

Evaluating STEM Education in the U.S. Secondary Schools: Pros and Cons of the «Project Lead the Way» Platform

<https://doi.org/10.3991/ijep.v9i1.9277>

Melissa Stebbins, Tatiana Goris ^(✉)
Pittsburg State University, Pittsburg, USA
tgoris@pittstate.edu

Abstract—Starting in 1990-s, the Project Lead the Way (PLTW) program became one of the most known and favorable interdisciplinary STEM platforms in K-12 education in the United States. Moving away from the traditional classroom, PLTW focuses on the integration of several subjects into one. It includes various hands-on-activities that, according to PLTW mission, help to develop deeper practical hands-on skills in Science, Technology, Engineering, and Mathematics (STEM). In nowadays, PLTW is a nationally recognized curriculum, which offers many opportunities for teachers, as well as students, developing engineering skills and preparing the youth for college and upcoming STEM-oriented carriers. However, despite of its popularity, various factors (such as the cost of PLTW equipment, supplies, and software, as well as support of school administration) might significantly influence quality of PLTW teaching.

Keywords—Project Lead the Way (PLTW), K-12, American Secondary Education, Engineering and Technology Education Introduction, STEM, Project Based Learning (PBL).

1 Introduction

The purpose of the present article is to outline existing controversial opinions about the PLTW Educational Platform (curriculum). The authors reveal not only the benefits, but the problems of implementation of this curriculum as well. Although we focused on the US secondary STEM education, this discussion might be interested for a more broad audience outside the US, since the effective implementation of STEM education in secondary schools is on the global demand.

The present work is organized as a literature review of multiple academic sources, brining discussion about the most known STEM curriculum in the North America. The main guiding question for this study was to understand “*What is a real effectiveness of the PLTW Platform? May PLTW be effective only in ideal settings: where all tools and materials are available to support the curriculum and instructions?*” This important question should be raised, since the consistency of factors influence on pedagogical strategies of how the course content is taught.

The topic of STEM secondary education crosses multiple disciplines in science, cognitive psychology, pedagogy, technology and engineering education. Thus, a methodological approach was undertaken to conduct the literature review. No single source assesses academic work about STEM educational platforms. The majority of scholarly sources were accessible through the online library of Pittsburg State University, as well as Google Scholar Search Engine, Web-of-Science, digital library Xplore IEEE,

1.1 Engineering village-2, and ERIC databases

Searching in databases, the presented above keywords were used for every section of this literature review. These searches constructed many hundreds of matches. The only considered articles were those with keywords in titles or abstracts because they endow an essential means of sorting based on the content. The criterion for rejecting or accepting search results was based on the relevance of the title and the abstract's content.

2 Background

In recent years, there has been a major push to introduce students to Science, Technology, Engineering, and Mathematics or STEM. There is an overwhelming demand in the US (which continues to grow) for new graduates with STEM-related backgrounds entering the workforce. The current serious issue is that the most of the U.S. college graduates in engineering and technology fields are international students. If the trend continues further, more than 90 % of scientists, technologists, and engineers will live in Asia. To add fuel to the fire, according to a Census Bureau, 74 percent of STEM graduates do not go into a STEM-related job market.

STEM degree graduates are highly sought after, and often make higher wages comparing to non-STEM counterparts. Mainly because of the learned skills, such as a critical thinking and problem solving. As an example, Kansas and Missouri States (the authors' residence land) alone will need 185,000 additional people with STEM Education by 2018 [1]. This demand places pressure on the local public-school systems to produce those students. The same demand has generated a supply of STEM project-based learning packages that are ready to go with the click of a mouse and a transfer of funds.

One such curriculum, presented by the 'Project Lead the Way' organization provides a transformative learning experience for K-12 students across the U.S. PLTW is a pre-engineering curriculum with several pathways ranging from Launch (for Elementary) to Biomedical Science (for Secondary). In addition, multiple professional-development programs are offered for the instructors. All PLTW curriculums meet Next Generation Science Standards [2] and the Standards for Technological Literacy [3] depending on a pathway subject. To become a PLTW instructor, a teacher must take a costly two week long certification, no matter what degree he/she currently holds. It requires extra funding on top of the needed budget (approximately \$2000 per

person). Adding to those expenses, instructors have to order specific supplies and equipment to be able to follow the PLTW curriculum. In another words, Project Lead the Way is a curriculum that is marketed and sold to schools as a way of improving STEM education. It is assumed that after adaption of PLTW curriculum by a school district, students will be deeply involved into hands-on projects, helping to reach higher levels of learning and retention. Often the curriculum adapted by a school district may depend on where the funding for the program originated. In many states, the office of Career and Technical Education (CTE) funds the various STEM programs in public schools. Then CTE dictates what curriculum should be taught. May PLTW be effective only in the ‘ideal’ settings: where all tools and materials are available to support the curriculum and instructions? It also includes supportive school administration with a sufficient budget that can cover larger expenses. Usually, these factors influence on pedagogical strategies of how the course content is taught.

