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THE IMPACT OF DEMOGRAPHICS ON THE SELF-EFFICACY, TECHNOLOGY USE, AND PROFESSIONAL DEVELOPMENT EXPERIENCE FOR HIGH SCHOOL SCIENCE TEACHERS

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ABSTRACT

Several studies have been done to identify the impacts of educators' demographic factors on their use of technology in the classroom. The objective of this study was to identify the possible impacts of teacher demographics and self-efficacy, the use of technological tools in the classroom, and/or their professional development experience. The demographic factors included scientific discipline, gender, age, class length, class size, years of teaching and the school environment. In this study, the participants of a random sample of full-time high school science educators across 46 states were surveyed. Teachers' emails were gathered online from public high schools' websites. All the data was obtained through an online, closed-ended survey via the Qualtrics website. We did send a survey to 3000 science educators and 104 completed it. Data was analyzed quantitatively through SPSS Software. Findings showed that there are no significant relationships between science educators' demographic factors and self-efficacy, tool use, or professional development for the variety of technology tools given in this study. Although our research considered all possible demographic factors about self-efficacy, the use of technology tools in the classroom, and/or their professional development experience, no significant relationship between these variables was found. To continue to examine demographics' impacts on educator self-efficacy levels with technology, future research needs to involve class observations and interviews of educators using technology while teaching. Observational studies would better assess educator efficacy levels and the extent to which teachers are involved with different types of professional development and how demographics affect those levels.

Keywords: demographic factors, science educators, technology tools, regression analysis.

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INTRODUCTION AND LITERATURE REVIEW

In the following section, the literature relating demographic factors with educator professional development and self-efficacy using technology tools in the classroom is discussed. This section seeks to recognize what kind of demographic factors might have been pursued in prior studies and what factors may need to be considered further.

Gender

A few studies have focused on the connection between gender and self-efficacy in technology tool use. Hong and Koh (2002) found that female teachers had more anxiety when it came to hardware use; while Bang and Luft (2013) found that male teachers used PowerPoint more frequently than female teachers did. However, when it came to comparing teachers' self-efficacy of technology tool use with their gender, Bang and Luft (2013) found no differences. In contrast, Bebetsos and Antoniou (2009) found men had higher self- efficacy towards using technology than women. A study by Hong and Koh (2002) revealed that overall, male teachers and female teachers had similar anxiety levels. The research generally indicates there is a difference in gender when it comes to aspects of technology use in the classroom. We were curious if gender differences in self-efficacy and use of technology might be mediated by professional development. One issue that researchers are facing today is that more research may be needed for this gender demographic, given that gender is no longer considered binary- Male or Female exclusively. We need a future study to look more closely at different non-binary gender categories, but that would also compare teacher self-efficacy levels and current professional development with technology tools in the classroom.

Teaching Experience

It is crucial to also examine teachers' experiences with integration technology and teachers' experiences with professional development in using technology tools. Overall, less-experienced teachers used technology more than more experienced teachers. Isman, Yaratan, and Caner (2007) revealed that the educators who have been teaching less than ten years used technology more than those who had been teaching for 11 years or more. Willams and Kingham (2003) found that experienced teachers are not integrating technology consistently. Even though some professional development is being provided, it was not enough to fully equip veteran teachers to incorporate technology tools into their classrooms at their full abilities. Previous studies have been essential to study the relationship between both a teachers' years of experience as well as the training they have received, which is something that researchers could continue to study. It was our interest to determine if the amount of professional development increases use or self-efficacy of technology use in teachers with more experience.

School Setting and States

There are many specific difficulties that school systems must overcome in connection to technology professional development. For educators to develop methods for technology to be implicitly combined into the curriculum so that it impacts student learning, they must first become competent with the new technology to the point where they are no longer merely trying to master the hardware or software. Few studies considered school setting as a demographic variable in their research with technology tool integration. Pierson & Borthwick (2010) recognized that many teachers remember a time when a specific type of new technology was revealed at their school, only to be thrown out when new technology was introduced. The technology tools were too complicated or were never fully adopted. In other cases, teachers may spend personal time in their classrooms or at home trying to learn how to use and integrate new technologies, only to find that they failed or felt inadequate when it came time to teach. Events like this cause problem for professional development creators, leaving them wondering how to encourage and efficiently assist teachers in integrating today's high-tech classroom tools (Pierson & Borthwick, 2010). While true, it appears as if very few educators or professionals are making strides to increase their useful knowledge about technology use and classroom integration.

