PLTW Gateway:

An Evidence-based Learning Solution for Middle School Students

PLTW GATEWAY

Introduction

Project Lead The Way (PLTW) is the leading PreK-12 applied learning curriculum and teacher professional development provider with pathways in computer science, engineering, and biomedical science. PLTW provides engaging, high-quality activities and projects that challenge students to use what they learn in the classroom to solve real-world problems. Developed by teachers and industry experts, the PLTW curriculum enables students to gain mastery of important content standards and concepts, while building problem solving, critical and creative thinking, communication, collaboration, and ethical reasoning and mindset.

PLTW's teaching and learning approach uses activities to build content knowledge, and incorporates projects and open-ended problems to achieve understanding, develop meaning, and reinforce transportable skills.

Problem Statement

Now more than ever, schools are facing intense pressure to maximize every instructional minute to ensure students master essential content standards while developing transportable skills. Educational leaders recognize the added value of new or existing programs reinforcing current priorities and cross-pollinating research-based strategies across district-wide initiatives. Additionally, middle school educators recognize that they must engage students in learning that allows for exploration and addresses their social and emotional developmental needs.

Background

We know from research that "social, emotional, and academic development is an essential part of PreK-12 education that can transform schools into places that foster academic excellence, collaboration and communication, creativity and innovation, empathy and respect, civic engagement, and other skills and dispositions needed for success in the 21st Century" (Jones, Kahn, & the Aspen Institute, 2017, p. 9). Furthermore, research shows that problem-based (PBL) and project-based (PjBL) learning approaches positively impact student achievement, increase intrinsic motivation and participation, and develop critical thinking skills (Auler, 2020; Bowen & Peterson, 2019; Cerezo, 2004; Dole et al., 2017; Harris, et al., 2015; Jerzembek et al., 2013; Lattimer & Riordan, 2011; Lucas Education Research, 2021; Merrit et al, 2017; Wirkala & Kuhn, 2011). PBL and PjBL overlap with learning experiences that "launch from an open-ended question, scenario, or challenge" that focuses on engaging students in solving open-ended, real-world situated problems while building content understanding and critical thinking and collaboration skills (Krauss & Boss, 2013, p. 10). With this approach, "students make sense of why content is useful and how it might be applied" (Lucas Education Research, 2021, p. 1). PBL has been described as "an instructional method in which students learn through facilitated problem solving" (Hmelo-Silver, 2004, p. 235). PjBL is a "model that organizes learning around projects" that stem from challenging questions and involve students in problem-solving, investigation, designing, making decisions, and result in products or presentations (Thomas, 2000, p. 1).

Grounded in the evidence-based research on PBL and PjBL, the **PLTW APB (activity-, project-, problem-based) instructional approach** develops conceptual understanding as students are "actively gathering information, making observations, formulating questions, and then creating new ideas or solutions to answer their own inquiries'' (Krauss & Boss, 2013, p. 31). Research indicates that coupling a problem- or project-based approach with STEM learning has a positive impact on student learning, critical thinking skills, and social-emotional learning (Alemdar, et al., 2018; Cerezo, 2004; Harris, et al., 2015; Krajcik et al., 2021). "A well-design project causes students to stretch their intellectual muscles in ways that traditional learning activities may not" (Boss & Krauss, 2018, p. 74). The emphasis is "not on the outcome but on the process" (Cerezo, 2004, p. 1). Embedded social-emotional learning builds student confidence, increases engagement in learning, improves grades, and reduces behavior issues (Greenberg et al., 2017). APB learning allows students to develop social, emotional, and cognitive skills through authentic problem-solving.

PLTW has transformed traditional, teacher-led classrooms into collaborative spaces where students solve problems, think creatively, and apply their learning in real-world contexts. The APB approach helps students become active and engaged learners by creating student-centered learning experiences in which teachers act as facilitators, rather than lecturers. In this environment, students learn by doing and begin to lead their own discovery through hands-on activities, projects, and problems that become increasingly more challenging and open-ended as they progress through the curriculum. Students "develop flexible knowledge, effective problem-solving skills, self-directed learning skills, effective collaboration skills, and intrinsic motivation" (Hmelo-Silver, 2004, p. 235). Critical thinking is embedded in the process as students investigate phenomena and make sense of the world around them.

- **Activities** engage students to develop knowledge and skills they'll use to navigate projects and real-world problems. They are structured, hands-on learning experiences that engage students in exploring phenomena as they seek to make sense of the world around them.

- **Projects** encourage meaning-making as students draw on their learning and background understandings to investigate concepts or skills.

- **Problems** are open-ended with no clear or best solution intended. They challenge students to apply their learning in novel situations that reflect real-world challenges placing students in the role of scientists and engineers.

