



# Classroom Examples: Problem-Based Learning in Secondary Education

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## Abstract

The most important responsibility of teachers is to give students the ability to learn, reason, think creatively and critically, make decisions, solve problems, and function as part of a team. Problem-based learning (PBL), where these skills can be acquired, has been used for many years around the world. Scholars and teachers are increasingly aligned with the application of PBL methods in secondary education. The purpose of this article is to report qualitative case study research of four middle school teachers and students, in the USA public school system, who are engaged in PBL. Data collection included semi-structured voice-recorded one-to-one interviews with all participants, classroom observation field notes, bi-monthly researcher debriefing sessions, and reviews of curriculum materials and student work. Results are organized as 3 scenarios describing PBL in action. Each scenario represents a detailed classroom description written as a first-person account to represent participant voices. The scenarios exemplify the benefits of interdisciplinary PBL as well as the often-unanticipated obstacles involved in curriculum implementation. Implications endorse a shift away from curriculum tailored to standardized testing success with more emphasis on authentic PBL that promotes real-world, 21<sup>st</sup>-century critical thinking, problem-solving, and collaboration skills. Starting small, with a lesson or topic, and gradually expanding PBL experiences in classroom settings is recommended.

## Subject Areas

Curriculum Studies, Education, Teacher Professional Development

## Keywords

Problem-Based Learning, Middle School Teachers, Qualitative Case Study Research, Problem Solving, 21<sup>st</sup>-Century Critical Thinking

## 1. Introduction

In today's classrooms, teachers are called to provide a range of learning options to capture best practices that honor the needs of all students. Should they instruct in a time-efficient, subject-oriented, teacher-centered way following a scripted curriculum to assure that students perform proficiently on standardized tests? Or should they apply creativity in designing time-consuming, but authentic and interdisciplinary problem-based curriculum intended to engage and motivate students to participate in critical thinking, problem-solving, and collaborative projects? Bringing this pedagogical conflict home, [1] conducted a mixed-methods study to examine the pedagogical mindsets of 252 pre-service teachers who received K-12 schooling in test-based accountability environments. Accountability era research underscores the idea that lower-quality instruction typically occurs in classrooms focused on test-prep instruction [2] [3]. They note that after two decades of test-based accountability mandates [4] [5], the USA education system continues to rank below other advanced industrialized nations [6]. The pre-service teachers were aware of the pros and cons of teaching for standardized testing success and cognizant of the ineffectiveness of repeating what they experienced in their K-12 schooling. Most understood that teacher accountability must go above and beyond the achievement of proficient standardized test scores, meaning that accountability requires the implementation of engaging, experiential, and intrinsically motivating student-centered learning experiences.

Traditional pedagogical models are based on the premise that students must know the content to apply it in solving a problem. Problem-based learning (PBL) reverses this order and considers that students obtain the knowledge while solving problems. Curriculum researchers suggest that PBL results in a higher quality of the information students use to solve a problem that is shared, discussed, and applied in a concrete situation. As an instructional practice, PBL is viewed in concert with constructivist teaching to guide the examination of pre-determined world issues and concepts. This involved a process of student guesses based on prior understanding, followed by the development of hypotheses, and in turn, making tentative conclusions [7].

[8] notes that PBL expands the transfer of concepts to new problems, enhances intrinsic interest in subject matter, and supports self-directed study skills. They outline three key facets of PBL that lead to authentic teaching and learning:

- 1) Construction of knowledge that guides students to synthesizing, generalizing, hypothesizing, and arriving at conclusions to produce new understandings;
  - 2) Disciplined inquiry in which students address ideas central to the respective discipline with enough thoroughness so that conceptual relationships can be explored, and complex understandings produced;
  - 3) Values that extend beyond school to help students make connections between disciplinary content and either public problems or personal experiences.
- Thus, PBL provides a platform for students to plan, discuss, and implement

projects that have real-world impact and significance.