Lu & Overbaugh (2009) examined if school setting (urban, suburban, and rural) affected teachers' perceptions of their environments and the effects it had on their technology integration. Time and access were the biggest factors that affected teacher's integration of technology, specifically for urban and rural schools. Suburban schools were better able to efficiently integrate technology into their classrooms. Urban schools did not provide training in the specific technology tools for teacher use. Even though all school administrators were encouraging the use of technologies, rural schools lacked technology resources. Lu and Overbaugh (2009) recognized that professional development was not provided enough for the schools that required efficient use of technology sources. Overall, school setting does impact teacher use of technology. Additionally, state education policies differed regarding professional development for teacher integration of technology. Prior research we conducted led us to question whether, in addition to the factors above, school setting, class period length, class size, teacher discipline area, or level of teacher education, might also impact technology use or teacher efficacy in science classrooms. In our previous study, we had a small sample size, but saw interesting data trends that might have multiple explanations if we had a larger sample size to work with (Aljuzayri, Pleasants, & Horvitz, 2017).

Based on the literature review, we noted that certain demographic factors had been addressed in previous studies, such as school type, school experience, and gender. All these demographics must be addressed as having a role in our research and can be investigated as part of the relationship between teachers' demographic factors and science teachers' self- efficacy, use of technology tools in the classroom, and/or their professional development experience.

Purpose of the Study

The goal of this study was to recognize the relationships between teachers' demographic factors and science teachers' self- efficacy, use of technology tools in the classroom, and/or their professional development experience. Demographic influences included: science discipline, gender, age, class duration, class size, years of teaching, and school setting (urban, rural, suburban, online/virtual, or other).

Research Question

What, if any, are the relationships between teachers' demographic factors (gender, age, science discipline, class duration, class size, education level, years of teaching, and school setting) and their' self-efficacy, use of technology tools in the classroom, and/or their professional development experience with a variety of technology tools (course management systems, student wireless or digital devices, social networking/media, class response systems, hardware, software, and mass media)?

Significance of the Study

This research is intended to help science teachers by providing them with a research-based view on how demographics can affect teacher self-efficacy and professional development in their technology use. This study examines teachers at the high school level at schools around the United States, rather than at one specific school or location. This can help faculty and administrators who educate teachers be more aware of how they can increase teacher self-efficacy and improve professional development. Additionally, this study provides a large sample that can help determine the extent to which demographic information predicted the dependent variable. The findings in this study can be used as a basis for qualitative research.

METHOD

Participants and Research Design

Participants for this research were a random sample of full-time high school science educators in the United States from 46 states (excluding Alabama, Kentucky, New York, and Pennsylvania). A survey that inquired about technology use in classrooms, and correlated efficacy was sent to 3000 instructor emails, but only 2456 science educators were reached via those emails. The emails were sent via the Qualtrics program. A total of 134 educators began the survey, but only 104 finished it. This non-experimental quantitative research was designed to use a correlational and descriptive survey to investigate the connection between science teachers' self-efficacy in using technology tools in the classroom and the professional development educators have had in technology use.

The inclusionary characteristics used: any current high school science instructors could have been chosen randomly to receive the email if: a) they taught in any one of the 50 United States, b) if they taught science at the high school level, c) if the school or district they taught in had an active website, d) if educator email addresses were available through the school or district website. Any teacher enrolled in the study was asked to participate by filling out the questionnaire. Exclusionary characteristics: a) teachers outside the 50 American states, b) Teachers at the secondary or elementary school level, c) teachers who did not teach science, d) If a participant did not complete the survey in its entirety, e) surveys where participants did not spend adequate time on the survey.

