I. Title of Project

Integrating STEM and PBL Among Different Disciplines

II. Curriculum Topics, School Name, Number of Educators, Grade Level(s)

My presentation took place at John Adams Middle School(JAMS) in Charleston, WV. JAMS is a suburban school which draws a diverse array of students from the surrounding area. With a student population of around 830 it is one of the larger middle schools in the area and the only feeder school for George Washington High School. JAMS is one of only two middle schools in the district that offers advanced math classes in 7th and 8th grades as well as advanced science class in the 8th grade.

My professional development(PD) presentation did not focus on a specific curriculum but instead was aimed at increasing awareness of integrating Science, Technology, Engineering, and Math(STEM) along with Project Based Learning(PBL) across the different curriculums at the school. It was given to a total of 12 teachers, all of which have students in the 8th grade with a few that teach 6th and 7th grade as well. The breakdown included mostly teachers from the core subjects in the 8th grade, specifically: one science teacher, and two of each from math, English, and Social Studies (specifically West Virginia Studies). The breakdown of other teachers is made up from related arts teachers and is as follows: two special education teachers (1 learning disabled and 1 advanced studies/gifted), one art teacher, two general music teachers (one also teaches band and the other teaches chorus).

III. Standards Addressed

Since my presentation was not subject specific I didn't have a certain set of standards that were being addressed. I did, however, create a list of standards from the other disciplines that I felt were relevant to the sample lesson that I included in my presentation (TREE, n.d.). Some of the possible standards I identified were as follows:

English Language Arts

ELA.8.26

> Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

ELA.8.27

> Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of

others while avoiding plagiarism and following a standard format for citation (e.g., MLA or APA).

ELA.8.28

Draw evidence from literary or informational texts to support analysis, reflection, and research.

Math

M.8.6

Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities. (e.g., Use millimeters per year for seafloor spreading.) Interpret scientific notation that has been generated by technology.

M.8.15

Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

M.8.24

Know the formulas for the volumes of cones, cylinders and spheres and use them to solve real-world and mathematical problems.

Social Studies/West Virginia Studies

SS.8.23

Demonstrate an understanding of major social, political, and economic developments that took place in West Virginia during the twentieth century

SS.8.26

Demonstrate an understanding of West Virginia in the modern era

Science

S.HS.ETS.1

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

S.HS.ETS.2
Design a solution to a complex real-world problem that can be solved through engineering

S.HS.ETS.2
Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints

Art

VA.6-8.2
Construct—individually and collaboratively, for peer review—both two- and three-dimensional art that uses multiple media to communicate ideas, experiences, and narratives.

Music

MU.AH.6
Evaluate a given music work and determine how music elements are used to prompt an emotional response.

MU.AH.10
Compose and/or arrange music.

IV. Summary of Project

As I mentioned in my proposal, my topic comes from a desire to move more towards project based learning in all of my classes. Inevitably, when I do PBL in my classes I cover areas from the other disciplines at the school. Thus, my presentation focused on introducing STEM concepts into the other classes along with the idea of developing a cross-curricular unit around the topic of the world water crisis. My goal was not to develop a unit plan during the presentation, but to provide a framework for how it could be accomplished in the event we decided to take on the task.

V. Pre-questions Survey List

My pre-questions survey was a mixture of questions that involved a rating scale from 1 to 5 and short answer survey questions. The survey was as follows:

1. Have you ever used PBL in your classroom?
2. On a scale of 1 to 5, how favorable is your opinion of PBL?
3. Have you ever incorporated, or considered incorporating, STEM content into your lessons?
4. If no to #3, would you consider it?
5. On a scale of 1 to 5, how favorable is your opinion of STEM in schools?
6. On a scale of 1 to 5, how likely would you be to take part in a cross-curricular, STEM based, PBL lesson?

VI. Brief Description of the Actual Professional Development Training

The PD training started off with a brief description of the scope of the session. I explained to the attendees that we would be looking at possible ways to incorporate STEM topics and PBL across the different curriculums.

