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

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Background

- Agricultural education was originally designed to be an extension of science (Dewey, 1916; 1938; 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 vocaitonalism 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; Rickets, 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?

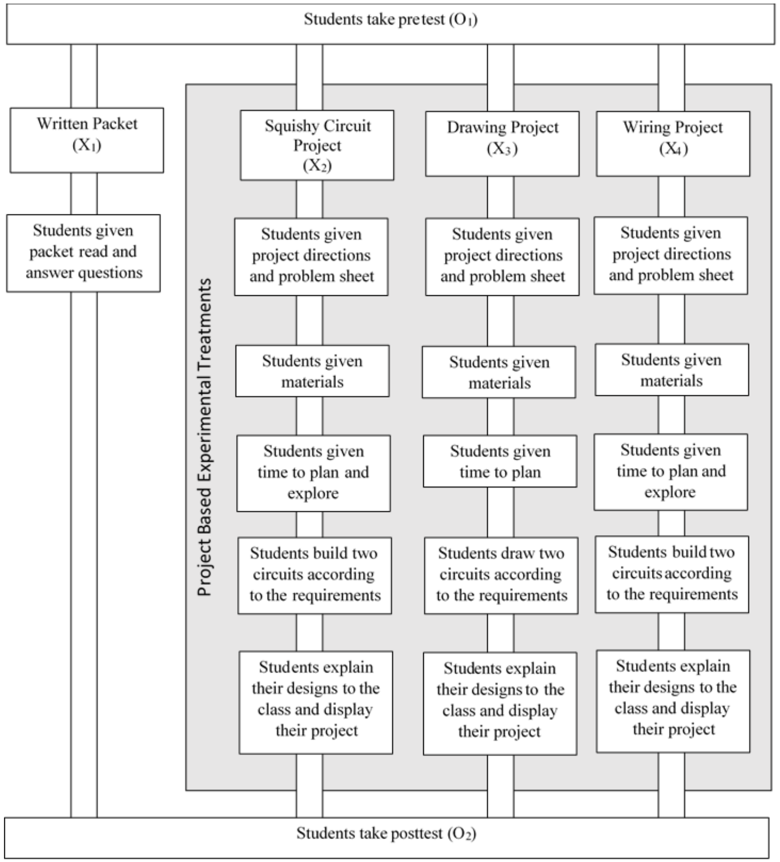
Methods

- 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



Instrumentation

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

Treatments

	a	b	c	d	e	f	g	*n*
Paper packet (X_1)						U		23
Squishy circuit wiring (X_2)					S	U	S	61
Drawing of a wiring diagram (X_3)	S	S			S	U	S	25
Wire using wires (X_4)	S	S	S	S	S	U	S	50

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
  - ($F(3,145) = 3.59$ $p = .015$, $\acute{\omega}^2 = .04$, $1\text{-}\beta = .78$)
  - Significant using at .025 alpha (Bonferroni correction)

Estimated Mean Differences with Covariate Adjustments of Change Score

Treatment	*M*	*SE*	95% Confidence Interval Lower bound	Upper Bound
Wiring (X_4)	.843[a]	1.81	50	-2.72
Squishy (X_2)	6.03[a]	1.64	61	2.79
Drawing (X_3)	3.53[a]	2.55	25	-1.51
Paper Packet (X_4)	-3.90[a]	2.68	23	-9.20

[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

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	*p*	95% Confidence Interval for Difference: Lower bound	95% Confidence Interval for Difference: Upper bound
Wiring	Squishy	-5.19	2.47	.038*	-10.08	-.30
	Drawing	-2.69	3.15	.395	-8.92	3.54
	Paper Packet	4.74	3.21	.142	-1.61	11.09
Squishy	Drawing	2.50	3.02	.410	-3.48	8.47
	Paper Packet	9.93	3.19	.002*	3.62	16.24
Drawing	Paper Packet	7.43	3.74	.049*	.04	14.82

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.)

Paper Packet | Squishy Circuit | Drawing a Circuit | Wiring a Circuit

Low levels | Authenticity | High Levels

Paper Packet / Wiring a circuit | Drawing a Circuit | Squishy Circuit

Lower Score | Exam scores | Higher Score

Discussion

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

	a	b	c	d	e	f	g
Paper packet						U	
Squishy circuit wiring					S	U	S
Drawing of a wiring diagram	S	S			S	U	S
Wire using wires	S	S	S	S	S	U	S

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)

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