Evolving Project Based Learning Methodology at the Higher Education Level: A Need for More Guidance and Accountability

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Abstract

Project based learning instructional strategies have been used in the K-12 and college setting to activate learning and engagement. Problem Based Learning allows students to learn by taking on real world problems. Research and literature shows that Project Based Learning can increase collaboration, problem-solving skills, communication, self-direction, creativity, time-management, and work-ethic (Wurdinger & Qureshi, 2015). Moreover, literature reveals that 21st century teaching strategies such as flipped learning can enhance Project Based Learning Strategies (Sams & Bergman, 2013). Recent research and professional discussion reveal that more guidelines and accountability lead to better outcomes when using Project Based Learning (Cooper et al., 2017; Ferren & Anderson, 2016; & Klyoster et al., 2018). This meta-analysis explores the most recent scholarly research in Project Based Learning and addresses the need for guidance and accountability.

Key Words: Flipped Classroom, Project Based Learning, Problem Based Learning, Instructional Technology, Accountability

Bell (2010) defines project-based learning as an advanced approach to education that teaches an abundance of ideas critical for success in the twenty-first century where students drive their learning through study, as well as working together to research and create projects that reflect their knowledge. The idea of learning by doing is a critical component of project-based learning. This idea was studied and developed by John Dewey's "theory of inquiry" in the late 1800's. During the last twenty years, insurmountable research has developed demonstrating the positive benefits of project-based learning in the classroom (Bell, 2010). More recently, within the last few years' research is showing that guidelines and accountability lead to better outcomes when using project-based learning (Cooper et al., 2017; Ferren & Anderson, 2016; & Klyoster et al., 2018). Effective project-based learning allows 21st-century learners to collaborate utilizing an open system across multiple disciplines.

There is a difference between how students are guided on student projects and project-based learning. According to Sam Houston State University (2018), project-based learning is inquiry-based, open-ended, ongoing, engaging, problem-solving, driving, and contextualizing versus traditional student projects which are teacher directed, highly structured, summative, thematic, fun, answer given, and de-contextualized. The university also asserts that project-based learning has elements of traditional student projects; however, there is a more formative assessment as part of the guidance, and project-based learning activities are centered around real-world problems.

Project-based learning has become a main staple in educational pedagogy across multiple disciplines at the higher education level. Due to the National Academy of Engineering calling for revitalization in how engineering students are instructed, researchers at Rensselaer Polytechnic Institute found that incorporating project-based learning across multiple STEM disciplines included high student engagement amongst other benefits (Gadhamshetty et al., 2016). These students already had success in courses related to their STEM subjects leading to their admittance into their respective programs. Thus, students had a depth of pre-existing knowledge that their teachers could guide them on in their project-based learning pursuits.

Early project-based research models used a more open approach to project-based learning where students guided more of their education. However, more recent research demonstrates that professors are guiding pre-existing knowledge (Cooper et al., 2017; Ferren & Anderson, 2016; & Klyoster et al., 2018). David (2018) used project-based learning to build on the preexisting knowledge of junior and senior level biology students so that they would have a deeper understanding of theories and concepts associated with phylogenetics after they completed biology as a freshman and sophomore. Thus, he used two years of precise developed knowledge in biology as a foundation for developing his project-based learning activity to motivate his students to understand more advanced expertise in phylogenetics.

A project-based partnership between a university, a local business, and a local government improved the skills that new software engineers needed coming into the workforce (Cooper et al., 2017). Students were guided on specific tasks to solve a problem that is faced by local businesses and governments (Nagle & Pecore, 2018). These students gained unique software engineering skills that are much needed in their communities (Nagle & Pecore, 2018). Another example of a project-based partnership was designed around the redeveloping of a demolished shopping mall where students were guided by community stakeholders and their teachers on ways to improve the land (Nagle & Pecore, 2018). The instructors used prompts to direct students on solutions.

Project-based learning has even been used positively in the liberal arts curriculum (Ferren & Anderson, 2016). Collaboration between college students and community leaders also took place in this project. College students used learned knowledge from their liberal arts program to partner with a local community to promote health and wellness programs, business development to education and immigration policy reform. (Ferren & Anderson, 2016). Experts from the community, as well as their professors, guided their preexisting knowledge in these projects. These students gained a more in-depth understanding by exercising their skills in real-world projects.

Researchers in a bioinformatics training program found project-based learning very useful in helping students learn the complicated competencies (Emery & Morgan, 2017). The course organizers guided their students along the way by reviewing the projects in developmental stages. This guidance assisted the students in understanding what is expected of them in the project and to ensure that they are taking the appropriate steps throughout the process. Students were also assessed using formative assessment techniques in these steps and were provided feedback to aid them in perfecting their project. Students responded positively commenting that the project-based activity was their favorite part of the course (Emery & Morgan, 2017). Similarly, Suyanti, and Sinuraya (2018) indicated that project-based learning combined with guided practice significantly increased student achievement in chemistry compared to conventional teaching methods.