Scholars highlight the benefits of constructivist PBL [9] [10]. Little, however, is written from the voices of teachers and students as they engage with PBL in classroom settings. In response, the purpose of this article is to report qualitative case study research on teachers and students, in the USA public secondary school system, engaged in PBL. Secondary education in the United States system consists of two programs, the first is middle school (grades 6-9) and high school (grades 9-12). The overarching aim is to provide understanding through the voices and actions of 4 middle school teachers as they implement PBL. To begin, the meaning of PBL is defined and discussed. Next, a description of the research setting is provided which leads to an outline of the methodological framework of the study. This is followed by three descriptive scenarios that showcase the benefits and obstacles of implementing PBL curriculum in classroom settings.

## 2. Meaning of PBL

In constructivism, knowledge concerning real-world concerns is actively created by students who take ownership of their learning [8]. Power and authority shift from the teacher to students; teachers act as facilitators, rather than information transmitters [10] [11] [12] [13]. In the role of facilitator, teachers challenge students and scaffold their learning by asking questions such as *What do you mean? How do you know that is true? What do we need to know more about? What are the diverse perspectives surrounding this issue? Where can we find this information? What might be a viable solution?* As students engage in self-directed learning, they simultaneously pose questions, research, analyze, and critique diverse perspectives, think critically, brainstorm collaboratively, problem solve, and effectively communicate in discussions and debates where their views and ideas and those of others are heard and considered [10] [12] [13].

Stemming from constructivism, PBL is an engaging and motivating form of experiential learning [8] [10] [12] [13]. PBL was first developed in 1970s medical education in response to low clinical performance based on memorized knowledge [14] [15]. In K-12 classrooms, PBL has been increasingly implemented since the early 1990s [8] [10] [15]. As defined by [10], PBL is a "...learner-centered approach that empowers learners to conduct research...and apply knowledge and skills to develop a viable solution to a defined problem" (p. 12). Researchers [8] [10] [12] [13] [16] describe PBL as focused learning organized around the investigation and resolution of messy, ill-structured, real-world issues. PBL accentuates the importance of students becoming informed citizens able to find, evaluate, and use appropriate resources as they research diverse perspectives [8] [10]. When students thoroughly understand diverse perspectives surrounding an issue, they can generate and implement robust and viable solutions [10].

PBL is emergent (responsive to students' interests and driven as needs arise). With such learning, an element of uncertainty is introduced, and outcomes are often unpredictable. As students process through this work, however, they attain

a level of comfort with the ambiguity of such convoluted issues [13]. Because PBL is responsive to students' interests and learning needs, students are naturally engaged; in the process they become intrinsically motivated and autonomous, self-directed learners [8] [10] [12] [13] [16].

Young global leaders empowered to tackle the world's most pressing challenges is a vision shared worldwide. Thus, students need practice--learning experiences to critically analyze and resolve challenging local and global issues. As noted by [17], "Knowledge and skills divorced from real world situations leave young people unprepared for the complexities of the modern world" (p. 3). [10] contends that the selection of authentic, personally relevant, "ill-structured problems" is critical to the success of PBL. He explains that when confronted with well-structured problems, learners are less motivated and less invested in the development of a solution. As such, the problems need to be complex with no simple or perfect solution [8] [10] [12] [13].

[10] [18] assert that researching contemporary real-world issues and brainstorming viable solutions is interdisciplinary; it integrates information related to the problem from a wide range of standards and skills in multiple subjects. When researching real-world issues, students build vocabulary, reading comprehension, and writing skills as they compare researched information and evaluate its validity.

[19] conducted an experimental study in a middle-school setting. Comparing 9 weeks of small-group PBL, solitary PBL, and lecture environments, superior mastery of comprehension and concept application was achieved in both PBL environments relative to the lecture environment. Students developed their inquiry skills as they learned to ask relevant questions and engage in unbiased and balanced investigation of diverse stakeholder perspectives. Students improved their oral communication and collaboration skills. Critical problem-solving skills and creative thinking were practiced as students drew inferences, made deductions, and justified their opinions, decisions, and actions [8] [9] [10] [18] [19].