Hmelo-Silver (2004) concluded, "Problem-based learning is well-suited to helping students become active learners because it situates learning in real-world problems and makes students responsible for their learning" (p. 236). Students "gain important knowledge, skills, and dispositions…" as they work collaboratively to investigate open-ended questions (Krauss & Boss, 2013, p. 5). Providing a scaffold for students as they actively learn is a critical component of PBL (Allen, et al., 2011). The APB approach builds problem-solving and process thinking, technical expertise, collaborative practices, and communication skills as students develop conceptual understanding.

APB learning also fosters a strong sense of self-efficacy--students may set higher goals for themselves, demonstrate firmer commitment to their goals, consider more career options as possibilities, and see an impact on academic achievement (Bandura, 1993, 1997; Parajes, 2003). We know that "in order for students to meet high expectations for learning and development, the heavy lifting must be done by the student, but schools and teachers need to provide relevant, rigorous, grade-level, opportunities and support" (Aspen Institute, 2019, p. 6). Learning experiences build students' capacity for responsible decision-making, self- and social-awareness, and relationship skills (Greenberg et al, 2017; Reid-Griffin, Sterrett & Stanback, 2020; Taylor et al., 2017). Students who learn this way are more likely to "share the same goal, feel supported, value the learning, become more competent, and persevere when facing learning challenges" (Lee & Blanchard, 2019, p. 1).

Essential features of the APB approach include student-centered learning, the teacher as facilitator, collaborative learning experiences, application of learning to solve problems, meaningful feedback and assessment, and a scaffold of learning experiences across the APBs. PLTW believes in this approach because it guides students toward owning their own learning, provides scaffolding, and prepares students

to tackle challenges. Creating a problem scenario that is real-world and relevant to the learner's world "effectively eliminate[s] the students' often posed question, 'Why do we need to know this?'" (Lambros, 2002, p. viii). Students thrive when given the opportunity to demonstrate evidence of their learning as they solve open-ended, real-world problems.

Solution

Middle school is a time of exploration and transition for students. They need opportunities to develop deep learning, which encompasses content mastery, critical thinking, problem solving, collaboration, effective communication, self-directed learning, and academic mindsets (Hewlett Foundation, 2013). They can thrive in an environment that fosters and empowers them with relevant content and opportunities to explore their interests. PLTW Gateway middle school curriculum offers deep learning through evidence-based, interdisciplinary units that are scaffolded for success by employing the hands-on APB instructional approach. As students navigate the open-ended problems, they are immersed in exploration of phenomena that leads to sense-making of the world around them. The impact on student learning is why PLTW Gateway has become the cornerstone of transforming teaching and learning for thousands of educators and millions of students across the U.S.

In addition to providing "best in class" STEM education, PLTW's approach to learning strengthens schools' and districts' commitment to a project- and problem-based instructional model to maximize engagement and contextualize crucial science, math, and literacy objectives. PjBL and PBL encourages students to develop mastery of academic learning using hands-on lessons. Research shows that curriculum that engages students in engineering design may diminish achievement gaps in science (Cantrell et al., 2006). Engaging students in solving real-world problems "not only develops knowledge in a more complex way, but helps students develop 21st century skills such as emotional intelligence, communication skills, and complex thinking" (Auler, 2020, p. 33).

Using PLTW's unique instructional activity-, project-, problem-based (APB) approach, students explore relevant content standards, while also applying math and literacy skills to solve real-world problems. The PLTW Gateway program offers 10 units that empower students to build and apply knowledge and skills to solve problems. Applying their learning in novel situations requires a deeper level of understanding than just memorizing facts or procedures (Miller & Krajcik, 2019). The units build students' capacity for responsible decision-making, self- and social-awareness, and relationship skills (Greenberg et al, 2017; Taylor et al., 2017). As students engage in PLTW's activities in computer science, engineering, and biomedical science, they see a range of paths and possibilities they can look forward to in high school and beyond. PLTW's APB approach leverages research to create a high-impact, high-interest experience for students and teachers.

PLTW Gateway units address middle school standards, including the **Next Generation Science Standards**, **Common Core State Standards** for mathematics and English language arts/literacy (ELA), **Standards for Technological Engineering Literacy**, **National Health Science Standards**, and **Computer Science Teachers Association Standards**. The breadth of PLTW Gateway content allows schools to maximize their investment by using PLTW Gateway during the school day, in after-school learning, and/or as summer learning experiences. PLTW Gateway participation has a positive impact on students' interest in pursuing additional STEM coursework (Bellinger, 2019; Overschelde, 2013).

