research. Since it was most of the students' first time learning in this way, he was more concerned that they were learning how to collaborate, research, and think critically than that their solutions were perfect. That might come with time and practice.

Conclusion

Dr Picksie created The *Case of the Crowded Sidewalks* to introduce his class to the process of undertaking PBL. He had more intensive problem scenarios planned throughout the semester, so he only used three class sessions to help his students learn how to become self-directed and metacognitive learners. While the students did not propose perfect solutions, largely due to inexperience and time limitations, the PBL process and feedback Dr Picksie provided would help them become more reflective critical thinkers and self-directed learners. As an added bonus, the students in his class personally connected and became more comfortable with one another early in the semester, which made them more willing to share in class discussions and support one another throughout the course.

The previous semester, Dr Picksie attempted to have his class start with a very complex scenario, and it did not go well. After using *The Case of the Crowded Sidewalks* to introduce students to PBL, he was confident that these three class sessions were not in vain; his class addressed concepts required as part of one of his course learning outcomes and were more prepared to tackle more involved problems afterward. This gave Dr Picksie the confidence as an instructor to begin developing his courses to be more problem-based, authentic and engaging.

References

Barrows, H. S. (1980). *Problem-based learning: An approach to medical education*. Springer Publishing Company.

Barrows, H.S. (1986). A taxonomy of problem-based learning methods. *Medical Education, 20*, 481-486.

Barrows, H. S., & Tamblyn, R. M. (1980). *Problem-based learning: An approach to medical education*. New York, NY: Springer.

Darling-Hammond, L. (2010). *The flat world and education: How America's commitment to equity will determine our future*. Teachers College Press.

Dubas, J. M., & Toledo, S. A. (2016). Taking higher order thinking seriously: Using Marzano's taxonomy in the economics classroom. *International Review of Economics Education, 21*, 12-20.

Fukuzawa, S., & Boyd, C. (2016). Student engagement in a large classroom: Using technology to generate a hybridized problem-based learning experience in a large first year undergraduate class. *The Canadian Journal for the Scholarship of Teaching and Learning*, *7*(1), 7.

Genareo, V. R., Sansale, A. J., Zidon, M. M., & Adjei-Boateng, E. (2015a). Implementing student-generated problem-based learning in teacher education. *Journal of Scholastic Inquiry: Education, 5*(1), 73-104.

Genareo, V. R., & Lyons, R. (2015b). Problem-based learning: Six steps to design, implement, and assess. *Faculty Focus: Higher Ed Teaching Strategies from Magna Publications*. Retrieved from:
https://www.facultyfocus.com/articles/instructional-design/problem-based-learning-six-steps-to-design-implement-and-assess/

Gijbels, D., Dochy, F., Van den Bossche, P., & Segers, M. (2005). Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of Educational Research, 75*(1), 27-61.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235-266.

Hmelo-Silver, C. E., Derry, S. J., Bitterman, A., & Hatrak, N. (2009). Targeting transfer in a STELLAR PBL course for preservice teachers. *Interdisciplinary Journal of Problem-Based Learning, 3*(2), 24-42.

Hung, W. (2006). The 3C3R Model: A conceptual framework for designing problems in PBL. *The Interdisciplinary Journal of Problem-based Learning, 1*, 1-21.

Hung, W., Harpole Bailey, J., & Jonassen, D. H. (2003). Exploring the tensions of problem-based learning: insights from research. *New Directions for Teaching and Learning*, *2003*(95), 13-23.

Marra, R. M., Jonassen, D. H., Palmer, B., & Luft, S. (2014). Why problem-based learning works: Theoretical foundations. *Journal on Excellence in College Teaching*, *25*(3-4), 221-238.

Newble, D., & Cannon, R. (2013). *Handbook for teachers in universities and colleges*. Milton Park, Abingdon: Routledge.

Onyon, C. (2012). Problem-based learning: A review of the educational and psychological theory. *The Clinical Teacher*, *9*(1), 22-26.

Pereira, D., Flores, M. A., & Niklasson, L. (2016). Assessment revisited: A review of research in assessment and evaluation in higher education. *Assessment & Evaluation in Higher Education*, *41*(7), 1008-1032.

Savery, J. R., & Duffy, T. M. (2001). *Problem based learning: An instructional model and its constructivist framework*. Bloomington, IN: The Center for Research on Learning and Technology.

Wiggins, S., Chiriac, E. H., Abbad, G. L., Pauli, R., & Worrell, M. (2016). Ask not only 'What can problem-based learning do for psychology?' But 'What can psychology do for problem-based learning?' A review of the relevance of problem-based learning for psychology teaching and research. *Psychology Learning & Teaching*, *15*(2), 136-154.

Wijnen, M., Loyens, S. M., Smeets, G., Kroeze, M., & van der Molen, H. (2016). Comparing problem-based learning students to students in a lecture-based curriculum: learning strategies and the relation with self-study time. *European Journal of Psychology of Education*, 1-17.

Williams, J. C., & Paltridge, D. J. (2016). What we think we know about the tutor in problem-based learning. *Health Professions Education,* 1-6. http://dx.doi.org/10.1016/j.hpe.2016.05.001

Yousef, A. M. F., Wahid, U., Chatti, M. A., Schroeder, U., & Wosnitza, M. (2015). The effect of peer assessment rubrics on learners' satisfaction and performance within a blended MOOC environment. *CSEDU,* 2, 148-159.