Although PBL has many benefits, there are obstacles in its classroom implementation. It requires educators who are committed to instruction organized around time-consuming, learner-centered investigation and resolution of messy and unpredictable real-world issues [10] [20] [21]. Teachers must be flexible and willing to adjust their facilitation efforts at a moment's notice. Moreover, today's learners are new to PBL and require significant instructional scaffolding to support development of problem-solving, self-directed learning, and collaboration skills [10] [11]. Complicating this matter further, adolescents tend to be idealistic, thinking the solutions to complex problems are straightforward. This mindset is not easy to change [11].

Currently, secondary school teachers in the United States system do not have the freedom to develop their own curriculum and instructional style. Secondary school teachers in both programs (middle school and high school) are required to follow a prescribed curriculum to assure they teach all essential standards and

prepare students for proficient standardized test performance [11] [20] [21]. Furthermore, teaching subjects in isolation is conventional practice in many schools. Rarely do teachers from diverse subject areas work together to plan and teach an interdisciplinary unit [10]. These obstacles suggest difficulty for middle school and high school teachers to break the mold and adopt emergent, interdisciplinary PBL experiences in their classrooms.

### 3. Methods

The research was designed as a qualitative case study. [22] defines case study research as "...an empirical inquiry that investigates a contemporary phenomenon within its real-life context, ...and in which multiple sources of evidence are used (p. 26)." [23] describe a case as an individual, a program, a group, a school, or a community. They describe qualitative case studies as particularistic because they focus on one social unit, are richly descriptive, and have the potential to contribute to scholarly discourse. Beginning research questions included:

- 1) What are the essential tools and considerations for implementation of PBL in middle school classroom settings?
- 2) What are the benefits and obstacles involved in the implementation of PBL in classrooms?

#### 3.1. Participants

Pseudonyms were used for all participants and all locations. Four teachers were invited to participate in the study based on their student-centered curriculum and problem-based instructional style. At the time of the study two were language arts/social studies teachers and two science/math teachers with 70 6<sup>th</sup>-9<sup>th</sup> grade students between the ages of ten to fourteen. The teacher participants had 12+ years of middle school teaching experience and were employed in a public middle school-of-choice with a learner-centered philosophy. The middle school was a lab school located on a university campus in a community in the Rocky Mountain region. Although teachers in this school strive to effectively address the essential standards and were required to participate in annual standardized testing, they were given autonomy to develop curriculum and teaching strategies. Most implemented a project- and problem-based pedagogy as a significant part of their curricula.

#### 3.2. Data Collection and Analysis

Data collection included semi-structured voice recorded one-to-one interviews with all participants, classroom observation field notes, bi-monthly researcher debriefing sessions, and review of curriculum materials and student work (artifacts). Development of the interview guide followed principles outlined by [22] involving semi-structured, open-ended questions designed to obtain detailed descriptions and analysis of the focus topic. Interview procedures included an introductory overview of the focus topic followed with open-ended questions.

Field observations were guided by a focus on what participants and students were doing in the classroom related to problem-based learning and by first-hand evidence of the benefits and obstacles involved. Review of curriculum materials and student work served as further evidence of the details, benefits, and obstacles surrounding PBL.

The [24] categorization style of case data was used for analysis. To begin a case record was established for each of the four teacher participants. Maintaining individual case records was a strategy to compare and cross reference themes between cases. This approach limited the loss of potential contributions of each case [24]. Primary themes were determined after all data were transcribed as case records. Topics and emerging themes were recorded, and a master list was generated. A reexamination of case records was completed followed by member checks.

## 4. Results

This section is organized as 3 scenarios describing PBL in action. Each scenario represents a detailed description written as a first-person account to represent participant voices. All scenarios describe PBL implemented in a 6<sup>th</sup>-9<sup>th</sup> grade middle school; however, each scenario is unique, which underscores the notion that there is no one right way to implement PBL [8] [19]. The scenarios exemplify both the benefits and the often-unanticipated obstacles involved with use of PBL in classroom settings.

