7-2019

Meeting the Vision of the NGSS: Critical Factors of Effective Science Teaching (Poster)

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Meeting the Vision of the NGSS: Critical Factors of Effective Science Teaching

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Introduction & Rationale

- Becoming an effective teacher takes "good" preparation, time, and practice….**but how much?**
- Preservice teacher education, even robust preparation, cannot *immediately* prepare teachers to be effective teachers, but some preparation designs are better than others, **but which ones?**
- At some point the effects of teacher preparation programs attenuate, **but when?**

Thus, we need more studies that carefully describe the relationship between:

science teachers' preservice preparation AND
enacted reformed-based teaching practices.

Our study addresses this knowledge gap… by investigating:
Beginning science teachers'
NGSS-aligned instructional practices
with a range of in-field content knowledge and
relationship to exemplary, reform-based instruction

Conceptual Framework

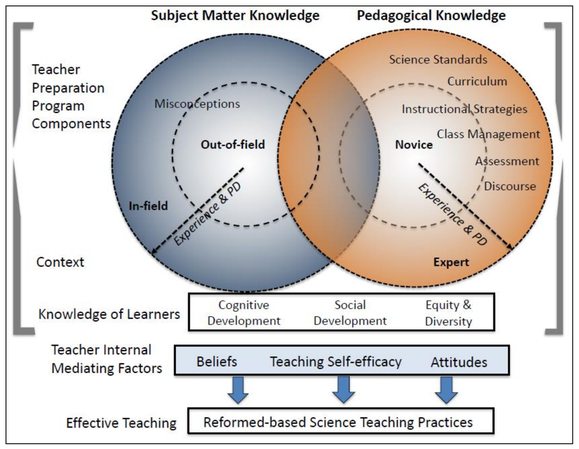


Figure 1. Conceptual framework of teacher preparation program and reformed-based science teaching practices.

Research Approach and Data Sources

Approach & Methods

- We adopted a ***multi-method approach*** to investigate beginning science teachers' enacted practices.
- Longitudinal study of secondary science teacher program graduates from a large Midwestern (U.S.) 4-year state university.

Data sources

- **Transcript analysis** of all science coursework (credit hours and GPA).
- **Classroom observations and student-level demographics.** Coded with a validated instrument (**EQUIP**) and a second instrument (**DiISC**) to code the degree of inquiry-based science instruction.
- **5-days of instruction interviews and coding**
- **School-level level demographics**

Analytic Methods

- Used **ANOVA, multiple regression, and structural equation modelling** to investigate significant variables that contributed to effective science teaching.

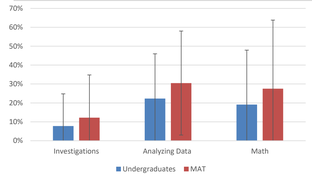
Project 1: Secondary Science Teachers use of *NGSS* Science Practices in the Classroom

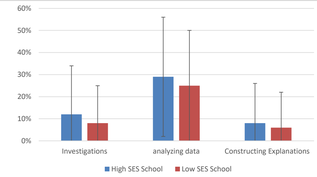
Question #1A: ***What and how often are NGSS scientific practices used in science teachers' instruction?***

Table 1. *Teachers' use of NGSS Scientific Practices (n=514 weeks)*

Most Commonly Used Practices	Least Used Practices
• Analyzing and Interpreting Data (27%) • Using Mathematical and Computational Thinking (24.5%) • Asking Questions and Defining Problems (21%)	• Planning and Carrying out Investigations (11%) • Constructing Explanations and Designing Solutions (8%) • Engaging in Argumentation from Evidence (2%)

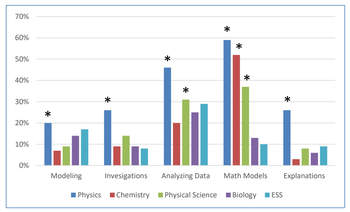
Question #1B: ***What is the relationship between teacher and classroom variables and use of NGSS scientific practices in the classroom?***





Scientific practices use differed by:

- **MAT** alumni used more SEP than undergrads.
- **Science subject area.**
- Teachers in **high SES** schools used more SEP than those in low SES schools.



Project 2: Factors Affecting Teachers' use of Inquiry

Question #2: ***What factors affect teachers' use of inquiry-based lessons?***

Factors	# of items significant of remaining EQUIP items (n=14)
Diversity Index	**1**
Years of teaching experience	7
Student sex	8
Classroom level	12
Teacher preparation program	**13**

Table 2. *Factors affecting Teachers' use of Inquiry*

More Inquiry	Less Inquiry	No Effect
		Classroom diversity
Teacher with MA Ed. and BS in science	BA secondary science education	
Middle school lesson	High school lesson	
More teaching experience	Less teaching experience	
Male-dominated classroom	Female-dominated classroom	

Predictors of Inquiry-based Instruction (EQUIP Total Score)

- The predictors accounted for **10.5%** of the variance (R^2 = 0.105, F(5,649) = 15.18, p < 0.001) in the level of inquiry used in the science lessons.
- **Significant**: **Teaching experience** (β = 0.230, p < 0.01); **Teaching level** (β = -0.210, p < 0.001); **Teacher preparation program** (β = 0.203, p < 0.001); **Student sex** (β = -0.122, p < 0.01)
- **Non-significant**: Class diversity index (β = -0.041, p > 0.1)

Project 3: Validation of the Discourse in Inquiry Science Classroom (DiISC)

Rationale

- The DiISC was developed and validated within the context of a **specific program.**
- It requires further scrutiny and development of an external validity argument for widespread use.

