STEM, Project-Based Authenticity; More Is Not Always Better

Jason D. McKibben
West Virginia University

Tim H Murphy
Texas A&M
Background

- Agricultural education was originally designed to be an extension of science  
  (Dewey, 1916; Hammonds, 1950; Hummel, & Hummel, 1913; Stevenson, 1925; Sutinen, 2012)

- In fear of being outpaced, sciences and math were pushed out of the context of agriculture several times  
  (Hillison, 1986).
  - Prosser and Snedden in the name of vocationalism with the Smith-Hughes act.  
    (Hyslop-Margison, 2000).
  - 1950’s “red scare”  
    (Gardner, 1983; Hammonds, 1950)
Background

- Agricultural education
  - primarily practical and experiential segment of education (Newcomb, McCracken, & Warmbrod, 1993; Phipps & Osborn, 1988)
  - a prime place to give credence, context, and relevance to the information taught in core area classes (Lee, 1994; National Research Council, 1988).

- Purposefully integrating science concepts into agriculture course work has a positive effect for students in agriculture and students in science (Clark, Parr, Peake, & Flanders; 2013; Chaisson & Burnett, 2001; Enderlin & Osborne, 1992; Myers & Dyer, 2006; Myers & Thompson, 2009; Ricketts, Duncan & Peake, 2006).
Background

- Agricultural mechanics instructors teach students math and science through hands-on technical skill development. (Johnson, Wardlow, and Franklin, 1997; Parr, Edwards & Leising, 2008; Rosencrans, 1997)

- “Agricultural engineering and mechanics is applied mechanics and applied physics” (Buriak, 1989, p. 22).

- Learner-centered education, such as project-based learning, is in line with the philosophical theory of constructivism (Emes & Cleveland-Innes, 2003; Doolittle & Camp, 1999).
Background

- Project based learning
  - A project is a problematic act carried to completion in its natural setting (Stevenson, 1925)
  - Noted origin with Stimson’s Home Project Method and that has been the focus of most of agricultural education (SAE) (Moore, 1988).
    - Not much work done on the integration of projects into agricultural education classroom settings.
  - PBL sets the project design as paramount and is bound by several common primary elements: (Larmer & Mergendoller, 2015).
    - the use of a question
    - sustaining inquiry
    - student voice
    - product production
    - revision
    - reflection
    - authenticity
Theoretical Framework

Model of School Learning
(Carroll, 1963; 1989)
Theoretical Framework

Model of School Learning
(Carroll, 1963; 1989)

- Quality of instructional events
  - Challenging Problem or Question
  - Student Voice & Choice
  - Reflection
  - Critique & Revision
  - Public Product
  - Sustained Inquiry
  - Authenticity
Authenticity

- Involve a real-world process
- Have actual impact on others
- Be based in real performance standards
- Use industry appropriate tools
- Involve the building or creation of something that will be experienced by others
- Be deemed personally important
- Be involved in context (Larmer & Mergendoller, 2015).
Research Question

- Did project authenticity affect change in science knowledge?
Methods

- Quasi-experimental
  - Cohort-based nonequivalent comparison groups
    - Such groups when used in schools are reliably comparable (Shadish, 2002)
- Pre-/Post- design
- ANCOVA test procedures
  - **IVs**: Treatment (Project type)
  - **DV**: Change Score (MCAS post – pre)
  - **CoVs**: Course work in science
Population & Sample

- Purposive sample of known practitioners.
- 8 site authorizations
  - 5 sites kept in the pool
    - 14 high school classes (cohort groups) assigned one of four treatments
  - 219 participants, 159 usable results
Participant Experience

- Written Packet ($X_1$)
  - Students given packet read and answer questions

- Squashy Circuit Project ($X_2$)
  - Students given project directions and problem sheet

- Drawing Project ($X_3$)
  - Students given project directions and problem sheet

- Wiring Project ($X_4$)
  - Students given project directions and problem sheet

- Project-Based Experimental Treatments
  - Students given materials
  - Students given time to plan and explore
  - Students build two circuits according to the requirements
  - Students explain their designs to the class and display their project

Students take pretest ($O_1$)

Students take posttest ($O_2$)
Instrumentation

- Knowledge portion
  - 23 multiple choice items ($\alpha = .87$)
  - Taken from the MCAS physics exam
# Treatments