Survey Development

A new survey was developed, covering all fields of modern teaching technology, self-efficacy, and professional development. Our survey included demographic questions such as school environment, level of education, discipline of science, and teaching years, gender, age, and period of class. From previous studies, we used a similar model such as Yidana's (2007) Technology Integration Survey and the framework he used to shape his statements on the 5 Likert-type scales. There were questions in our survey about our how often teachers used these technology instruments, as well as how many hours they had for those instruments in professional development. Seven different technology platforms addressed the questions we asked: Course Management Systems, Wireless or Digital Devices for Students, Social Networking, Class Response Systems, and Hardware for Teachers, Software, and Mass Media. While I used Pan and Franklin (2011) survey model for the question about how often teachers use specific tools that were included in my survey, we adjusted the frequency options (never, less than once a month, 1-3 times a month, weekly, daily). Likewise, we did review surveys that only discussed professional development technology tools or self-efficacy when utilizing technology tools. A review of statements written for education and teaching for self-efficacy was conducted by reviewing the "Technology Education Teaching Efficacy Belief Instrument" written by Kelani (2009). We utilized some of the material by rewording and adapting the material for my needs.

The survey had two parts: the first part covered demographic information such as age, gender, science discipline, level of education, the state teachers teach in, class periods, class size, school setting, and years of teaching experience. The second part of the survey comprised a variety of 5-point Likert scale style questions inquiring about the use of course management systems, learner wireless or digital devices, social networking/media, class response systems, instructor hardware, software, and their professional development and self-efficacy related to these tools. For every item, high school science instructors were asked to imply the degree to which they agree or disagree with each statement (Strongly Disagree, Disagree, Uncertain, Agree, Strongly Agree). The measure of the 5-point Likert-scale was recognizing under three categories: low-self-efficacy in the point range of (1.0-1.80 to 1.81-2.60), moderate self-efficacy in the point range of (2.61 – 3.40), and high self-efficacy in the point range of (3.41-4.20 and 4.21-5.00) (Pimentel, 2010).

Validity is the term used to describe whether a concept has been properly demonstrated in the content. A committee comprised of one research graduate and four associated faculty members evaluated the survey for preliminary validation and changes were made to the discussion. One of the committee faculty members was an expert in teaching technology, and face-validated the revised survey.

The survey was re-created on the Qualtrics platform and sent to a convenience sample of educators as a pilot study that was conducted two months prior to the research study. The purpose of this pilot study was to prove the validity of our research. The survey was also sent to friends and relatives (all teachers) of the research committee for comment and validation. A second committee member also provided face-validation given his expertise in teacher professional development. Once all comments were received, a final version of the survey was completed. The Cronbach alpha coefficient was used to test the internal coherence of the instruments for this research in order to infer the coherence and accuracy of the responses (Heale & Twycross, 2015). Cronbach' s alpha standards are noted as: 0.90 to 1.0 excellent, 0.80 to 0.89 good, 0.70 to 0.79 acceptable, 0.60 to 0.69 questionable, 0.50 to 0.59 poor, and below 0.50 unacceptable (Glassman, Prosch, & Shao, 2015).By utilizing the answers from the convenience sample of educators (n=36) for an initial reliability estimate, we coded all the replies throughout SPSS and ran a Cronbach' s Alpha (=0.724). This number implied that the investigation was of acceptable reliability of the research.

Data Collection

High school educators from 46 States were the participants in this study. Included an educator from Connecticut, West Virginia, Wyoming, New Hampshire, Maryland, Florida, Missouri, Washington, New Jersey, Maine, Georgia, Kansas, Mississippi, North Dakota and Hawaii. In total, two teachers from the following states were involved: Louisiana, Vermont, South Carolina, Oklahoma, Virginia, Arizona, Tennessee, Michigan, Indiana, Idaho, Massachusetts, South Dakota, Delaware, California and Oregon. A total three teachers from Minnesota, Nevada, Rhonda Island, Nebraska, Arkansas, Taxes, Alaska and Montana were involved. Four teachers from the states of Ohio, Wisconsin, NC, Colorado and Illinois participated in the study. Five teachers from the state of Iowa took part, and six from New Mexico.