Establishing a Modern Validity for the DiISC

- **Content Validity.** Test developers provided a table of specifications and a description of the domains of the instrument.
- **External Validity.** DiISC factor scores were used to predict the EQUIP factor scores (inquiry, Pillai's Trace=0.63(2,652); p<0.01 discourse, Pillai's Trace=0.04(2,652), p<0.01; learning principles, Pillai's Trace=0.23(2,652), p<0.01).
- **Generalizability.** Analyses were conducted over several subgroups of the population; issues of differential item function (DIF) were not prevalent.
- **Structural Validity.** Exploratory Factor Analysis (EFA) using 660 DiISC-scored science lessons resulted to a three-factor solution with a simple structure that accounted for a reasonable amount of variance.
- **Substantive Validity.** The four raters who participated in a semi-structured, think-aloud interview did not fundamentally differ in their scoring of a video lesson using the DiISC.

Results

- There is a strong body of evidence for the validity of the DiISC across standard aspects of a modern validity argument.
- The generalizability or predictive validity is currently the weakest area of the overall validity argument.

NSF Noyce Grant Overview

NSF Noyce Track I, Phase II
Longitudinal Evaluation of Noyce Science Teachers to Determine Sources of Effective Teaching

- Four-year NSF grant (September 2015 – August 2019)
- 60% of grant is required to be dedicated to the Noyce stipends (30 stipends at $16,000 each) in MAT program.
  Supporting diverse learners. Noyce recipients must complete 2 years of teaching at high-needs school districts.
- Remainder of grant is used to investigate two models of science teacher preparation.
- Our NSF Noyce Phase II grant has enabled us to add a comparison group to our previous study of MAT graduates started with our Noyce Track I, Phase I grant.

Table 3. *Study participants and Observations*

2015-16	2016-17	2017-18
40 teachers from both programs were recruited (2:1 MAst to undergrad program) **234 classroom observations** (coded with EQUIP and DiISC)	**38 teachers** from both programs were recruited (2:1 MAst to undergrad program) **268 classroom observations** (coded with EQUIP and DiISC)	**42 teachers** from both programs were recruited (2:1 MAst to undergrad program) **241 classroom observations** (coded with EQUIP and DiISC)

Note:
Many teachers were participants for multiple years
23 % participated for 1 year
36 % participated for 2 years
41 % participated for 3 years

Project 4: Modelling Beginning Science Teachers' Inquiry-based Science Teaching

Question #4: ***What teacher characteristics and preparation lead to effective secondary science teaching?***

Specific Research Questions

1. To what degree are teachers' practices **reform-based** (i.e., inquiry-based)?
   a. Does science teachers' **inquiry-based instruction** change over time?
   b. And if so, what are the **significant variables** that contribute to this change?
2. Is there a difference between lessons by teachers with less or more **teaching experience**?
3. Is there a difference between lessons that feature **in-field** (e.g., highly qualified certified teachers) and **out-of-field** teachers?
4. Do **middle or high school teachers** enact greater inquiry-based instruction?

Results

1. MAT program teacher alumni used higher levels of inquiry-based instruction.
   a. **Teacher program membership (in favor of the MAT program)** was also associated with **increased inquiry-based instruction *when combined with* professional development over time**.
   b. Having membership in a **high-quality teacher preparation** program (i.e., MAT program) coupled with **ongoing professional development** was important for inquiry-based instruction once teachers had been in classrooms longer.
2. **More experienced teachers used more inquiry in their lessons**. (*Pillai's Trace* (5,651) = 0.37, *p*<0.01))

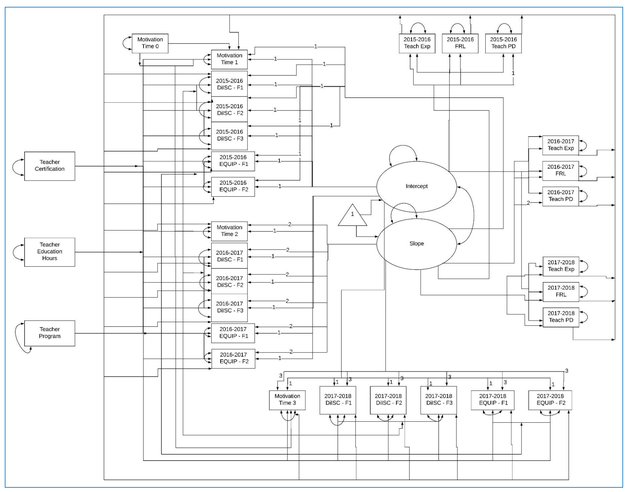


Figure 2. Simplified version of multivariate growth SEM specification.

3. **In-field single-subject science teachers delivered lessons using greater inquiry.** (*Pillai's Trace* (5,651) = 0.49, *p*<0.01)
4. **High school teachers enacted lessons using greater levels of inquiry.** (*Pillai's Trace* (15,1953) = 0.38, *p*<0.01)