

Data Analysis and Findings Review

Giancarlo Perez-Flores

New Jersey City University Educational Technology Leadership Program

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Dr. Mark Connolly

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Introduction

The shift to virtual learning during the global health crisis highlighted the importance of technology at all educational levels. Particularly in science, the limited access to labs can be detrimental to scientific learning like computational thinking and collaboration (NRC, 2012). Virtual labs are an alternative to physical labs experiences, and these computer simulations recreate the aspects and skills needed for scientific experimentation. Unfortunately, just like with any new educational technology, poor teacher preparation could negatively impact the implementation of new programs in the classroom. This paper will compare the data analysis and findings of five studies investigating the factors impacting teachers' self-efficacy in using and implementing new technologies.

Table 1

Comparison of instruments and data analysis procedure

Author	Instrument	Data Analysis Technique
Barton & Dexter	Surveys Interviews	Analytical induction
Geng et al.	Surveys	Descriptive statistics Independent T-test Correlations Rapid Automatic Keyword Extraction (RAKE)
Horvitz & Beach	Surveys	Descriptive statistics Informal matched-pair T-test
Kriek & Stols	Surveys	Descriptive statistics Correlations and regressions Partial least squares
Pan & Franklin	Surveys	Descriptive statistics Correlation and multiple regressions

As seen in Table 1, one of the studies used analytical induction, while the other four used descriptive statistics. The study by Barton and Dexter (2019) used interviews as their primary data collection method. Thus, the researchers coded the interviews and used analytical induction to determine the sources of teacher self-efficacy. Also, while the other four studies used quantitative methodologies and descriptive statistics, the study by Horvitz and Beach (2011) was not clear on the data analysis technique. The following sections will discuss the data analysis and findings for each of the articles in detail.

Sources of Teachers' Self-Efficacy

In the study Sources of Teachers' Self-Efficacy for Technology Integration from Formal, Informal, and Independent Professional Learning (PL), Barton and Dexter (2019) find that a holistic approach combining the different modalities of PL improves teachers' self-efficacy. The authors gathered data from participants through 9 surveys about the quantity and mode of PL sessions attended and conducted six interviews. Survey data was analyzed for demographics, and interviews were coded using a predetermined codebook (Barton & Dexter, 2019). The codebook included the types of PL, formal, informal, and independent, as well as four sources of self-efficacy, verbal persuasion, vicarious experience, mastery experience, and physiological arousal (Barton & Dexter, 2019). The use of a predetermined codebook validated by a previous study aligns with the authors' purpose of exploring the self-efficacy information in each participant's experience with professional development.

The authors analyzed the coded interview data through analytical induction to reveal the sources of self-efficacy in each PL type. Barton and Dexter (2019) present the results as four emergent themes. First, formal PL allows for verbal persuasion but might not be relevant to teachers' needs. The second and third themes claim that independent and informal PL provide

verbal persuasion and vicarious experiences while allowing reflection on mastery experiences. Lastly, teacher-lead formal PL offers similar results to informal learning and relevant content to teachers' specific contexts. Altogether, the authors suggest that providing a variety of professional learning opportunities in a holistic approach to teachers can improve their self-efficacy (Barton & Dexter, 2019). The qualitative analysis of the interview data provides a deeper understanding of the source of teacher-self efficacy by the type of professional development attended.

Teacher Self-Efficacy and Concerns about STEM Education

The following study by Geng et al. (2018) explores the teachers' self-perceived efficacy to implement STEM education in Hong Kong. The quantitative phase employed surveys to collect data from 225 participants on teachers' self-efficacy (SE) and their Stage of Concern (SoC) towards the adoption of STEM education. The authors first used independent T-tests to calculate the mean difference between the primary and secondary school participants' responses to the SE and SoC instruments (Geng et al., 2018). The report showed no significant difference (sig. > 0.05); thus, the participant responses were combined (n=235). Using descriptive analysis of the participant responses to the SE instrument, the authors used descriptive analysis to determine a grouping, moderate efficacy (N=78, cluster mean=3.67), negative efficacy (N=115, cluster mean=2.82), and high negative efficacy (N=42, cluster mean=1.75) The results showed that only 13 participants rated themselves well-prepared. None ranked in the high efficacy group.