Project-based learning improved many variables amongst students in foreign language classes (Klyoster et al., 2018). This project expanded the participant's preexisting knowledge of cultural understanding and communication through their knowledge of electronic educational resources (Kloyster et al., 2018). These students used electronic educational resources to communicate across the globe. Instructors developed a unique project pertinent to their curriculum that promulgated their student's preexisting knowledge (Kloyster et al., 2018). Proficiencies in linguistics, regional, cultural, computer, plan, and management were improved through this project (Kloyster et al., 2018).

Effective project-based learning also assisted college students in developing the skills necessary to be successful in life. Wurdinger and Qureshi (2015) researched college students by using a paired sample T-test to determine if project-based learning developed life skills. A 35 question Likert scale survey was implemented before and at the end of a course (Wurdinger & Qureshi, 2015). They discovered there was a significant difference in survey one compared to survey two when it came to responsibility, problem-solving, self-direction, communication, and creativity. Moreover, on average life skills improved in all areas (Wurdinger & Qureshi, 2015).

Another quantitative study by Kumari and Nandal (2016) was implemented to find if project-based learning in a professional education MBA program developed professional skills compared to traditional teaching methodologies (Kumari & Nandal, 2016). Their study found that project-based learning enhanced professional skills in the students at the .01 significant level (Kumari & Nandal, 2016). Furthermore, they recommended that other institutes and professional bodies use project-based learning (Kumari & Nandal, 2016).

A pre- and post-intervention survey found that project-based learning significantly improved higher-order cognitive skills, self-efficacy, teamwork, and communication skills in a transportation engineering program (Fini et al., 2018). Instructors devised an instrument to measure the gains that were unique to their curriculum. These types of skills were beneficial to college students as they entered life after graduation (Fini et al., 2018). College students were able to think for themselves, work together in teams, communicate more effectively, and have more confidence in what they were capable of from project-based learning (Fini et al., 2018). College

students not only developed life skill, but they also gained a strong sense of public service from project-based learning (Fini et al., 2018).

Hunter and Botchwey (2017) enacted a problem based and project-based learning activity where college students and elementary students collaborated to work on an interdependent civic engagement project. Both groups were formally assessed along the way to provide better guidance (Hunter & Botchwey, 2017). Twenty-first-century techniques were used for both groups resulting in a higher order learning of public service (Hunter & Botchwey, 2017).

Belagra and Draoui (2018) researched to discover if project-based learning made it possible for their students to be more motivated to take on the education of complicated content. The control group was a class of students who did not use project-based learning (Belagra & Draoui, 2018). The experimental group was a similar class of students who did use project-based learning (Belagra & Draoui, 2018). Results from the study found that the combination of the tutorial with the project-based learning was likely to raise students' motivation to learn and to master the subject (Belagra & Draoui, 2018).

Mekaria and Widjajanti (2018) researched math students which involved an attitudinal component. There were two randomly selected sample classes (Mekaria & Widjajanti, 2018). The first class used project-based learning (Mekaria & Widjajanti, 2018). The second class was treated with quantum learning (Mekaria & Widjajanti, 2018). The aim was to determine if both learning methods affected reasoning ability, achievement, and attitude towards mathematics using quasi-experimental research (Mekaria & Widjajanti, 2018). Findings indicated that both project-based learning and quantum learning was effectively viewed from student's reasoning ability, performance, and attitude toward mathematics (Mekaria & Widjajanti, 2018).

Seman, Hausmann, and Bezerra (2018) analyzed statistics on the perception of electrical engineering students' understanding of content in a project-based activity in conjunction with traditional teaching methods. They used partial least squares path modeling to discover how the learning process connected to the project-based learning activity (Seman et al., 2018). Data from this research suggested that student perception was grounded in the humanist ideal of the formed ego and cooperation among student (Seman et al., 2018). Moreover, Lutsenko (2018) found that students' perception of project-based learning influenced their professional characteristics such as teamwork, autonomous learning, communication and problem-solving abilities in an engineering program. Furthermore, Hanney and Savin-Baden (2013) stated that combining problem-based learning and project-based learning signaled a shift from a pedagogy based on epistemological inquiry towards one of ontological inquiry where students engaged with their own identity as learners in a world of unknowns.

