EXAMINING THE RELATIONSHIP BETWEEN SCIENCE TEACHERS' EPISTEMOLOGY AND SELF-EFFICACY ON SCIENCE INSTRUCTIONAL PRACTICES AND CONCEPTUALIZATION OF STUDENT RESEARCH EXPERIENCES ROOTED IN THE NEXT GENERATION SCIENCE STANDARDS

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Abstract & Introduction

Teachers' values, beliefs, and self confidence are critical components of decisions educators make every day, especially as they implement the Next Generation Science Standards. The purpose of the study is to examine the relationship between secondary science teachers' epistemology and self-efficacy on science instructional practices and conceptualization of student research experiences rooted in the Next Generation Science Standards. A mixed methods explanatory sequential design will be utilized to examine the variables The Science Teachers Beliefs about Science Survey (STBAS), Self-Efficacy to Teach Science in Integrated STEM Framework (SETIS), and the Science Instructional Practice Survey (SIPS) will be administered to secondary science teachers. A follow up semi-structured interview will be administered to secondary science teachers, chosen based upon STBAS scores, to gather an understanding of the conceptualization of science instructional practices related to student research experiences.

Science, Technology, Engineering, and Mathematics (STEM) are integral to our lives (National Research Council, 2012)
- Requires a work force equipped to tackle the problems of the future (Mobley, 2015)
- STEM education concentrates on best instructional practices for teaching science, technology, engineering, and math
- *Indicates a divide between the traditional way science is taught in school and ways science is practiced by scientists in the field* (National Research Council, 2012)

Next Generation Science Standards (NGSS):
- Encourage authentic science practices
- Emphasize a three-dimensional model of K-12 science education (Krim et al., 2019)
- Enhance students' understanding of science concepts (National Science Teaching Association, 2020)
- Better informed citizens (National Science Teaching Association, 2020)

Rationale

- Teacher's beliefs more predictive than content knowledge or instructional strategies (Huling, 2014)
- Perceived self-efficacy strong predictor of behavior (Bandura, 1997)
- How teacher include NGSS in classroom important in evaluating success (Lipsitz, 2018)

Further study is needed to understand teacher epistemologies, perceived self-efficacy, and how they influence science instructional practices.

Problem & Significance

Changing instructional practices and beliefs related to student learning can be a challenge for teachers; therefore, the change in science curriculum prompts further investigation into teacher epistemologies, perceived self-efficacy, and how they influence science instructional practices (Wilde, 2018).

- **Awareness** of teacher epistemology and self-efficacy in relation to science instructional practices
- Citizens of a democratic society need to be able to **understand the nature of science** (Sandoval, 2005)
- **Understand** teacher epistemology, self-efficacy, and its relationship to science instructional practices

Theoretical Framework

Constructivism
- A perspective that acknowledges that knowledge lies in the minds of individuals, who construct what they know based on their own experiences.
- Five assumptions of constructivist conditions for learning are; embed learning in complex realistic and relevant environments, provide for social negotiation as an integral part of learning, support multiple perspectives and the use of multiple modes of representation, encourages ownership in learning, and nurture self-awareness of knowledge construction processes.
- Nelson (2017): Science teachers held constructivist beliefs pertaining to student questioning of the learning process and student autonomy in interacting with other learners.

Epistemology
- A branch of philosophy related to the study of knowledge and beliefs that has been shown to influence instructional practices.
- Four epistemological themes that could influence scientific inquiry and may impact how students perceive inquiry in the science classroom and understanding of the nature of science are; scientific knowledge is constructed, diversity of scientific methods, forms of scientific knowledge, and scientific knowledge varies in certainty (Sandoval, 2005).
- Lipsitz (2018): Science and engineering practices (SEPs) are included in elementary teachers' plan for instruction, but focus on aspects of the practices and in ways that are more teacher-driven.
- Huling (2014): Correlational relationships between understandings of the nature of science and personal epistemological beliefs were investigated.

Teacher Epistemology
- Distinction between a teacher's professed and enacted epistemology
  - Professed beliefs are an individual's views about knowledge and knowing as identified in self-reported surveys.
  - Enacted beliefs are an individual's view about knowledge and knowing as indicated during task processing.
- Payne (2007): Identified valuable components of the teacher research experience such as advanced resources, feeling of rejuvenation in teaching, a new perspective on science, and scientific research, and first-hand experiences in science.
- Samuel and Ogunkola (2015): Even through the findings revealed a moderate prediction of inquiry-based instructional practices, it nevertheless indicates the importance of sophisticated epistemological beliefs in science teachers.