### 4.1. Scenario One: Implementing Students' Solutions for a Global Dilemma

In her interview, Ms. Miller, a middle-school English, and social studies teacher, described how she immerses her students in real-life learning where they choose a local or global issue to focus on and collaborate to thoroughly research and understand the issue's convoluted aspects and diverse perspectives. As they strive to make a difference in the world, her students brainstorm solutions for these issues and often put their brainstormed ideas into practice. Ms. Miller explained some of the benefits and obstacles involved:

When teaching this way, you trip over from make-believe world into real world. It's not teaching like we were taught to teach—*here's my nice, neat lesson plan and clear objective(s)*. Making the learning engaging, meaningful, authentic, and relevant to the students' lives is so far away from traditional, old-fashioned social studies teaching. If you're going to do this work, it's not going to feel good all the time and it's not going to be conflict free. Your students will encounter failure, problems, and conflict, and as the teacher, you facilitate as they negotiate and manage their way through it. It's messy as hell (JJ10071).

Ms. Miller clarified that the learning is very engaging for the students because it has a real-life connection and impact. She explained, "I don't want the kids to be bored or waste their time. I do my best to design work that is worth doing."

Ms. Miller described one project called *A Taxi for Farai* as being “fraught with conflict yet extremely beneficial.” On a trip to West Africa, two of the school’s teachers were transported by Farai, a local taxi driver. They learned that, although Farai charged \$60 a day for his taxi service, he only got to keep \$3.00. The rest of the money went to the owner of the taxi. Farai was attempting to support his immediate and extended family on \$3.00 a day. With his own taxi he would make \$60 a day.

The teachers brought this real-life dilemma back to the school and a group of students expressed their desire to buy Farai his own taxi; they wanted to take this on as their student-chosen and student-led, problem-based project. They began by sharing Farai’s dilemma with the school’s other K-9<sup>th</sup>-grade students. Then, through various initiatives and a lot of hard work over a year’s time, the necessary \$12,000 was raised. Three teachers and three of these middle-school students planned another trip to West Africa to gift Farai with the \$12,000 and help him acquire his own taxi. The teens were extremely excited and could not wait to see Farai’s reaction when they handed him this generous gift.

In Africa, Farai politely, but reluctantly, accepted the gift. The students were shocked with Farai’s lack of enthusiasm concerning the gift of a new taxi and learned that having his own taxi changed Farai’s status. Overnight he went from being poor and on an even playing field with most of the other citizens to being rich by his community’s standards and, therefore, more elite. They also learned that the people in this West African culture do not like to accept charity—their value system involves working hard to make a living even when it is a daily struggle. Much more important than growing his business and being financially successful was being connected with family and friends and being able to truly help others in the community. Through this experience, the students discovered that they did not have adequate cultural understanding of the situation to prevent this disappointing outcome. As Ms. Miller explained,

The students were so disappointed; they were all exclaiming, “*This whole thing is a failure!*” “*This is awful!*” It was mind blowing for the kids! In learning like this you cannot predict what will happen and the students learn to deal with the unexpected. Although difficult, this situation resulted in much more effective learning than teaching in a make-believe, textbook-driven manner. This is as real as it gets. Following this extremely discrepant event, I facilitated as my students analyzed Farai’s unexpected response. They talked to an expert in West African culture and to a person who grew up there to try to better understand the cultural perspective. As a result of this experience, these kids’ ideas about effective international aid did 180s and so did mine (JJ10072).

The teacher was allowed the efficacy of facilitating an emergent curriculum that effectively empowered the participating students to autonomously choose, learn about, and find a solution to an authentic, ill-structured, real-world issue. Throughout the process, the teacher encouraged the students to collaborate as self-directed learners while scaffolding their efforts (providing resources, contact



information, permissions, etc.) as needed. As a result, the students were intrinsically engaged in exciting, challenging, and memorable learning that promoted the development of their critical thinking, problem-solving, and collaboration skills. **Table 1** summarizes these benefits.

Brainstorming a solution to this real-world dilemma seemed easy and straight forward at first as students reacted to the idealism that is often characteristic of this age. As a result of this experience, however, the students learned that this issue was complex, convoluted, and messy. As students encountered reactions that were unexpected, they learned powerful lessons regarding the assumed efficacy of charity. They learned that this type of work is often fraught with unexpected conflict, disappointment, and even failure. Beginning with an understanding of the perspectives of all stakeholders was an essential, but missing, aspect of their PBL experience. Instead, as the students with teacher facilitation reflected on this experience, they examined the unexpected stakeholder perspectives after the fact. Even though it is impossible to thoroughly predict or control the outcomes of PBL, the teacher learned the necessity of providing more guidance to troubleshoot in advance. **Table 1** summarizes these obstacles.