The researcher collected from Wikipedia the list of high schools by a state, which gave the name of all public, private, and charter high schools in the United States. These schools were grouped by county and the counties were alphabetically ordered. All the lists were copied and pasted directly from Wikipedia by the investigator and then inserted into Microsoft Word documents. The list was stripped of the bullet points and headings and then counted. Each state has been provided with its own Word document. The list was stripped of the bullet points and headings and then counted. Each state has been provided with its own Word document. A random number generator (https:/www.random.org, 2018) was used to pick schools from each state. The survey, which could be performed on any computer or device with Internet access anywhere in the world, took participants 15 minutes or less to complete. At any moment, teachers who did not want to participate in the research might quit the survey.

Data Analysis

In order to answer the research question for this research, Statistical Package for Social Scientists (SPSS) version 24.0 was used for data analysis to respond to the research question for this study. We used the Cronbach alpha with the final sample size (n = 104) to determine the reliability of the multi-scale Likert survey. Multiple regression is a statistical method for analyzing the relation between a dependent variable and several independent variables. The main objective of multiple regression analysis is to use independent variables with known values to predict the value of the single dependent value. We used multiple regression analysis to find the relationship between the dependent variable (science teachers' self- efficacy, use of technology tools in the classroom, and their professional development experience) and the independent variables (demographic factors). Reliability analysis was conducted with the sample size (104). So, first, we confirmed all assumptions of multiple linear regressions: There is a linear relationship between the outcome variable and the independent variables. There is no multicollinearity, so the independent variables are not highly correlated with each other. This assumption was tested using variance inflation factor (VIF < 3). VIF is the reciprocity of the tolerance value; small VIF values indicate little correlation between variables under ideal VIF<3 conditions, but that's fine if it's less than 10 (Hair, Anderson, Tatham, & Black,1995). Homoscedasticity was also met, so that the variance of error terms is similar across the values of the independent variables (Appendix A).

RESULTS

Firstly, the results showed the demographic information of participants Females had the highest participation of the 104 respondents, with 64 participating in the survey. We had only one non-binary individual respond (Table 1). Regarding age, the highest percent of the sample was 46 or older (36.5%). The second largest age group was between 26 and 35 years (33.7), followed by 26% of teachers between 36 and 45 years. The lowest percent of the sample were under 25 years (3.8%). Most respondents had a Master's degree (66.3%). Just over a quarter of the sample had a Bachelor's degree (27.9%), while only 3.8% held a PhD (Table 1). The highest percent of the sample teach Biology (36.5%), closely followed by Chemistry (31.7%). Physics (17.3%) and Earth Science (5.8%) had much less representation. Engineers represented only 1% of the sample (Table 1). The largest percent of the sample (36.5%) teach in Suburban schools, followed by Rural (30.8%) and Urban (29.8%). Only one teacher taught at an Online/Virtual school (Table 1).

Most of the teachers in this study had 21 to 30 students per class (57.7%). Another 24% had a class size of 11 to 20 students, and 12.5% of teachers had 31 to 35 students. The least frequent class sizes were on either end of the spectrum, with 4.8% of teachers having 36 or more students, and only one respondent had one to ten students per class (Table 1).

Most teachers reported that their class periods were up to 90 minutes long (89.4%), while only 9.6% of the total sample had classes that last 90 to 120 minutes (Table 1).For teaching experience, the highest percent of the sample had 4 to 10 years of experience (36.5%). Teachers with 11 to 20 years and those with 20 or more years of experience represented the same percent of the sample (26%). Teachers with one to three years experience were only 11.5% of the sample (Table 1).