Social Cognitive Theory and Self-Efficacy
- Social Cognitive Theory is a psychological and sociological perspective defined as a model composed of cognitive, affective, and biological events, behavioral patterns and environmental events all interact in a bidirectional determinants of behavior
- Self-efficacy is related to belief in one's ability to successfully accomplish a task under specific conditions:
  - Suggest that an individual's expectations about their ability to perform an action can influence behavior and effort put into action when encountering a challenge.
  - Individuals will make assumptions about their ability to accomplish a task to succeed at the desired outcome.
- Akella (2016): Focused and targeted professional development helped improve participants' self-efficacy in incorporating the NGSS practices and addressed several barriers to teachers' self-efficacy.
- Mobley (2015): SETIS can be useful in guiding pre-service and professional development for integrated STEM science teaching.
- Kang, Donovan, & McCarthy (2018): Relationship between teachers' rating of their perceptions of knowledge and confidence.

Research Questions

1. To what degree and in what manner does a science teacher's personal epistemology regarding science and science teaching and self-efficacy to teach science in an Integrated STEM framework, impact science instructional practices rooted in the Next Generation Science Standards and Engineering Practices?

   1. Non-directional: There will be a significant correlation between the predictor variables of personal epistemology regarding science and science teaching and self-efficacy to teach science in an Integrated STEM framework with the criterion variable of science instructional practices rooted in the Next Generation Science Standards Science and Engineering Practices.

2. How do science teachers conceptualize science instructional practices in the classroom in terms of student research experiences in relation to underlying science teachers' personal epistemology regarding both science and science teaching?

Research Design

Explanatory sequential mixed method design
- Research Question 1: Quantitative component (Hayes et al., 2016; Mobley, 2015; Payne, 2007)
- Research Question 2: Qualitative component

Figure 1. Explanatory sequential mixed methods design (Creswell and Plano Clark, 2011).

Quantitative Design:
- Correlational Research Design (Creswell and Plano Clark, 2011)
  - Distributing three surveys to secondary science teachers:
    - Science Teacher's Personal Epistemology regarding both Science and Science Teaching (Payne, 2007)
    - Self-Efficacy to Teach Science in Integrated STEM Framework (Mobley, 2015)
    - Science Instructional Practices (Hayes et al., 2016)

Qualitative Design:
- Multiple Case Study Design (Creswell and Plano Clark, 2011)
  - Each case will be bound by: A secondary science teacher who has experience guiding student research experiences
  - Administer semi-structured interviews to 3-6 participants

Setting & Sample

Setting:
- Lower Hudson Valley Region of New York State

Quantitative Sampling:
- Convenience sample
- Intendent sample will be approximately 90 secondary science teachers
- Required for the participant to be currently employed as a secondary science teacher in a public-school district

Qualitative Sampling:
- Purposive sample
- 3 to 6 of the semi-structured interview participants will be chosen based upon: mean score of the STBAS and self-identified as having experiences guiding students through research experiences (Payne, 2007)

Instrumentation

Science Teacher's Beliefs about Science (STBAS)	• Measure of science teacher's personal epistemology • Total of 26-items with 6 subscales assessed by seven-point Likert scale survey instrument (Payne, 2007) • Demonstrates acceptable validity and reliability
Self-Efficacy to Teach Science in Integrated STEM Framework (SETIS)	• Measure of self-efficacy of science teachers • Total of 19-items with 3 subscales being assessed by a four-point Likert scale (Mobley, 2015) • Demonstrates acceptable validity and reliability
Science Instructional Practices Survey (SIPS)	• Measure of science instructional practices • Total of 24-items with 6 subscales being assessed by a five-point Likert scale (Hayes et al., 2016) • Demonstrates acceptable validity and reliability
Semi-Structured Interview	• Measure of conceptualization of student research experiences • Best practices of student research experiences (SRE) (Adapted from Payne, 2007) • 12 open-ended questions

Analysis

Quantitative Analysis:
- Multiple Regression
  - Predictor Variables: Personal Epistemology and Self-Efficacy
  - Criterion Variable: Science Instructional Practices

Qualitative Analysis:
- Evaluate teacher's conceptualization of science instructional practices
- Inductive and deductive coding (Ravitch & Carl, 2016)
- Axial coding (Ravitch and Carl, 2016)

Limitations

- Inability to manipulate the independent variable
- Differential selection

Trustworthiness

- Credibility: member checking, triangulation of data
- Transferability: sufficient description data of the samples and results will be provided to allow for comparison for further studies
- Dependability: a dense description of the research methods will be provided to allow for replication by further studies
- Confirmability: internal audit of coding and analysis will be conducted by Dissertation Chair