Next, I addressed two specific questions with the group of attendees: 1. “What is STEM and why is it important?” and 2. “What is PBL?”. I explained to the group the meaning of STEM and even explained that in some cases an “A” is added to represent the arts making the acronym STEAM. We discussed that science, technology, engineering and math play a vital role in our society. They are truly the basis of manufacturing, food production, healthcare, and much more. Then, discussing PBL, I mentioned that students engage with real-world scenarios/challenges and gain valuable knowledge and skills. Then I went a little deeper into the benefits of PBL. These included: students engage deeply in the content, focuses on long term retention as opposed to short term memorization, can improve students’ attitudes towards education, increase student engagement, and correlates positively with student achievement. In addition, PBL also builds student choice into the program, encourages critical thinking, collaboration, and communication, and provides opportunities for feedback and revision (Schuetz, R., 2018). I also explained that STEM and PBL blend together perfectly because STEM based projects are interdisciplinary, collaborative, inquiry based and self-directed, and address a full range of learning styles (Schuetz, R., 2018).

I then introduced the sample lesson “Water Woes, Solving the World’s Water Crisis”. This lesson is adapted from high school and middle school curriculum put out by Water.org. the lesson entails student groups first being assigned developing country. They have to research specific information about their country including but not limited to: Description of physical location and geography, description of the water crisis, relevant statistical information, and problems specific to the country/region. After their research, the students are required to write a list of recommendations to improve the water crisis in their assigned country and present their research and recommendations to the class.

The second part of the lesson student groups, 1. Research, analyze, interpret and apply information to invent and design new water supply, collection and/or sanitation technology.
2. Present their original concept for a design, an illustration and description of the working parts of the technology, as well as a detailed rationale or explanation for the necessity of the design. 3. Submit the collection of their work to the teacher group operating as an “international patent office” for constructive feedback.

Finally, the attendees took part in the planned activity. Their task was to

select two of their standards and then generate a general lesson idea, based on their chosen standards, that would fit within the sample lesson. Following this activity, I distributed the post-survey questions and then followed up with the teachers over the next few days.

VII. Brief Outline of the Activities in the Pick-up Unit

As I mentioned before, my PD presentation did not focus on one particular curriculum. Since that is the case I did not have a specific set of activities. Instead, what I did was to provide possible lesson ideas for each discipline to enact within the scope of the sample lesson that I used for the session. The possible lesson ideas I presented to my colleagues were:

Science

Investigate/research water-borne pathogens as well as water filtration/sanitation techniques

English Language Arts

Professional/technical writing and proper citation of sources

Math

Calculating flow rates of different filtration materials and calculating scale for models

Social Studies/West Virginia Studies

Research the history of water filtration/sanitation and the West Virginia Water crisis along with its causes, implications, and impact on the local community.

Art

Creating drawings/blueprints of students' designs to scale.

Music

Creating/arranging music to accompany student presentations.

VIII. NASA Data/Endeavor Course Components Included

The NASA data that I included with my session came from the NASA Earth Observations website https://neo.sci.gsfc.nasa.gov/ . This site provided a multitude of maps, related to the sample lesson, dealing with the atmosphere and land. There are many different maps that can be used to provide data relevant to the world water crisis such as day and night land temperatures, rainfall, population density, and many more. In addition to the NASA data, I was also able to use information from my other Endeavor class that I am taking this spring SCED 550, The Arts in STEM: Advancing Meaningful Integration. This class, in addition to providing the insight to include music and art teachers in my PD, but it also helped me to generate ideas on how to integrate the arts into this lesson using the standards for those classes.

IX. Follow-up Activities and Post-questions Survey List

My follow-up activity consisted of the teachers who were present choosing two standards for their curriculum and coming up with a lesson idea that they felt would fit into the PBL unit. My post questions were once again a mix of different types of questions. There were some that used the same rating scale as before and asked them to rate their feelings towards STEM and PBL

after the session, and there were some short answer questions eliciting feedback on the quality of the PD.

1. On a scale of 1 to 5, following the presentation, how favorable is your opinion of PBL?
2. Based on the presentation, would you consider incorporating STEM content in your lessons? Is this answer different from before? If so, why?
3. Compared to your opinions prior to the presentation, how likely would you be to take part in a cross-curricular, STEM based, PBL lesson?
4. How well did this presentation address your concerns regarding the use of cross-curricular STEM/PBL lessons in your school?
5. What would have made this presentation more beneficial for you?
6. What kind of support would you expect from a science teacher in this type of unit?