Table 1. *Frequency and Percent Distribution of Gender, Age, level of Education, discipline, type of school, typically class size, typically a class period, total teaching experience*

Demographic	Frequency	Percent
Gender		
Female	64	61.5
Male	39	37.5
Non-Binary	1	1.0
Total	104	100.0
Age		
Under 25 years	4	3.8
26-35 years	35	33.7
36-45 years	27	26.0

46 and Up	38	36.5
Total	104	100.0
Level of Education		
Bachelors	29	27.9
Masters	69	66.3
PhD	4	3.8
Other	2	1.9
Total	104	100.0
Discipline		
Biology	38	36.5
Chemistry	33	31.7
Physics	18	17.3
Earth science	8	7.7
Engineering	1	1.0
Other	6	5.8
Total	104	100
Type of School		
Urban	31	29.8
Suburban	38	36.5
Rural	32	30.8
Online/Virtual	1	1.0
Other	2	1.9
Total	104	100
Typical Class Size		
1-10	1	1.0
11-20	25	24.0
21-30	60	57.7
31-35	13	12.5
36 and Up	5	4.8
Total	104	100.0
Typical Class Period		
Up to 90 mins	93	89.4
90-120 mins	10	9.6
120-180 mins	1	1.0
Total	104	100.0
Total Teaching Experience		
1-3 years	12	11.5
4-10 years	38	36.5
11-20 years	27	26.0
20+ years	27	26.0
Total	104	100.0

Secondly, a summary of the outcomes of the multiple regression examinations is indicated in. (table 2 below). For each model, only one of the technology tools was inserted as a dependent variable, and the demographic factors were inserted as independent variables (Predictors): gender, age, education, experience, subject, class periods, class size and school setting. Table 2 below shows that there is no significant regression, since all (F-ANOVA) had p- value > 0.05 across all regression models. These results indicate a convergence between means among all demographic groups in their self- efficacy, use of technology tools in the classroom, or professional development experience in each technology tool.

Table 2. *Summary Results of Multiple Regression Tests*

Model	Dependent variables	R	R^2	F	P-value
Model 1	Course Management Systems	0.287	0.082	1.067	0.393
Model 2	Student Wireless or Digital Devices	0.215	0.046	0.574	0.797
Model 3	Social Networking/Media	0.321	0.103	1.363	0.223
Model 4	Class Response Systems	0.286	0.082	1.055	0.401
Model 5	Instructor Hardware	0.310	0.096	1.267	0.270
Model 6	Software	0.223	0.050	0.621	0.758
Model 7	Mass Media	0.272	0.074	0.848	0.481

Note. Dependent Variable: For each model, there is one D.V (technology tool).
Predictors: (Constant), Gender, Age, Education, Experience, subject, class periods, class size and school setting.

Discussion, Conclusion and Recommendations

Bebetsos and Antoniou (2009) found that males were more likely to use technology than females. Previous study by Hong and Koh (2002) also found that teachers as a whole had similar levels of anxiety. Nevertheless, our study which recently found that there are no significant difference between the use of technology and gender in teacher self-efficacy.

Overall, we found that there are no significant differences between educators' demographic factors (gender, age, science discipline, class duration, class size, education level, years of teaching, and school setting) and science teachers' self-efficacy, use of technology tools in the classroom, and/or their professional development experience with the seven technology tools. Even with the study considering all possible demographic factors in relationship to self-efficacy, use of technology tools in the classroom, and/or their professional development experience, no significant relationships between these variables were found. However, the results of this study should not be overly generalized because the sample size of this study became too limited once the large group was subdivided into demographic categories. In order to better determine whether demographics affect effectiveness, the use of tools or professional development, a larger sample size may be required.

We noted that previous studies suggest that certain demographic characteristics are effective, but that our study's demographic data had no effect in this study. Possibly Science teachers are more knowledgeable about the technology itself and its implementation to achieve educational goals compared to other disciplines.

