Mandatory 4: Final Paper on Professional Development

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Professional Development Project Title:

STEM, a model for cross-curricular education.

Justification

During my initial discussion with Principal Steve States of Grand River Academy, Principal States expressed interest in a professional development that addressed how to incorporate STEM across all subject areas including ELA. Therefore, I designed the professional development around demonstrating how STEM can be used in cross-curricular education. After receiving responses from a pre-survey, I re-designed the professional development to include the engineering design process and the 5E lesson plan format, as described below.

The professional development was held at Grand River Academy on September 24, 2018 for an hour-long session. I approached Grand River Academy because I have one of their high school students in my concurrent enrollment STEM Discovery program, and it was my understanding that Grand River Academy does not have a defined STEM program. Grand River Academy is a blended school model offering on-line classes with regular on-site classes once a week. Grand River Academy headed by Principal Steve States has 23 elementary students, 73 middle school students, and 221 high school students. The teaching staff consists of 1 elementary teacher, 3 middle school teachers, 5 high school teachers, a kindergarten teacher, and 3 resource staff. All 13 teachers (covering math, science, language arts, social studies, and ELA) attended the professional development, as well as Principal States.

Learning Goals for Educators:

I conducted a simple pre-survey for the professional development to gather information on the teachers understanding of STEM and related pedagogy. Below are the questions on the pre-survey:

- *What grade level and subject do you teach?*
- *What does STEM education mean to you?*
- *Are you familiar with the 5E lesson plan? If so, do you use the 5E lesson format?*

Of the thirteen teachers surveyed, 31%, or 4 responded to my pre-survey. Two from middle school that teach math/science and language arts, and two from high school that teach math, comp/lit and electives. All respondents had a good idea of what STEM education should look like, however, two of the respondents did not include engineering in their description of STEM. Only one of the respondents was familiar with the 5E lesson plan. Because of the missing engineering component in 50% of the respondents, and unfamiliarity of 75% of the respondents I re-designed the professional development to incorporate the engineering design process and the 5E lesson plan format. I decided to introduce, then model the engineering design process and a 5E lesson. Therefore, the key learning goals for the teachers are as follows:

1. *The teachers will be able to describe the Engineering Design Process.*

2. *The teachers will be able to define a 5E lesson plan.*
3. *The teachers will be able to use a carbon footprint calculator to incorporate STEM into their curriculum.*

Summary: Curriculum Topics and Standards Addressed Including NASA Resources

Starting with the pre-survey questions listed above, I used the responses to provide direction of my professional development. The focus of this professional development was to enhance the teachers' content and pedagogical knowledge (Daugherty, 2009, p. 11) to integrate STEM into their curriculum. Even though those who responded to the pre-survey could define STEM, those who did not respond may not have done so, because they were not confident in responding to questions 2 and 3 of the pre-survey (listed above). Therefore, I felt it appropriate that we define STEM, and I did so by incorporating the responses that I *did* receive from the pre-survey. In summary: STEM is the integration of Science, Technology, Engineering, and Math into your curriculum in a Problem Based Learning environment, developing Problem Solving and Critical Thinking Skills. From the pre-survey, I identified the need to model the Problem Solving/Engineering Design Process and the 5E Lesson Plan, through a hands-on activity, and encourage teacher collaboration (Daugherty, 2009, p. 20), and to engage the teachers as adult learners (Daugherty, 2009, p. 11), during the professional development. I introduced the Engineering Design Process with the graphic from the NASA site: https://www.nasa.gov/audience/foreducators/best/edp.html. We discussed how problem solving parallels the engineering design process. I then used the Nasa eclips site: https://nasaeclips.arc.nasa.gov/teachertoolbox/the5e, to introduce the 5E Lesson Plan and how the 5E lesson follows the natural patterns of problem solving, thus tying the 5e lesson to the engineering design process. I then explained that I was going to use the carbon footprint calculator: https://footprintcalculator.org to model a 5E lesson and the engineering design process. I modeled the 5E Lesson: How Big is Your Carbon Footprint (created for the Endeavor methods course, and a copy provided to each teacher at the end of the professional development).

ENGAGE: I presented a photo of a polar bear perched on a small piece of floating ice. I asked the teachers to describe what was happening in the photo. We were able to agree that this could be a result of global warming. I modeled additional questions from the 5E lesson plan:
EXPLORE: Each teacher had a computer and used the carbon footprint calculator to calculate their own carbon footprint and identify the data for their personal overshoot day, the consumption category that had the greatest impact on their carbon footprint, and the number of earths required to sustain the worlds' population if everyone lived their lifestyle.
EXPLAIN: I asked the teachers to discuss what the data meant with the other teachers at their table. I then posed the question: How can you reduce your carbon footprint? We had a brief open discussion on the ways this could be done. Then I asked them to develop a plan to reduce their carbon footprint.
ELABORATE: The teachers revisited the carbon footprint calculator to test their reduction plan. The teachers were then challenged with cutting the number of earths required to

sustain the worlds' population in half by redesigning their plan and testing as needed. **EVALUATE:** We had a brief open discussion on how the teachers might evaluate their students throughout the lesson.

Throughout modeling the lesson, I identified each stage of the 5E lesson we were engaged in as well as how we were progressing through the engineering design process. Following the modeled lesson, I asked each the teachers how they could use this in their grade and subject area. This prompted collaboration between and across grade levels and subject areas. I finished the professional development by identifying the related Next Generation Science Standards (NGSS) as follows:

Next Generation Science Standards (NGSS).
High School: Engineering, Technology, and Applications of Science (ETS)

> *HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.*
> *HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.*

I explained that each teacher should make adjustments to the lesson to address concepts, topics and standards appropriate for their grade level and subject area. I then answered any questions the teachers had.