According to PLTW advertising, once a school-district purchases the program, the whole access to sources covering instructor needs will be provided, including lesson plans and activities. It requires less work on the instructor’s part and gives more time focusing on students. However, the raised question is: how truly this advertising statement represents reality after a PLTW package is purchased and put into use? While PLTW is nationally recognized for providing the hands-on STEM experience to youth, there are factors that could hinder a quality of teaching. These factors require further investigation, making awareness of it prior purchasing PLTW packages.

3 A Few Words about STEM

STEM as an acronym first became used by the National Science Foundation in the 1990s: Science, Technology, Engineering and Mathematics. All four component are intertwined in the ever more technical world, and each component has its own proponents. Today the majority of general public knows what it stands for, but cannot describe what STEM is. The meaning of STEM tends reflect on a personal interest in it. Science educators focus on science; technology and engineering educators lean towards the tech and engineering; and same goes for the mathematicians. It should be noted that in nowadays STEM education observes a rapid replacement of traditional lecture-based lessons with applied learning. The main direction in STEM education is to give students a ‘real-world problem’ to solve using the skills learned in each discipline, and at the same time developing critical thinking that is so desired in a workforce. In [4] the authors refer to a recent reform movement in the STEM arena. This reform has three main goals:

- To increase the number of students choosing degrees in STEM fields,
- To expand and broaden the participation in the STEM workforce, and
- To make all students STEM literate.

In addition, there is a movement towards a more unified approach; where not only the four traditional disciplines integrated in lessons, but art and social studies as well.

4 History and Structure of PLTW

Founded in 1997 in New York State, PLTW provides an inclusive curriculum for engineering and biomedical disciplines for more than 400,000 students nationwide. It began with 12 schools launching a “Pathway to Engineering.” According to the Southern Regional Education Board (SREB), students enrolled PLTW have higher scores in math and science classes. These achievements led SREB to partner with PLTW and bring the curriculum to 30 more states within a few years. In 2000, the Gateway to Technology (GTT) programs for middle schools were added. They serve as a mechanism for encouraging middle school students to be interested in technology and lead them to the high school engineering path. In addition, GTT focuses on increasing interest of females and minorities in STEM careers [5]. Today PLTW is offered in every state to thousands of elementary, middle, and high school students, and is known as a premier curriculum for STEM education.

Project Lead the Way is a 501(c) (3) nonprofit organization and a service provider [6]. The curriculum is structured in a manner that it can be fulfilled at one level without being implemented at all levels. School-districts could choose any or all of the available courses for grades 9-12 without employing courses into K-8. There is no course prerequisite. In addition, PLTW offers the Learning Management Software (LMS), assessments, reporting tools, and the solution center as part of the annual mandatory participation fee. This fee varies depending on the school level (elementary, middle, or high) and courses (Biomedical, Computer Science, or Engineering). The participation fee does not include a 2-weeks-long Core Training workshop and certification, which is required for the official implementation of the curriculum [7].

5 Filling Educational Gaps: Challenging Questions about PLTW Effectiveness

Multiple studies attempted to determine the effectiveness of PLTW in filling educational gaps preparing a workforce in STEM areas. The authors in [8] confirmed that enrolling in PLTW leads to increasing student math and ELA scores in the state of Texas. He found that students who normally performed lower, were more prepared for higher education due to being enrolled in a PLTW course. The also scored higher on the state assessment tests. Similar studies had been conducted in other states monitoring what progress PLTW made towards the stated goals. One such state is Indiana, which had been a strong supporter of PLTW even before headquarters moved to Indianapolis [9]. Evaluating enormous growth of PLTW in Indiana, the authors in [5] stated that one of the important goals of PLTW is to increase girls’ participation in STEM fields and future careers. There is a need to point on a steady disconnect between female high performance in STEM disciplines in middle and high schools, and losing girls in college. Critical transition from school to college might not always be successful; as a result, there is a consistent loss of female students at college level, or on early stages of employment in STEM areas. Thus, PLTW curriculum on the middle and high school levels has to impact on participation of female youth in STEM.

In addition, it should be noted that despite of positive results, PLTW has its own ‘side effects’ which may appear once the commitment of integrating this curriculum been made. It is well known that schools across the nation are battling budget crunches and funding pitfalls. Thus, it would not be a light decision for them to be involved into PLTW. Certain school districts may have a general lack of sources for meeting these expenses. Despite of multiple opportunities for funding PLTW programs, the authors in [10] pointed on a common scarcity of awareness of these funding opportunities. For example, the majority of the school principals were not aware about the funding help provided by the State or the Federal governments. Yet, even if administrators and principals desire to use a successfully obtained funding, physical space issues may still lead to indirect costs that are not directly attributed to PLTW implementation. Reference [11] indicated that mutual support from administrators, counselors, and teachers was the most critical factor for successful PLTW implementation.