The findings supported by the study conducted by McConnell (2011) who reported that teaching experience did not have a significant relationship to the level of technology integration in K-12 classrooms. Isman et al. (2007) have also found no major differences in the use of technology in classrooms, between genders of teachers. Also, another study by Joseph and Buehl (2009) found there were no also significant gender differences in teacher self-efficacy for technology use. Since there were no significant differences between teachers' demographic factors, so it will be better for future study to be replicated in two to four years to see again if demographics have an influence on efficacy, tool use, or PD a larger sample size might be needed, as our sample size developed limited once the group was subdivided into demographic categories. Surveying on a state-by-state basis might be more representative in the United States, since it does not have a federal educational system.

A limitation at the forefront of this study is it used self-reported data, obtained via email (a technological tool in itself), and so there were no observations or interviews to see exactly how, and how well, the teachers use these tools in the classroom. Another limitation is that the only high school list, which was used to identify teachers to distribute the survey to, came from Wikipedia. Any other updated source(s) of statewide high schools from all school types (private, public, and charter, urban, rural, and suburban) couldn't be located. Some of the schools listed on Wikipedia were no longer operating, or there may have been others that were not updated on the page. Also, we were first trying to send emails to the 2000 high school science teachers, not all went through. Some bounced, were invalid, or were deducted. This led to a decreased sample size for us to pull from. Going forward for future studies, adding more of a wide-range and a larger variety of questions that touch on more different varieties of technology types as well as going further into demographics in specificity might yield more conclusive results. That would mean a focus of more micro-niches such as young, female teachers, under age 25 teaching Earth Science. That would help as long as the survey would have more participants and the data could be analyzed and aggregated for analyzing the data by these micro-niches.

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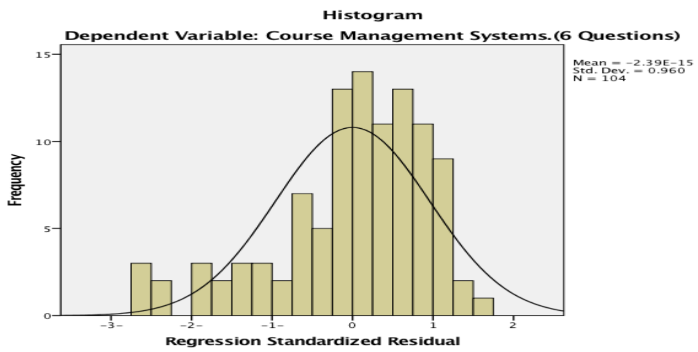
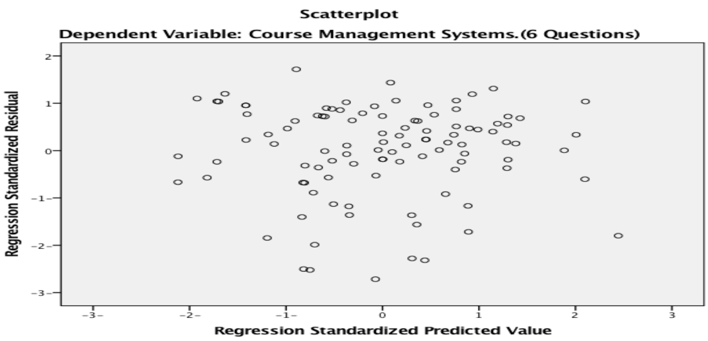
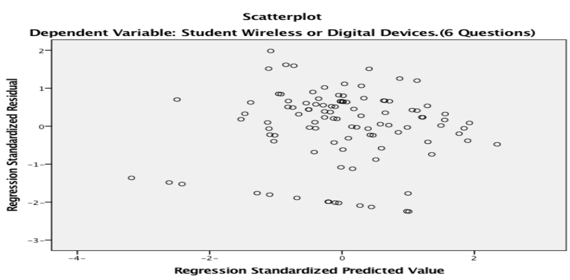
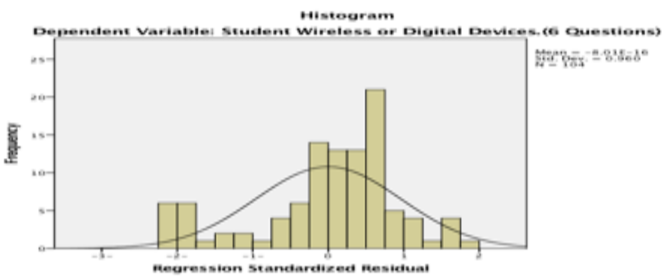
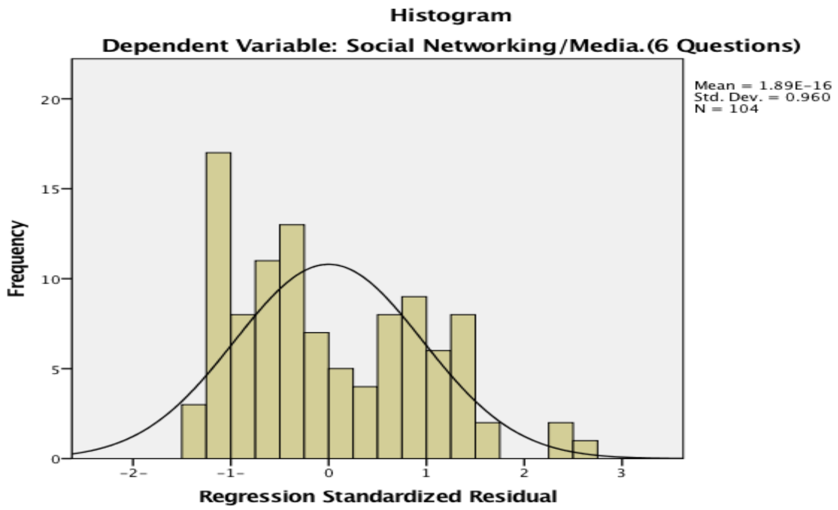
APPENDIX A Scatterplots and Histograms of Regression Standardized Residual