Follow-up

The afternoon of the professional development, I emailed the participants my 5E Lesson Plan: How Big is Your Carbon Footprint, with all the supporting documents; rubrics, assessments, worksheets and answer sheets. I attached a list of my ideas and thoughts on how the carbon footprint calculator could be used to integrate STEM into the following subjects: Language Arts/Writing, Earth Science, Environmental Science, Oceanography, Social Studies, Math, Engineering, Technology, and ELA. I also included links to the following resources:

- **Carbon Footprint Calculator**
  https://www.footprintcalculator.org/
- **World footprint data:**
  https://data.footprintnetwork.org/#/
- **NASA BEST: (Engineering Design Process, Activities Guide)**
  https://www.nasa.gov/audience/foreducators/best/index.html
- **NGSS**
  http://www.nextgenscience.org/
- **CCSS**
  http://www.corestandards.org/
- **5E Lesson**
  https://nasaeclips.arc.nasa.gov/teachertoolbox/the5e
- **Activities and Challenges**

http://pbskids.org/designsquad/
http://pbskids.org/designsquad/project/309316/

Friday following the professional development (Monday Sept. 24), I sent out a post-survey (see Post-Survey Questions below). One week later, I followed up with a reminder, politely asking for those who hadn't yet had time, to please take a minute or two to complete the post-survey.

Reflection and Outcomes

I feel the professional development was well received. All were engaged in the carbon footprint activity and most contributed to discussions and peer collaboration. Effective professional development includes, enhancement of teachers' content and pedagogical knowledge; collaborative participation; in-depth, active learning opportunities; and engaging teachers as adult learners (Daugherty, 2009, p. 11). I believe the professional development was effective as I was able to enhance the teachers' content and pedagogical knowledge by first introducing the engineering design process and the 5E lesson plan as content, then modeling the pedagogical practices of both, by engaging the teachers as adult learners through the active learning activity of the carbon footprint calculator. I used SurveyMonkey for the first time to conduct a post- survey.

Post-Survey Questions:

1. *On a scale of 1 to 5, with 1 being confusing and 5 being clear, please rate how the Engineering Design Process was presented.*
2. *On a scale of 1 to 5, with 1 being not effective and 5 being effective, please rate how effective using the carbon footprint calculator was in demonstrating how to integrate STEM into your curriculum.*
3. *On a scale of 1 to 5, with 1 being the worst and 5 being the best, please rate how well the 5E lesson plan (Engage, Explore, Explain, Elaborate, and Evaluate) was integrated while doing the carbon footprint activity.*
4. *What did you learn from the Professional Development on STEM integration?*
5. *On a scale of 1 to 5, with 1 being the worst and 5 being the best, please rate the Professional Development on STEM integration.*
6. *Comments or Questions:*

From the 46% who responded to the follow-up survey, I can conclude that the professional development was successful with improvement needed on the 5E lesson plan. The scores for each question are as follows: Q1 4.33/5 (engineering design process); Q2 4.5/5 (integrating STEM with carbon footprint calculator); Q3 3.83/5 (5E lesson plan); Q5 4.5/5 (professional development). Q6 was an optional open response for questions or comments, where the only response was a "thank you". Q4 was also an optional open response that shows evidence of a successful professional development as defined by Desimone (2009) as one of the four steps of effective professional development: "The professional development increases teachers' knowledge and skills, changes their attitudes and beliefs, or both" (p. 70). This is demonstrated by the following teacher responses:

- "It [STEM] is easy to incorporate into a Science lesson. Especially if already using an inquiry or
  Workshop lesson plan format."
- "Definition of STEM and how easy it can be incorporated into a lesson."

- “That there is no reason cross-curricular education between STEM and ELA shouldn’t be happening”

I can say with confidence that the educators met learning goal #3 (see Learning Goals for Educators above) from the responses to Q4 in the post survey, the 4.5/5 score received on Q2, and the 4.5/5 score on Q5. Without any direct reference from Q4 to the engineering design process or the 5E lesson plan (learning goals #1 and #2), I can only draw conclusions from post survey Q1 and Q3. The 4.33/5 score for Q1 indicates that there was some success, but there may be a need for some of the educators to receive additional professional development on the engineering design process. The 3.83/5 on Q3 tells me that there is a need for additional professional development on the 5E lesson plan. I hope that the teachers are motivated enough to find time to visit the NASA sites (provided) on the engineering design process and the 5E lesson plan to enhance their pedagogical practices. From discussions during the professional development, I learned that there were a few teachers that have used a carbon footprint calculator in the past. Through the professional development these teachers learned how to enhance their lessons to include more of the STEM disciplines. So, I believe that there are some teachers that will use the carbon footprint activity and incorporate the pedagogy modeled in the professional development. My presentation of this professional development went overtime, taking 75 minutes rather than the 60 minutes planned. I was grateful that Principal States was flexible with the time. Now that I have been through presenting this professional development, I am confident I can refine (put more emphasis on the 5E lesson plan) my presentation and be more successful. I would certainly do these activities in another professional development if the opportunity presents itself. I think it would be more effective to schedule three successive professional development sessions: the first being the one I presented; the second, focusing on the 5E lesson plan, having the educators collaborate with other educators in the same subject to write a 5E lesson plan with peer feedback; and third, focus on the engineering design process, having the educators collaborate with other educators in the same subject to design a lesson around the engineering design process with peer feedback.

Two Attending Educators:

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References:

Daugherty, J. L. (2009). Engineering Professional Development Design for Secondary School Teachers: A Multiple Case Study. *Journal of Technology Education, 21*(1), 11, 21.

Desimone, L. M. (2001). A Primer on Effective Professional Development. *Kappan, 92*(6), 69-70.