**Table 1.** Summary: scenario one benefits and obstacles.

Benefits	Obstacles
Teacher efficacy to implement learner-centered, emergent curriculum where students choose, research, & solve real-world issues	Student idealism regarding issues as easy & straight-forward was tested
Challenging, memorable, & motivating work worth doing	Teacher & students dealt with unexpected conflict, disappointment, & failure
Students engage in self-directed learning	Failure to understand all stakeholder perspectives before implementing solution
Teacher scaffolds student learning as needed	Teacher learned necessity of troubleshooting before implementing solution
Promotes development of critical thinking, problem-solving, & collaboration skills necessary for 21 <sup>st</sup> century life, work, & democratic citizenship	Researching & solving real-world issues is complex, convoluted, & messy

## 4.2. Scenario Two: Global Issue Presentations

We observed in Ms. Wade's social studies classroom as 9<sup>th</sup>-grade students gave thoroughly researched, concise, presentations on controversial issues including legalization of marijuana, immigration, gun control, and more. Each presentation communicated the issue's history, its social, cultural, political, economic, and/or geographic impact, and the perspectives of diverse stakeholders. Each presentation was followed with open-ended questions to lead the class in an in-



teractive discussion and/or debate concerning the issue.

John chose to research and present on the current issue of transgender use of public bathrooms and locker rooms. He began with background information defining *transgender* as the gender with which a person identifies. Then he told how some states passed laws requiring transgender people to use the bathroom corresponding to the gender indicated on their birth certificate. He explained that a person can change the gender on their birth certificate if they have sex-change surgery, but approximately two-thirds do not get that surgery.

Following John's presentation, Ms. Wade interjected to illuminate the convoluted nature of this complex issue and make it clear that there is no simple or perfect solution:

There's potential controversy either way you go. A transgender person may be distressed if they are forced to use a bathroom that is different from the gender they identify with. On the other hand, if they use the bathroom related to their gender identity, they may be subjected to bullying and ridicule. On the other end of the spectrum if an adult transgender who is physically male uses a girls' bathroom or locker room, young girls may be disturbed if they are exposed to adult male physical anatomy (JJ80011).

Following this clarification, John led a follow-up discussion. The students' strong viewpoints on both sides of the issue were evident. Some expressed their opinion that this is a non-issue resulting in needless conflict. Gabe stated, "I don't feel like it's that big of an issue. There've been transgender people for a while, and it hasn't been a huge issue so far. So, I don't see any need for a law." Another boy commented, "Both sides are silly and they're reacting to each other. They need to either not make it a problem or compromise." A girl named Cathy commented that she had a strong opinion that differed from her more verbal peers, but after the comment about both sides being silly made by a popular classmate, she felt too intimidated to share. When called on, she dodged the issue by saying, "I want to sit this one out because I have a strong opinion and I don't want to offend anybody." At this point, Ms. Wade facilitated a mini class meeting which evidenced the strong classroom community she had established throughout the semester. She opened the meeting by explaining the situation:

It is risky when discussing a current event that may evoke strong emotion because you open yourself up to the possibility of criticism, bullying, and losing friends. At the beginning of the year, we talked about not letting this happen, but I know there's still concern in some of your minds when your opinion is strongly opposed to what you perceive the majority or popular opinion to be. I'd like to hear Cathy's opinion, but I need a guarantee from everyone that there will be no negative consequences socially in the halls, on social media, or otherwise if she expresses an unpopular viewpoint (JJ80012).

In the discussion that followed, the 9<sup>th</sup>-graders agreed to respect differing opinions and not gossip or engage in putdowns related to this discussion. Once the

air was cleared, Cathy felt comfortable speaking up and began by saying, “I’m very against this whole thing and that’s my opinion. I might think you’re wrong about what you believe, but that doesn’t mean you are wrong.” As a member of the community swim team consisting of 6 - 19-year-olds, she made the point that, “In the locker room changing into a swimming suit, you’re going to be exposed at some points. It would be very uncomfortable to have a person with a physically male body in there while you’re changing, even if they identify as a female otherwise.”