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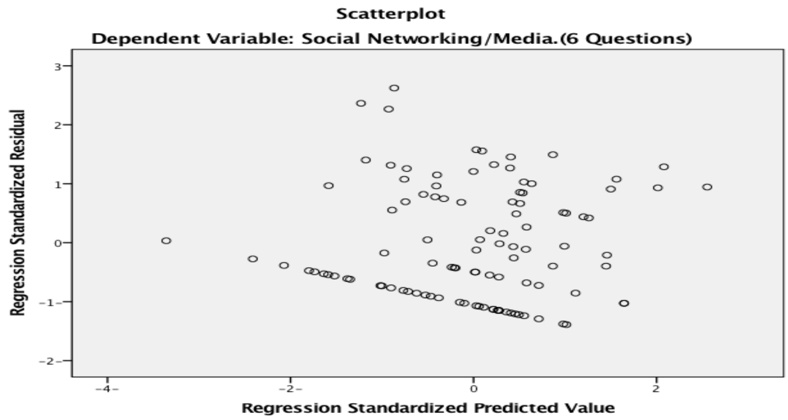
Mean = 1.89E-16
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual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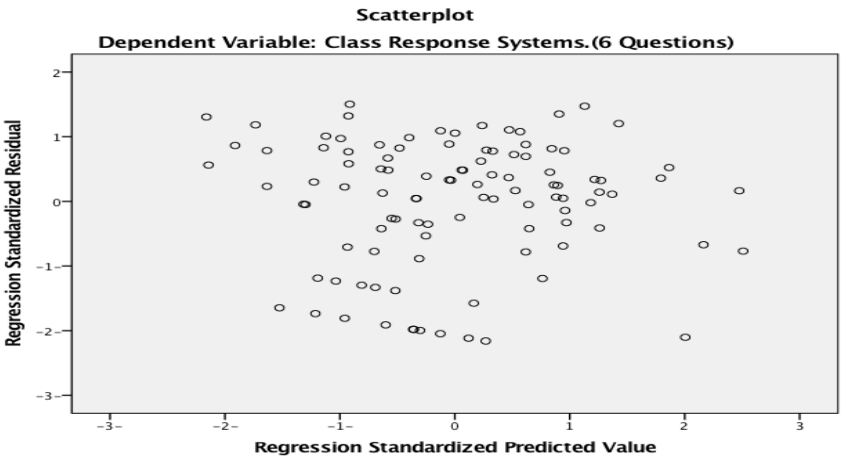
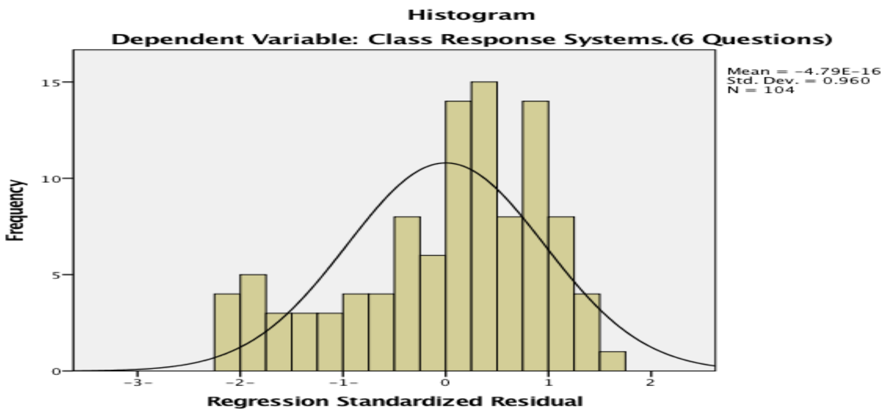
Dependent Variable: Social Networking/Media.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value