We know that teachers provide the necessary conditions for student success, and that ongoing participation in robust professional learning experiences prepares teachers to create these conditions in their classrooms. **PLTW Professional Development** empowers teachers to engage students in real-world and transformative APB learning experiences, inspiring them to impact the world with their learning. PLTW Professional Development is grounded in research that indicates effective professional development "leads to improvements in teacher knowledge or practice, or in student learning outcomes (Jaquith et al., 2011, p. 2). Embedding "a focus on curriculum and shared instructional challenges; collective participation; opportunities for active learning; sustained duration; and coherence with student achievement goals and other policies," PLTW Professional Development transforms teaching and learning (National Institute for Excellence in Teaching, 2012, p. 1).

Conclusion

The impact of the APB instructional approach extends far beyond a single classroom. In many cases, it has reinvigorated the learning experience across entire schools, as teachers are intentionally finding more opportunities for student exploration. This means more student-to-student discussion and discourse and less teacher-centered instruction, allowing for creativity, collaboration, and problem-solving in all subject areas. The instructional approach "enables students to master their learning strategies and obtain greater understanding of phenomena" (Reid-Griffin et al., 2020, p. 6). "Students need to see purpose in their learning and experience of school" (Aspen Institute, 2019, p. 6).

Research confirms that PLTW Gateway offers a program that prepares students for success cognitively, socially, and emotionally. "As education works to reconnect student learning to something more than standardized testing, project-based learning (PBL) has become a popular way to increase student engagement while providing more authentic applications of student knowledge" (Bowen & Peterson, 2019, p. 1). The APB instructional approach and the integrated curriculum design is a proven and effective way to deliver meaningful engagement in learning to complete the cradle-to-college pipeline for students. Students who participate in PLTW Gateway units build strong conceptual understanding in STEM, as well as developing transportable skills that include critical thinking, collaboration, communication, problem-solving strategies to benefit them in learning and in life.

References

Alemdar, M., Moore, R.A., Lingle, J. A., Rosen, J, Gale, J., & Usselman, M. C. (2018). The impact of a middle school engineering course on students' academic achievement and non-cognitive skills. *International Journal of Education in Mathematics, Science and Technology (IJEMST), 6*(4), 363-380. DOI: 10.18404/ijemst.440339

Allen, D.E., Donham, R. S., & Bernhardt, S.A. (2011). Problem-based learning. *New Directions for Teaching and Learning, 128*, 1-9. http://dx.doi.org/10.1002/tl.465

Aspen Institute. (2019) *Integrating social, emotional, and academic development: An action guide for school leadership teams*. Washington, D.C.: Aspen Institute. Retrieved from https://www.aspeninstitute.org/wp-content/uploads/2019/03/UPDATED-FINAL- Aspen_Integrating-Report_4_Single.pdf

Auler, I. C. F. (2020 February). What's keeping us from doing PBL? Mastering standards at a deeper level with project-based learning. *Association for Middle Level Education, 8*(1), 32-34.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148. https://doi.org/10.1207/s15326985ep2802_3

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: W. H. Freeman and Company.

Bellinger, P. J. (2019). A quantitative study examining Project Lead The Way Gateway program outcomes in a suburban school district. [Doctoral dissertation, Lindenwood University]. In *ProQuest LLC*. Retrieved from https://www.proquest.com/docview/2236403375

Boss, S., & Krauss, J. (2018). *Reinventing project-based learning: Your field guide to real-world projects in the digital age*. Portland, OR: International Society for Technology in Education.

Bowen, B., & Peterson, B. (2019). Exploring authenticity through an engineering-based context in a project-based learning mathematics activity. *Journal of Pre-College Engineering Research, 9*(1), 1-10. http://dx.doi.org/10.7771/2157-9288.1073

Cantrell, P., Pekcan, G., Itani, A., & Velasquez-Bryant, N. (2006). The effects of engineering modules on student learning in middle school science classrooms. *Journal of Engineering Education, 95*(4), 301-309. doi:10.1002/j.2168-9830.2006.tb00905.x

Cerezo, N. (2004). Problem-based learning in the middle school: A research case study of the perceptions of at-risk females. *Research in Middle Level Education*, 27(1), 1–12.

Dole, S., Bloom, L., & Doss, K. K. (2017). Engaged learning: Impact of PBL and PjBL with elementary and middle grade students. *Interdisciplinary Journal of Problem-based Learning, 11*(2), 1-10/. http://dx.doi.org/10.7771/1541-5015.1685

Greenberg, M. T., Domitrovich, C. E., Weissberg, R. P. & Durlak, J. A. (2017). Social and emotional learning as a public health approach to education. Social and emotional learning: Introducing the issue. *The Future of children, 27*(1), 13-32. Retrieved from: *https://www.wallacefoundation.org/knowledge-center/Documents/FOC-Spring-Vol27-No1-Compiled-Future-of-Children-spring-2017.pdf*