Sams and Bergmann (2013) suggested that flipped learning enhanced instruction by maximizing instructional time and creating a more student-centered learning environment instead of the traditional teacher-centered. One example was using clickers to poll understanding of a lesson and then allow students to view a teacher made educational video. After this, students were guided toward project-based learning and problem-based learning to make this learning more exciting and to promote inquiry-based learning. Moreover, they demonstrated how the combination of project-based learning and flipped learning were used to enhance differentiated instruction (Sams & Bergmann, 2013). Moreover, a comparison study between a group of students who used project-based learning and flipped learning in character design and animation was conducted using a pre and post-test (Autapao & Minwong, 2017). Researchers found that flipped learning and project-based learning provided students the freedom to determine based on their aptitude (Autapao & Minwong, 2017).

Chis, Moldovan, Murphy, Pathak, and Muntean (2018) investigated the effectiveness of project-based learning and flipped classroom teaching method in a computer programming module. They used a case study to analyze the efficacy in the steps: traditional teaching flipped classroom and the combination of conventional classroom and project-based learning (Chis et al., 2018). Education and edutainment were examined in the three phases (Chis et al., 2018). Edutainment was analyzed through a questionnaire (Chis et al., 2018). Edutainment is entertainment-based technology that is educational (Chis et al., 2018). Researchers found that project-based learning and the flipped classroom was effective especially for lower level learners and the edutainment surveys found that the combined approach does advanced in the edutainment of more mature students (Chis et al., 2018).

Technology and Accountability

Various technology platforms can be used to support inquiry-based, open-ended, ongoing, engaging, problem-solving, driving, and contextualizing components of problem-based learning (Sam Houston, 2018). Bell (2010) stated that technology as a method, not an end, allows students to experiment with various technologies for all facets of project-based learning. A genuine use of technology is highly appealing to students because it makes use of their fluency with computers (Bell, 2010).

Ting-Ting, Yueh-Min, Chen-Ying, Lei, and Chen (2018) used e-book system to combine project-based learning and authentic learning into a community health nursing practice course. After a three-week study, they found the variety of functions, multimedia feature, and ease of the e-book system not only expanded learning appeal and motivation but also enhanced learning effectiveness (Ting-Ting et al., 2018). Also, Omar (2018) found that using project-based learning for better understanding microcontrollers allowed his students to improve performance and allowed them to connect more to their community. Moreover, he used this approach to enhance mathematical modeling, stability analysis, control design, and the application of the PID controller (Omar, 2018). Moreover, Novak and Wisdom (2018) researched preservice elementary teachers in a 3D printing science project. They wanted to know how 3D printing project-based learning affected science teachers' self-efficacy beliefs, nervousness, interest, and confidence (Novak & Wisdom, 2018). They discovered that 3D science printing project significantly lowered participants' nervousness and increased their self-efficacy, interest, and confidence (Novak & Wisdom, 2018).

Mallison (2018) along with her students created four podcasts built on unorthodox research about language differences and a short film that spotlighted linguistic diversity on campus. She was successful in combining project-based learning and podcasts as well as other technology to engage students at a university where many graduates will go on to be community activists in local low-income diverse communities (Mallison, 2018). Furthermore, students learned firsthand the procedures of sociolinguistic data collection, from research design and ethical discretions to choosing suitable methods and communicating results to broader audiences that are appealable (Mallison, 2018).

Research conducted by Hursen (2018) found that project-based learning applications assisted by Edmodo software created a positive impact on the inquiry skills and the academic achievement of prospective teachers. He used pre and post-test as well as a control and experimental group in his research (Hursen, 2018). Edmodo software platform allowed the

teachers in the experimental group to further their inquiry skills and increase academic achievement which are vital components of project-based learning (Hursen, 2018).

Splicah, Oshima, and Oshima (2018) focused on developing a computer-mediated learning environment that could be studied through the regulation of students' internal scripts. Forty-eight students participated in their before and after project-based learning study (Splicah et al., 2018). Researchers found that a significant number of students who experienced unknown situations during collaboration developed new regulation scripts (Splicah et al., 2018). Case studies pointed out that students raised their script for socially shared regulation when understanding socio-cognitive challenges and they worked with others to regulate and self-regulate socio-emotional difficulties (Splicah et al., 2018).

Kim and Lim (2018) developed a framework for the design and implementation of socially shared metacognitive regulations supports in project-based learning. First, they designed the structure to better guide students on socially shared metacognitive control (Kim & Lim, 2018). Second, they implemented the framework as collaboration script (Kim & Lim, 2018). Then, an empirical study validated by observing the effect of the collaborative script on thirty-two students' interactions in real settings (Kim & Lim, 2018). Shared metacognitive regulation after use of the collaboration scripts greatly affected participants' interactions concerning team planning and knowledge construction. Thus, the framework was validated (Kim & Lim, 2018).