At this point the boy who initially expressed these opinions on both sides of this issue commented, “Honestly, I agree that it would probably be uncomfortable; I haven’t been in that situation. However, I think that this is a controversy that can be worked out by itself rather than making more controlling laws.” Another boy offered the following suggestion, “If we just had some unisex bathrooms like they have in some facilities that would solve the problem. Instead of being for or against transgender people using bathrooms consistent with their identity, we could provide unisex bathrooms to satisfy both sides.”

The teacher felt empowered to develop an innovative learner-centered curriculum to address many social studies and language arts standards. The power of self-chosen, emergent, relevant, and problem-based curricula in effectively engaging 9<sup>th</sup> graders in interdisciplinary and intrinsically motivating learning was evident in the observations of presentations and follow-up discussions/debates. All the 9<sup>th</sup> graders in this class appeared to be interested, attentive, and engaged in this learning context. Throughout the process of researching, presenting, and participating in discussions/debates led by their classmates, they were memorably engaged in critical thinking about the disparate perspectives surrounding controversial issues and the brainstorming of some viable solutions. Although it is difficult to get students to think beyond their own perspective, these discussions prompted students to challenge and sometimes alter their thinking. Because of the supportive and trusting classroom community established at the beginning of the semester by a skilled facilitating teacher, students’ diverse perspectives concerning strongly held viewpoints could be safely aired and considered even though it was apparent that these issues were fraught with controversy. Such an instructional context is helpful in preparing students for their future 21<sup>st</sup> century life, work, and democratic citizenship. **Table 2** summarizes these benefits.

Students sometimes chose to research and present on sensitive issues that required some scaffolding clarification by the teacher. At first, giving in to their idealistic thinking, some of the students assumed that the answer to the issue of transgender bathrooms/locker rooms was simple and straight forward. It became obvious during this student-led discussion/debate that a supportive classroom community is essential for students to feel safe in sharing unpopular opinions. Impromptu class meetings to proactively resolve issues that naturally arise during PBL reinforce this positive environment. Once again, the teacher in this scenario was able to provide her students with general guidelines concerning their

research and presentation preparation but could not thoroughly predict or control the outcomes of each presentation and the resulting interactive discussion/debate. **Table 2** summarizes these obstacles.

**Table 2.** Summary: scenario two benefits and obstacles.

Benefits	Obstacles
Teacher efficacy to implement a student-led, emergent, & interdisciplinary curriculum	Student idealism regarding issues as being easy and straight-forward was tested
Establishment of a supportive/trusting classroom community = safety in airing diverse and sometimes unpopular perspectives	Issues chosen by students were often sensitive with strong conflicting viewpoints
Students interested, attentive, & intrinsically motivated in memorable, self-directed work worth doing	Teacher could not thoroughly predict or control the outcome of the presentations & interactive discussions/debates
Students engaged in critical thinking surrounding diverse perspectives & brainstorming viable solutions to authentic, real-world issues—helps prepare students for 21 <sup>st</sup> -century life, work, and democratic citizenship	Thinking on her feet, clarification scaffolding was required by the teacher
Discussions prompted students to challenge & sometimes alter their thinking	

### 4.3. Scenario Three: Multidisciplinary Garbology Unit

A middle-school science teacher shared how the school's 3 language arts/social studies and 3 science/math teachers met together weekly and sometimes daily throughout the school year to collaborate in the development and sustainability of a learner-centered, interdisciplinary problem-based curriculum. This problem-based unit focused on the issue of garbology (the study of garbage, environmental pollution, and how people choose, use, and dispose of materials). Throughout this unit, the teachers effectively addressed the essential standards in science, social studies, and language arts as well as many standards in math, art, and music through the study of real-world dilemmas related to the overarching concept of garbology.