Harris, C. J., Penuel, W. R., D'Angelo, C. M., DeBarger, A. H., Gallagher, L. P., Kennedy, C. a., Cheng, B. H., & Krajcik, J. S. (2015). Impact of project-based curriculum materials on student learning in science: Results of a randomized controlled trial. *Journal of Research in Science Teacher, 52*(100, 1362-1385. https://doi.org/10.1002/tea.21263

Hewlett Foundation. (2013, April). *Deeper Learning Competencies*. Retrieved from https://hewlett.org/library/deeper-learning-defined/

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235-266. http://dx.doi.org/10.1023/ B:EDPR.0000034022.16470.f3

Jaquith, A., Mindich, D., Wei, R. C., & Darling-Hammond, L. (2011). *Teacher professional learning in the United States: Case studies of state policies and strategies*. Oxford, OH: Learning Forward.

Jerzembek, G. & Murphy, S. (2013). A narrative review of problem-based learning with school-aged children: Implementation and outcomes. *Educational Review, 65*(20), 206-218. http://dx.doi.org/10.1080/00131911.2012.659655

Jones, S. M., Kahn, J., & The Aspen Institute (2017). The evidence base for how we learn: Supporting students' social, emotional, and academic development. *Consensus Statements of Evidence from the Council of Distinguished Scientists.* Washington, D.C.: Aspen Institute. Retrieved from https://www.aspeninstitute.org/wp-content/uploads/2017/09/SEAD-Research-Brief-9.12_updated-web.pdf

Krauss, J. & Boss, S. (2013). *Thinking through project-based learning: Guiding deeper inquiry*. Thousand Oaks, CA: Corwin University.

Lambros, A. (2002). *Problem-based learning in K-8 classrooms*. Thousand Oaks, CA: Corwin.

Lattimer, H. & Riordan, R. (2011). Project-based learning engages students in meaningful work. *Middle School Journal (J3), 43*(2), 18-23. https://doi.org/10.1080/00940771.2011.11461797

Lee, H. & Blanchard, M. R. (2019). Why teach with PBL? Motivational factors underlying middle and high school teachers' use of problem-based learning. *The International Journal of Problem-based learning, 13*(1), 1-19. http://dx.doi.org/10.7771/1541-5015.1719

Lucas Education Research. (2021). The evidence is clear: Rigorous project-based learning is an effective level for student success. George Lucas Educational Foundation. Retrieved from https://www.lucasedresearch.org/docs/the-evidence-is-clear-rigorous-project-based-learning-is-an-effective-lever-for-student-success/

Merritt, J., Lee, M. Y., Rillero, P., & Kinach, B. M. (2017). Problem-based learning in K-9 mathematics and science education: A literature review. *Interdisciplinary Journal of Problem-Based Learning, 11*(2), 1-13. https://doi.org/10.7771/1541-5015.1674

Miller, E. C. & Krajcik, J. S. (2019). Promoting deep learning through project-based learning: A design

problem. *Disciplinary and Interdisciplinary Science Education Research, 1*(7), 1-10. https://doi.org/10.1186/s43031-019-0009-6

National Institute for Excellence in Teaching (2012). *Beyond "job-embedded": Ensuring that good professional development gets results*. Retrieved from https://eric.ed.gov/?id=ED533379

Overschelde, J. P. (2013). Project Lead The Way students more prepared for higher education. *American Journal of Engineering Education, 4*(1), 1-11. Retrieved from https://files.eric.ed.gov/fulltext/EJ1057109.pdf

Pajares, F. (2003). Self-efficacy beliefs, motivation, and achievement in writing: A review of the literature. *Reading & Writing Quarterly, 19*, 139-158). Retrieved from https://www.uky.edu/~eushe2/Pajares/Pajares2003RWQ.pdf

Taylor, R. D., Oberle, E., Durlak, J. A., Weissberg, R. P. (2017). Promoting positive youth development through school-based social and emotional learning interventions: A meta- analysis of follow-up effects. *Child Development, 88*(4), 1156-1171. https://doi.org/10.1111/cdev.12864

Thomas, J. W. (2000). *Review of research on project-based learning*. Retrieved from http://www.bobpearlman.org/BestPractices/PBL_Research.pdf

Price, J.,Govett, A., Davis, M., Ivester, R., Howard, T., & Messimer, L. (2019). PBL meets PBL: Project-based learning meets planet-based learning. *Teaching Science, 65*(1), 28-33.

Reid-Griffin, A., Sterrett, W., & Stanback, A. (2020). Project-based learning (PjBL); Providing a community of engagement for middle school learners. *Journal of Classroom Interaction, 55*(1), 4-25.

Wirkala, C., & Kuhn, D. (2011). Problem-based learning in K-12 education: Is it effective and how does it achieve its effects? *American Educational Research Journal, 48*(5), 1157-1186. https://doi.org/10.3102/0002831211419491