X. Outcomes, Final Data Collection, and Analysis

a. Survey Results/Comments on the content included

For the STEM aspect of the PD session, on a scale of 1 to 5, 75% of the attendees had a favorable view of STEM in schools (rating of = or > 4) and 25% marked a rating of 3. However, 100% of attendees said they would be willing to include some STEM content into their lessons even though some had reservations which mostly had to do with their limited understanding of the content. When asked what type of support they would expect from a science teacher in this type of unit, most of the answers revolved around being provided the proper scientific resources, help with understanding the content, and help with integrating the content into the various disciplines. When asked on the post-survey if they would consider incorporating STEM content into their classes 100% of attendees responded yes but with support.

b. Survey Results/Comment on the pedagogy included

Concerning the pedagogy, the majority of attendees (75%) had, at one point, attempted to address PBL in their classes or had been in classes where PBL was being implemented. The only teachers that had not used PBL in some form were the two music teachers and the art teacher. On the pre-survey only 50% of the attendees had a mostly favorable view of PBL (rating of 4), 25% indicated a rating of 3, and 25% indicated a rating < 3. On the post-survey, those numbers did change with 75% of attendees giving their view of PBL a rating of 5, about 17% a rating of 4, and around 8% giving a rating of 3. All

attendees mentioned that their questions about PBL were answered sufficiently, that the presentation addressed “how” we could implement a cross curricular PBL lesson, and felt more comfortable with PBL than before the session.

c. Was your professional development successful? Why or why not?

Overall, I feel that my PD was successful. The vast majority of respondents left the session with a very positive view towards including a cross curricular, STEM based, PBL lesson. They felt as if the possibility of developing a cross-curricular lesson is much more feasible now than before the PD. The only attendees that did not express an interest in taking part in a cross curricular, STEM based, PBL lesson were the music teachers and art teacher. This was not due to their lack of interest in the content or the pedagogy, but due to the fact that there is so much cross-teaming with their classes, which means that unless both 8th grade teams are not taking part in the lesson then it would be harder for them to implement their parts of the lesson.

d. How did this project relate to the readings?

One way that this project related to the readings is referencing the reading, “Engineering Professional Development Design for Secondary School Teachers: A Multiple Case Study”. In that reading the author discusses the fact that focusing on standards in PD may lead to a “deskilling” of the teachers who are taking part (Daugherty, J.L., 2009). Even though I can see the logic behind their statement I feel that it is important to include standards in a PD. Since most school districts require teachers to address all of their standards throughout the school year I feel that it makes sense to include standards in professional development.

Another way that this project related to the readings stems from being a leader in the school environment and helping to reform procedures within the school and implementing change. In the article “Toward an Understanding of How Teachers Change During School Reform: Considerations for Educational Leadership and School Improvement”, the author states, “If educational leaders do not know how to engender change within teachers, the capacity to move a school forward would be restricted by the limited pedagogical knowledge”. I feel that PD has to move a school forward and engender change in order for it to be fully effective.

e. Will the teachers do these activities again?

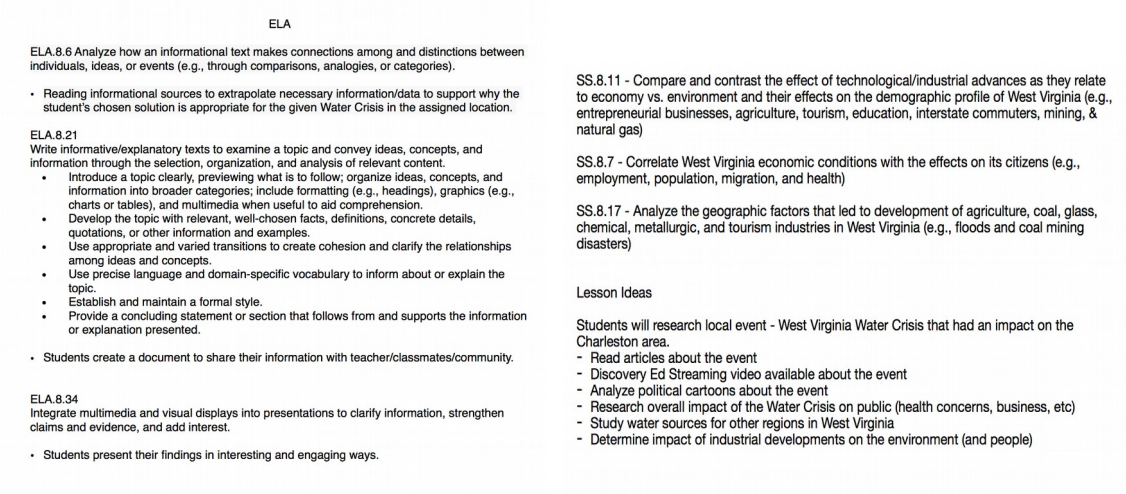
As mentioned before, all of the attendees except the music and art teachers, expressed an interest in taking part in a cross curricular, STEM based, PBL lesson. I look forward to working with my colleagues who teach the core subjects in developing the lesson that hopefully we will do next school year.