During the first semester, the 6<sup>th</sup>-9<sup>th</sup> graders were exposed to interdisciplinary background knowledge concerning garbology. They focused on the resources used to make things like plastic grocery bags and Styrofoam cups that are designed for minutes of use before being thrown away. They took the students on field trips to the wastewater treatment plant, landfill, recycling center, etc. Guest speakers presented differing perspectives regarding the mining and burning of coal, oil, and gas. Throughout this unit, they addressed the questions—*How are the things we use made? How do we dispose of the things we do not want anymore? Where does our waste end up? How are we impacted by this waste?*

During the second semester, with teacher facilitation, the students engaged in garbology-related research and problem solving. They naturally integrated their first-semester learning concerning the economic, political, geographical, cultural, and social aspects of garbology. Researched evidence was used to support their insights and opinions in class discussions as they brainstormed and implemented viable solutions to garbology-related dilemmas.

Because the second semester problem-solving phase was student chosen and student led, the curriculum was emergent, and the end projects were quite unpredictably diverse. One group was concerned that local grocers and caterers were throwing out good food and shared their research to convince them to donate edible food to the Soup Kitchen and Food Pantry. Another group was concerned about the use of Styrofoam in the school lunchroom. As a result of their request, reusable plastic trays were installed in the lunchroom immediately. Once this problem was solved, the students adjusted their focus to encouraging local restaurants to adopt an environmentally friendly, fiber-board alternative to Styrofoam take-out containers. By sharing their research, they successfully convinced five major restaurants in the city to do this. A third group was concerned about the often-one-time use of plastic bags in grocery/department stores. Sharing their concern, they convinced three stores to eliminate plastic bags and require customers to provide their own (generally cloth) bags to tote their purchases.

In this scenario, the teachers felt empowered to design and facilitate an emergent, interdisciplinary curriculum where essential standards in many subject areas were effectively addressed. This problem-based unit involved a lot of student voice and choice focused on relevant and authentic issues concerning garbology. Observations revealed that most of the students were motivated and actively engrossed in this challenging learning experience. Throughout this unit, students were engaged in the research of diverse perspectives and the discussion of viable solutions to the garbology problems they identified. They quickly discovered that these problems play out in complex and convoluted dilemmas with no easy or perfect solution. These students were immersed in making claims based on their critical analysis of the researched evidence they collected. Students brainstormed viable solutions to the garbology issues that they identified and researched. This led to worthwhile civic action where the students helped effect positive differences in their community, a preparatory activity for their future life, work, and democratic citizenship. **Table 3** summarizes these benefits.

As is the nature of PBL that is real-world driven, it was impossible for teachers to plan out completely ahead of time. Sometimes events that students assumed were complex issues, were easily solved. Furthermore, their idealistic solutions were not always easy to implement in the real-life community. Consequently, the students had to be flexible in their thinking as they changed their focus or altered their plans. The teachers also had to be flexible as they followed the lead of the students, not knowing from day to day where the students' research and

**Table 3.** Summary of scenario three: benefits and obstacles.

Benefits	Obstacles
Teacher efficacy to implement interdisciplinary, student-led, emergent curriculum	Impossible to plan out completely in advance--required flexibility as teachers followed lead of students
Brainstormed viable solutions to implement civic action related to garbology issues	Areas students idealistically as challenging, were issues easily solved
Students interested, attentive, & intrinsically motivated in memorable, self-directed work worth doing	Students idealistic solutions were not always easy to implement in the real-life community
Students engaged in critical thinking, problem-solving, & collaboration skills to help prepare them for 21 <sup>st</sup> -century life, work, & democratic citizenship	PBL implemented by a team of teachers who had to manage extensive blocks of time to plan

ideas would lead them. Because this was implemented by a team of teachers, they had to be willing to chisel out time in their busy schedules to meet, sometimes on a daily basis, to keep this evolving, student-led unit progressing optimally. This required innovation on the part of the teachers as they facilitated an emergent curriculum to address their social studies, science, math, and language arts standards in a way that related to their overarching theme of garbology. **Table 3** summarizes these obstacles.