Similarly, the data analysis for the SoC instrument using descriptive analysis clusters the participants into two groups. The authors designated the two groups as highly concerned (N=163, mean=39.86) and moderately concerned (N=72, mean=3) (Geng et al., 2018). The researchers further analyzed the open-ended question in the SoC section with RAKE word

indexing revealing that resources, funding, class & instruction, and training & development were classified as concerns frequently mentioned by teachers. Lastly, the correlation report shows that Evaluation, like student attitude, and Refocusing, like the transition to STEM learning, have a relationship with teachers' SE (Geng et al., 2018). The authors present that the correlation between teacher SE and Evaluation and acceptance of the STEM program is a weak positive relationship ($r=0.154$). Similarly, SE and the Refocusing model have a weak positive relationship ($r=0.297$). The authors suggest that future professional development in STEM education focuses on the areas of concern presented in the study.

Professional Development to Support Online Teaching

Horvitz and Beach (2011) aim to explore the impact of a professional development (PD) program on teachers' instructional self-efficacy in an online class. The Master eTeacher Program seeks to improve online teaching through weekly workshops for teachers. Five participants were surveyed three times during the program to assess their self-efficacy in five different aspects of online instruction like student engagement, instructional strategies, course management, use of computers, and overall efficacy. Authors mention that cells were too small; thus, statistical analysis was not used, but means analyzed (Horvitz & Beach, 2011). The presented results resemble a matched-paired T-test used to compare their self-efficacy means at the beginning and end of the program. The overall efficacy score of 6.78 in the first survey increased to 7.67 in the last survey. The results indicate a positive mean difference of +0.99 in the overall teacher self-efficacy category. However, the most significant improvement was in the course management section, with a first mean score of 6.78 and a mean score of 7.83 in the third survey. This positive mean difference of 1.05 indicates an improvement in management from the PD program. The authors suggest a positive impact of the Master eTeacher Program.

Teacher Attitudes on the Use of Virtual Labs

Kriek and Stols (2010) explore the impact of different teacher attitudes on their intention to use virtual labs in their lessons. The authors used a survey to collect data from 24 teachers on attitudes like pedagogical compatibility, perceived ease of use, perceived usefulness, and behavior influences from critical stakeholders and external factors like infrastructure and support. The authors used correlation, regression, and partial least squares (PLS) techniques to analyze the data. The correlation report shows that perceived usefulness ($r=.83$), pedagogical compatibility ($r=.602$), the expectation of colleagues ($r=.58$), and general technology proficiency ($r=.53$) have a significant relationship to teacher attitudes (Kriek & Stols, 2010).

Similarly, the regression analysis report shows significant predictability from the usefulness ($\text{sig}=.807$), compatibility ($\text{sig}=.58$), the expectation of colleagues ($\text{sig}=.77$) and parents ($\text{sig}=.64$), and general technology proficiency ($\text{sig}=.81$) to influence attitudes towards using virtual labs (Kriek & Stols, 2010). Next, the researcher used a PLS analysis to rank the behaviors by importance showing Attitude as the most important factor, followed by Subjective norm and perceived behavior, respectively. Finally, the authors followed up with the participants three months after the workshop to assess the predictability success of their model. The researchers determined an overall mean score higher than 4, out 7, on the surveys to represent a prediction to use the technology. The researchers were able to predict the impact of teachers' attitudes with 70% accuracy.

Factors Impacting Integration of Web 2.0 Tools in Lessons

This study explores the teacher factors that impact the adoption of web 2.0 tools in the classroom (Pan & Franklin, 2011). Through surveys, the researchers collected data from 599

teacher participants from K-12 U.S.A. schools. The researchers analyzed the data through descriptive analytics and multiple regressions. The 5-point Likert Scale survey on the use of web 2.0 tools (N=434) like blogs (M= 1.25, SD= .77), wikis (M= 1.44, SD= .98), podcasts (M= 1.31, SD= .75), social networking sites (SNS) (M= 1.37, SD= 1.0), image/photo sharing sites (IPSS) (M= 1.61, SD= 1.01), and course management systems (CMSs) (M= 1.89, SD= 1.45) (Pan & Franklin, 2011). The results show that most participants never use web 2.0 tools like blogs (N=383, 88%) and CMSs (N=296, 68%), and only a few participants use the tools every day, like podcasts (N=4, 0.9%) and CMSs (N=52, 12%) (Pan & Franklin, 2011). Similarly, the teacher self-efficacy data report shows many teachers were unsure about their ability to use web 2.0 tools (M=3.13) (Pan & Franklin, 2011).

Next, the researchers analyzed the data through multiple regression to identify the variable with the best predictability outcome. The regression report shows that factors like professional development (sig.=.002), administrative support (sig.=.003), and teacher self-efficacy (sig.=.00) are great prediction models for the implementation of web 2.0 tools in the classroom. The results show that teacher self-efficacy with web 2.0 tools is the more significant predictor of using these tools in the classroom.

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