Al Mughrabi and Jaeger (2018) developed a project-based learning capability maturity model that was used for system-wide evaluation and improvement of the ability of the institution to enhance the education of students through project-based learning. Maturity models were recognized across various organizations to improve organizational competitiveness continually (Al Mughrabi & Jaeger, 2018). They examined a literature review and two case studies to provide validity (Al Mughrabi & Jaeger, 2018). The case studies showed the effectiveness of the project-based learning capability maturity model identifying areas for improvement (Al Mughrabi & Jaeger, 2018). Furthermore, recommendations were made for this type of model to optimizing project-based learning (Al Mughrabi & Jaeger, 2018).

Lin (2018) developed the KIPSEE instrument which stands for knowledge integration, project skills, and self-efficacy scales. Item analysis and confirmatory factor analysis confirmed the reliability and validity of the KIPSEE instrument (Lin, 2018). Furthermore, Cronbach's alpha reliability coefficient was correlated for the entire instrument and found that there is a significant correlation between the KIPSSE instrument results and the student' product evaluation scores (Lin, 2018). A reliable and valid instrument was created to create more accountability for students in online courses.

Harmer and Stokes (2016) found that most students mainly favored prescription concerning research question and group membership for a project-based learning activity in geography, earth and environmental sciences course for undergraduates. They used semi-structured interviews and audio-recordings to gather data for analysis (Harmer & Stokes, 2016). This information led them to conclude further that proper guidance plays a vital role in the democratization of project-based learning (Harmer & Stokes, 2016). Creating suitable guides will increase accountability in the developmental process for project-based learning.

Rees Lewis, Easterday, Harburg, Gerber, and Riesbeck (2018) developed a system to overcome the barriers for incorporating professional experts in project-based learning. Their system included prompts for team planning, goal setting, monitoring progress, and displaying information to their professional experts online (Rees Lewis et al.,2018). They discovered that this system assisted participating in overcoming barriers when working with their professional experts

due to regulations (Rees Lewis et al.,2018). Moreover, the experts were better able to support students by having an automatic emailed report (Rees Lewis et al.,2018).

Shared regulation of learning SSRL and self-regulated learning are phrases that are associated with how groups members work and collaborate (Lin, 2018). The researcher used computer-supported collaborative learning CSCL environment with proper guidance to enhance the SSRL level with the group and individual SRL because of both effect collaboration during project-based learning (Lin, 2018). A better guided computer-supported learning environment led to more group awareness and group members understanding of their peer's contributions toward the group. The experimental group experienced a moderately reduced free-rider effect and more SSRL and SRL levels as compared to the control group (Lin, 2018).

Berry, Levine, Kirkman, Blake, and Drake (2016) developed an assessment instrument known as SkillSET which stands for Skill for Science/Engineering Ethics Test to increase motivation and accountability. They found that by using project-based and problem-based learning, that students developed a deeper understanding of the skills (Berry et al., 2016). Furthermore, based on their findings they suggested that more project-based and problem-based learning should be experimented so that students can gain a deeper understanding of complicated concepts (Berry et al., 2016).

Smith and Gibson (2016) discussed that professor assumes a significant role in project-based learning. They recognize the high value in project-based, problem-based, and flipped learning, but also understand the conceptual, theoretical limitations in these types of learning (Smith & Gibson, 2016). The professor must assume a more elevated role of responsibility in ensuring that trained properly through project-based learning (Smith & Gibson, 2016). So, the professor must devise and institute a level of accountability (Smith & Gibson, 2016).

Spikol, Ruffaldi, Dabisias, and Cukurova (2018) developed multimodal learning analytics that better guided them on understanding which features of student group work are good predictors of team success in an open-ended task with physical computing. They looked at traditional and deep learning techniques when analyzing participants from multiple modes of learning and observed interactions (Spikol et al., 2018). Their results indicated state of the art computational techniques allowed them to gain insights into the unknowns of learning in students' project-based learning. For example, the distance between students' hands and faces was an indicator of their type of interaction during the learning process (Spikol et al., 2018).

Conclusion

Developing effective project-based learning technique is vital toward the successful implementation of this learning approach. As project-based learning has evolved with new technological advanced so has our understanding of guiding and motivating students. We are now able to use technology to engage students more effectively. Moreover, technology can be used to develop better tools for guidance, assessment, and accountability. Project-based has been found to be effective across multiple disciplines from around the world. As the world progresses, so must our project-based learning activities which take on real-world problems. Project-based learning is even more effective when combined with other twenty-first-century learning approaches such as problem-based learning and flipped classrooms. Research in the area of effective project-based implementation needs to be continued and expanded to a broader audience.

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