f. Reflection

Reflecting on this experience I have learned a great deal about myself. I never thought of myself as a leader within my school community. Initiating this PD program taught me that I do have the ability to lead my fellow teachers and help guide the direction of education within my school and quite possibly my district. The comments I received after the session were all favorable. The attendees felt as though their concerns regarding implementing a cross curricular, STEM based, PBL lesson were addressed in a satisfactory manner. They felt confident that, as a science teacher, I would be able to provide support for them regarding the STEM content. Some changes I would make in the presentation come from my own observations as well as comments made by attending teachers. First of all, I don't feel that my questions on the pre- and post-survey were adequate. I would take time to review the questions rework them to make them more comprehensive. Second, most attendees mentioned that since I have done this lesson before with my own students, it would have been beneficial to show examples of student work in the presentation. Overall, I feel that it well and it was definitely a positive experience for myself and my colleagues.

XI. Appendix

A. PD Activity Artifacts



ELA

ELA.8.6 Analyze how an informational text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).

- Reading informational sources to extrapolate necessary information/data to support why the student's chosen solution is appropriate for the given Water Crisis in the assigned location.

ELA.8.21
Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

- Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts or tables), and multimedia when useful to aid comprehension.
- Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
- Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
- Use precise language and domain-specific vocabulary to inform about or explain the topic.
- Establish and maintain a formal style.
- Provide a concluding statement or section that follows from and supports the information or explanation presented.

- Students create a document to share their information with teacher/classmates/community.

ELA.8.34
Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

- Students present their findings in interesting and engaging ways.

SS.8.11 - Compare and contrast the effect of technological/industrial advances as they relate to economy vs. environment and their effects on the demographic profile of West Virginia (e.g., entrepreneurial businesses, agriculture, tourism, education, interstate commuters, mining, & natural gas)

SS.8.7 - Correlate West Virginia economic conditions with the effects on its citizens (e.g., employment, population, migration, and health)

SS.8.17 - Analyze the geographic factors that led to development of agriculture, coal, glass, chemical, metallurgic, and tourism industries in West Virginia (e.g., floods and coal mining disasters)

Lesson Ideas

Students will research local event - West Virginia Water Crisis that had an impact on the Charleston area.

- Read articles about the event
- Discovery Ed Streaming video available about the event
- Analyze political cartoons about the event
- Research overall impact of the Water Crisis on public (health concerns, business, etc)
- Study water sources for other regions in West Virginia
- Determine impact of industrial developments on the environment (and people)

These are the Algebra Standards:

M.A1HS.1

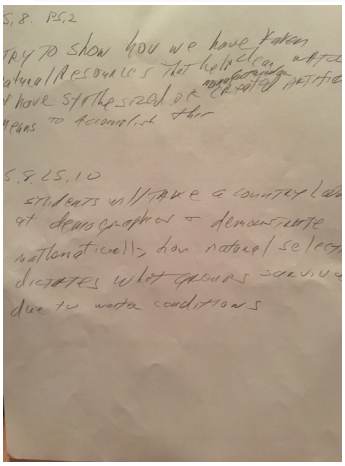
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

M.A1HS.2

Define appropriate quantities for the purpose of descriptive modeling. Instructional Note: Working with quantities and the relationships between them provides grounding for work with expressions, equations, and functions.

M.A1HS.3

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.



XII. Attendee Contacts

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XIII. Citations

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