Summarizing multiple research studies in the resent systematic literature review, the authors in [12] mentioned apparent weaknesses of PLTW. Mainly, the proof that participating in PLTW facilitates improvements in students’ math and science abilities was largely lacking. Some studies that did focus on this topic were at odds. In addition, an involvement in PLTW often faces scheduling and space issues that some schools may be unable to handle. According to [11], high school counselors consistently agreed that students needed extra time in their schedules in order to participate in PLTW. Another barrier for implementing PLTW was mentioned in [13], such as a lack of role models for students from demographic populations that are underrepresented through STEM. “Despite the rapid and still ongoing growth of PLTW, these results indicate that scholarly literature pertaining to the efficacy of PLTW curriculum is rather sparse” [12, p.20]. It is clear that there is a strong need for more information regarding of positive and negative effects of PLTW implementation. Additional studies are desirable that can bring a deeper understanding of teacher needs to a school administration, as well as PLTW organization. It also would help alleviate barriers and hurdles during and after implementation of PLTW programs, increasing the quality of the American STEM education.

Based on the analyzed literature, the Figure 1 was created that represents Pros and Cons of the PLTW Educational platform in regard of students and teachers need.

6 Conclusion

PLTW is marketed as one of the best solutions for pre-engineering education for middle and high school students. The benefits of PLTW have been widely debated, yet there are limited discussions of any drawbacks after implementing the curriculum. There are many variables that can affect the classroom experience of PLTW such as teacher experience, program or school budget, equipment available, and support from administration.

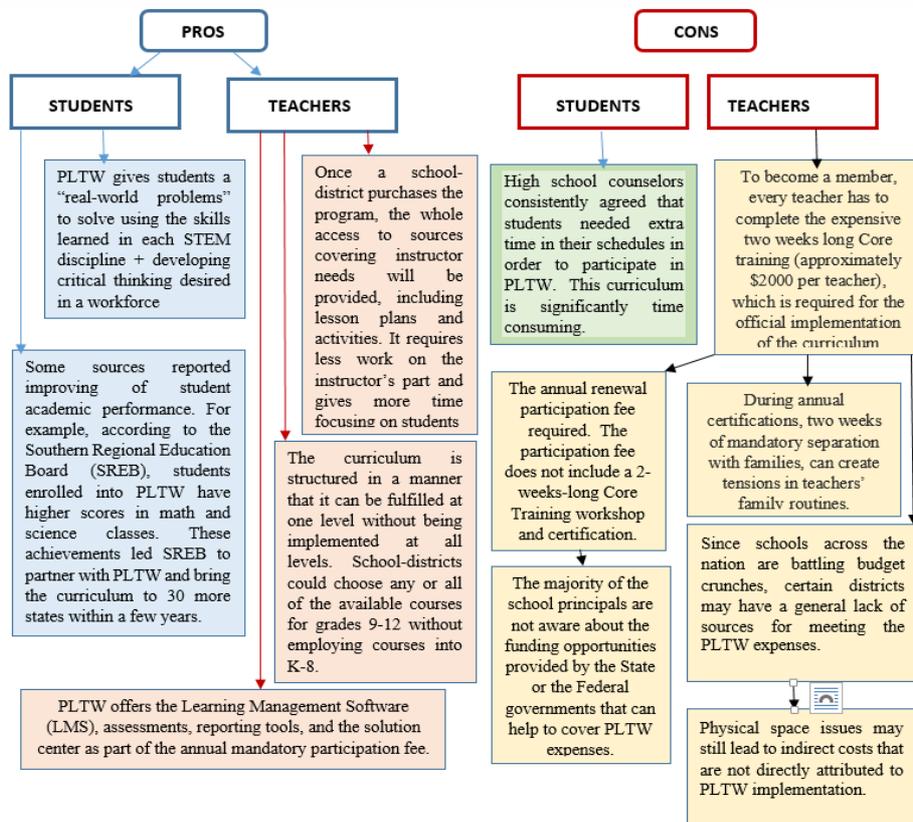


Fig. 1. Pros and Cons of the «Project Lead the Way» Educational Platform

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8 Authors

Melissa Stebbins is a recent graduate with a Master of Science in Technology Degree from Pittsburg State University, Kansas, USA and currently a Middle School Teacher of Engineering and Technology Education. During the past years, Melisa is a receiver of multiple teaching and research awards.

Dr. Tatiana Goris is an Assistant Professor at Pittsburg State University, Pittsburg, Kansas, USA. She obtained her PhD in Technology from Purdue University (2012), West Lafayette, Indiana, with an emphasis on Engineering and Technology Education. Her research interests relate to Theories of Learning, STEM Education, and Workforce preparation for Advanced Manufacturing.

Article submitted 27 July 2018. Resubmitted 13 October 2018. Final acceptance 16 October 2018. Final version published as submitted by the authors.