## 5. Discussion and Implications

The obstacles involved in implementing PBL were significant. Because students were given the lead in choosing problems, and because most had not yet developed proficient research, problem-solving, critical thinking, and collaboration skills, the daily learning as well as the learning outcomes were convoluted and unpredictable. Brainstorming solutions to real-world problems appeared straightforward. At first, students reacted to the idealism characteristic of this age, however, they soon realized that engaging with problems and solutions does not feel good all the time and is not conflict-free. Furthermore, the PBL environment was inefficient and time-consuming in terms of teaching planning and classroom implementation. Essentially, it was more time-consuming for teachers to plan and implement PBL in comparison with using a prescribed curriculum. As such, teachers' flexibility and commitment along with the skill for teachable moments are required to scaffold students' learning, address unanticipated student needs, and revise daily lessons instantaneously.

The benefits of immersing students in interdisciplinary PBL, as evidenced in the 3 case scenarios, are noteworthy. As thoroughly suggested by the results of this study and literature review, students who engage in PBL develop higher-level critical thinking skills [19], innovative problem-solving skills (15), and collaborative communication skills [11]. Students also experienced intrinsic mo-

tivation for learning [8] and gain the potential for becoming self-directed, life-long learners [15] in preparation for 21<sup>st</sup>-century life, work, and democratic citizenship [10].

The scenarios showcase how middle school students can collaborate with teachers, peers, and experts in their communities and around the world to investigate and brainstorm solutions to critical contemporary issues. They demonstrate how most students (regardless of SES, English-language proficiency, or ability) can be actively engaged in researching diverse perspectives, critical thinking, brainstorming and implementing solutions to authentic interdisciplinary local and global dilemmas. These opportunities prepare students for the challenges of future work, life, and citizenship, and help them become intrinsically motivated and self-directed lifelong learners [17] [25].

Moving beyond the traditional, test-prep, textbook- and lecture-based curriculum and beyond the drill-and-practice memorization, virtually all students can be engaged as active participants in authentically memorable learning environments. To that end, this study encourages teachers to take a close look at their current curriculum and instruction and ask themselves two simple questions:

- 1) Are my students engaged in learning?
- 2) Are my students internalizing the learning?

If the answer to either or both questions is no, teachers are encouraged to think outside the box and find ways to empower their students.

Teachers may ask why utilizing PBL is so essential when these learning experiences cannot guarantee improved standardized test scores. The answer goes much deeper than test scores. There is a lot of talk about ensuring that our students develop higher-level critical thinking skills, but often there is no action taken to effectively teach these skills. PBL is, therefore, essential because students are given a voice and choice in learning that is relevant, challenging, and authentic. Students will, at long last, be “*pounding down the doors*” to get into school rather than *pounding down the doors* to get out.

A powerful implication of this research is that educators everywhere are called to examine what is important in educating children—the promotion of student apathy to assure standardized testing success or the development of higher-level thinking skills while keeping students’ love of learning alive. Implications of this study endorse the idea that less emphasis should be placed on standardized testing success where, in preparation, students tend to develop an apathetic attitude toward school-based learning as they are required to passively absorb isolated and fragmented facts. In contrast, more emphasis should be placed on authentic PBL that promotes real-world, 21<sup>st</sup>-century critical thinking, problem-solving, and collaboration skills. To achieve this, it is essential that teachers be released from mandates requiring the use of scripted curriculums with fidelity.

As the world we live in changes to embrace the future, how and what we teach in public education systems will also be reshaped to keep up to date with the growing demands of the 21st century. As such the authors encourage the use of

the examples and lessons learned in the three case scenarios as a starting point to develop PBL lessons and curriculums that honor contemporary ways of teaching and learning. Although the PBL methodology is time-consuming and unpredictable, it is critical for student development of critical thinking, innovative problem-solving, and collaborative communication skills necessary for 21<sup>st</sup>-century life, work, and democratic citizenship [11] [12] [17] [25]. It is, of course, acceptable to start small and gradually expand PBL experiences in classroom settings. Taken together, the future of learning and teaching is essential because today's students will grow up to be the problem-solvers of tomorrow.

## Conflicts of Interest

The authors declare no conflicts of interest.

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