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper packet ($X_1$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>U</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Squishy circuit wiring ($X_2$)</td>
<td></td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td>U</td>
<td>S</td>
<td>61</td>
</tr>
<tr>
<td>Drawing of a wiring diagram ($X_3$)</td>
<td>S</td>
<td>S</td>
<td></td>
<td>S</td>
<td></td>
<td>U</td>
<td>S</td>
<td>25</td>
</tr>
<tr>
<td>Wire using wires ($X_4$)</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td>U</td>
<td>50</td>
</tr>
</tbody>
</table>

- a) Involve a real-world process
- b) Have actual impact on others
- c) Be based in real performance standards
- d) Use industry appropriate tools
- e) Involve the building or creation of something that will be experienced by others
- f) Be deemed personally important
- g) Be involved in context (Larmer & Mergendoller, 2015).
- Tested using ANCOVA
  - \((F(3,145) = 3.59, p = .015, \omega^2 = .04, 1-\beta = .78)\)
  - Significant using at .025 alpha (Bonferroni correction)

### Estimated Mean Differences with Covariate Adjustments of Change Score

<table>
<thead>
<tr>
<th>Treatment</th>
<th>(M)</th>
<th>(SE)</th>
<th>Lower bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wiring ((X_4))</td>
<td>.843(^a)</td>
<td>1.81</td>
<td>50</td>
<td>-2.72</td>
</tr>
<tr>
<td>Squishy ((X_2))</td>
<td>6.03(^a)</td>
<td>1.64</td>
<td>61</td>
<td>2.79</td>
</tr>
<tr>
<td>Drawing ((X_3))</td>
<td>3.53(^a)</td>
<td>2.55</td>
<td>25</td>
<td>-1.51</td>
</tr>
<tr>
<td>Paper Packet ((X_4))</td>
<td>-3.90(^a)</td>
<td>2.68</td>
<td>23</td>
<td>-9.20</td>
</tr>
</tbody>
</table>

\(^a\) Covariates appearing in the model are evaluated at the following values: Chem = .30, PhySci = .08, Bio = .92, Phy = .13, IPC = .09, None = .02, Astro = .03, Earth = .05, Enviro = .04,
## ANCOVA table

<table>
<thead>
<tr>
<th>(I) Treatment</th>
<th>(J) Treatment</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>( p )</th>
<th>95% Confidence Interval for Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Squishy</td>
<td>-5.19</td>
<td>2.47</td>
<td>( .038^* )</td>
<td>-10.08 - .30</td>
</tr>
<tr>
<td>Wiring</td>
<td>Drawing</td>
<td>-2.69</td>
<td>3.15</td>
<td>( .395 )</td>
<td>-8.92 3.54</td>
</tr>
<tr>
<td></td>
<td>Paper Packet</td>
<td>4.74</td>
<td>3.21</td>
<td>( .142 )</td>
<td>-1.61 11.09</td>
</tr>
<tr>
<td>Squishy</td>
<td>Drawing</td>
<td>2.50</td>
<td>3.02</td>
<td>( .410 )</td>
<td>-3.48 8.47</td>
</tr>
<tr>
<td>Drawing</td>
<td>Paper Packet</td>
<td>7.43</td>
<td>3.74</td>
<td>( .049^* )</td>
<td>.04 14.82</td>
</tr>
</tbody>
</table>
Conclusions

- Authenticity does play a part in the effectiveness of project-based learning.
- However, projects with the highest level of authenticity do not lead to the highest levels of learning.
Discussion

- Authenticity has an affect
- Not as we might predict
- Lowest and highest levels of authenticity are no different (Johnson, et al.)
Discussion

- None of the criteria set forth by the framework are relevant. None offer insight to the change.

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper packet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td>Squishy circuit wiring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
<td>U</td>
<td>S</td>
</tr>
<tr>
<td>Drawing of a wiring diagram</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td>S</td>
<td>U</td>
<td>S</td>
</tr>
<tr>
<td>Wire using wires</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>U</td>
</tr>
</tbody>
</table>
Discussion

- Familiarity could be playing a part in the focus a student has on the project (Carroll, 1963; 1989)
- They are more engaged in the learning thus they learn more (Carroll, 1963; 1989)
References


PLEASE USE THIS TEMPLATE TO CREATE PRESENTATIONS USING THE WVU BRAND.