Annotated Bibliography

Mary Vandergraff

EDCI 52002: Seminar II

Instructor Megan Elam, EdD

February 5, 2023

Euefueno, W. D. (2019). Project/problem-based learning in STEM: impacts on student learning. *Technology and Engineering Teacher*, *78*(8), 8–12. https://www.proquest.com/scholarly-journals/project-problem-based-learning-stem-impacts-on/docview/2226387176/se-2.

In this article, William D. Euefueno discusses what project/problem-based learning (PBL) is, its history, and how to apply it to STEM education. Project/problem-based learning is a way of teaching where students are given a task, something to solve or build, and they use various resources to complete or solve what they were asked to do. This is different from direct instruction, where students are given specific parameters in which to complete an activity. PBL was originally used in medical school in the 1960 but is now used in K-12 and postsecondary schools. With PBL, students work in teams to identify what it is they must solve, then come up with a plan on how to solve it, implementing and evaluating the plan, and finally presenting the plan. This type of learning will benefit students not just in the classroom, but also as they enter the workplace.

This article was designed to be a quick read of what PBL is and how to implement it. Often articles can get lengthy in describing all the steps for a theory. This one is short, easy to remember, and easy to implement. The author did not intend for this to be a lengthy in-depth discussion of all the benefits and research behind PBL, however several sources were used and included for further research. This article only talks about the positives of PBL, and specifically with STEM; it does not address any negatives nor does it branch outside of STEM, despite mentioning one of the Standards for Technological Literacy being to promote connections with other K-12 fields.

In my teaching program, we have several activities where we use PBL. I have learned the activities and how we as an institution taught them, however I am curious as to where some of these practices originate. Are they backed up by research? Are they effective? Articles like this provide a basic understanding of how to teach some of these lessons and how to best assist the students so they get the most out of the activity. I also can see sharing this with my instructors. Since we all come from different backgrounds, not just education or STEM, there can be quite a bit to learn for teaching the different programs. An article like this is short and to the points, something that's not overwhelming, but easy to start implementing and develop as they gain experience teaching.

Budinski, N., Lavicza, Z., & Houghton, T. (2022). Opportunities for 3D printing in Hybrid Education. *Open Education Studies*, *4*(1), 339–344. https://doi.org/10.1515/edu-2022-0175.

In this article, Budinski, Lavicza, and Houghton discuss the ways 3D printing can be utilized within the classroom environment. They introduce the importance and impact of 3D printing in society by referencing different types of manufacturing, from clothing to car parts, all of which either are currently using 3D printing technology or are developing it for consumer use. The purpose of this article, according to the authors, was to share their experiences using 3D printing in the classroom, to help other teachers who are interested in incorporating this technology in their classrooms. The data they collected was not statistical, rather narratives from students as to their perspective if the 3D printing helped them understand mathematical concepts. The article goes on to describe how students would use software to design the model then send it to another source to have it printed out. They would then

analyze the successes and failures. They also tie this type of learning into Experiential Learning, applying that theory to the 3D printing process. Their conclusion is that although the students were not all successful with their prints, they had a better understanding of geometric objects and gained experience.

The authors had a clear goal and they effectively communicated it. They specified that this was to be an analysis of their experience, a way to share one example of 3D printing in a classroom in hopes to help future teachers along the way. The only bias I saw was that they were in favor of the Experiential Learning model, that students learn by doing, and their project rested on that fact. However, they did reference different articles that would suggest this type of learning would be beneficial. The field was also narrow, this was one classroom experience and a hybrid classroom as well, although they were also up front with that limitation. They also go beyond the classroom, connecting what was learned in the classroom to real life applications currently in development.

My initial draw to this article is this is something I am looking to bring into my program – 3D printing in the classroom. This has direct applications to what NASA is doing (one program has invited companies/educational institutions to develop 3D printing buildings to habitats on the Moon or Mars) as well as what is happening in life now. I've been studying 3D printing the last 6 months and I'm getting to a point where I want to propose bringing it into the classroom, however I wanted to know more about how other classrooms have implemented this technology, what limitations or successes they encountered. I realize that this is just one sample, and that further research is needed, including specifics as to the printers themselves, but it did give insight into what could be possible and new software to look into.

Dickson, B., Weber, J., Kotsopoulos, D., Boyd, T., Jiwani, S., & Roach, B. (2021). The role of productive failure in 3D printing in a middle school setting. *International Journal of Technology and Design Education*, *31*(3), 489–502. https://doi.org/10.1007/s10798-020-09568-z.

In this article, Dickson et al discuss productive failure as a concept through the lens of 3D printing failures within an urban middle school classroom setting in Canada. This article goes beyond the mechanics of using a 3D printer in class and what software and hardware was used, but also includes the approach for how it was implemented. The introduction of the printer to the classroom was in front of the classroom so students and teachers were learning together. The article focuses on two main themes – the process of understanding how to use the 3D printer and an activity called the Prism Puzzler. When the printer had repeated failures, the teacher asked the students for suggestions, engaging the students in troubleshooting ideas, and then they discussed what questions to ask the manufacturer. The other difficulty some students experienced was in designing something to a specific dimension using the software. For the Prism Puzzler, they had to print two different objects of the same height and same internal volume, just of a different shape, and then measured water to prove the volumes were the same despite being different sizes. The students then reflected at the end of the year on this process and the majority saw benefit in learning about failure and how to try again.

When the authors initially set out on this project, I don't know that they intended to have this be an exercise in exploring failure. However they did research productive failure and that is what this article is geared towards, exploring how students and teachers can respond to failure. The only bias I observed was the belief that failure can be productive, a good thing. Not everyone would agree, certainly not entities that base success or failure on assessment, output rather than growth. I think these findings could be different if the teachers outlooks were different, that they set the tone rather

than the actual activity itself. The teachers were there facilitating discussions, learning along the way, and giving students the ownership of coming up with solutions. The authors caution that this kind of repetitious failure could lead to “pedagogy fatigue” meaning teachers may not want to keep going with the project after too many failures. The authors also comment that this was a limited study, that further research is needed to make any substantial conclusions. They also say that the 3D printer was engaging enough to keep the students wanting to keep trying, and that it would be hard to predict what technology will keep a student’s interest.

This source seems to be a combination of the other two articles I’ve previously referenced. It has an aspect of learning through projects, coming up with plans, and hands-on learning while also integrating 3D printing in the classroom. What drew me into the article was the idea of “productive failure”. It’s a term I hadn’t heard before, but certainly have used in my teaching. One of my favorite lessons to teach is when we have our end-effector build day. Students are asked to work in teams to build some sort of robotic arm that moves to pick up blocks and move them around an obstacle course. I start by letting the students know that day will be a day of a lot of failures, and that it’s ok to feel frustrated and disappointed by all the failures, that it’s normal, but what’s important is what they do next, what do they learn, and carry on. I don’t know if this has changed any perspectives I have, but it has given me another research topic for the future, knowing there’s an actual term for repeatedly failing in engineering and technology. I think this article would be good for any teacher to read who is looking to try something new in their classroom, whether that be something in engineering and technology, or something else entirely. It reminds teachers they don’t need to know all the answers, just how to guide students to find the right questions.