Scatterplot
Dependent Variable: Class Response Systems.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value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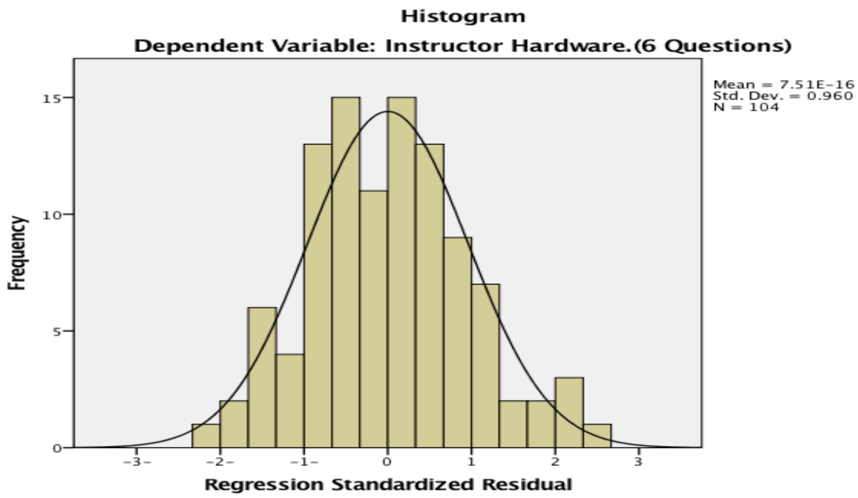
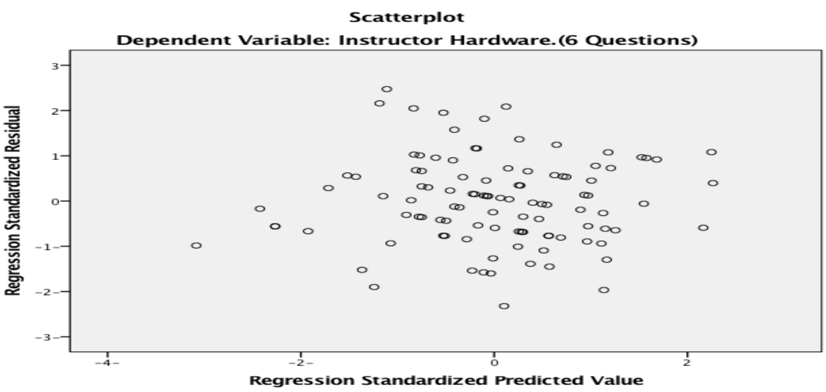
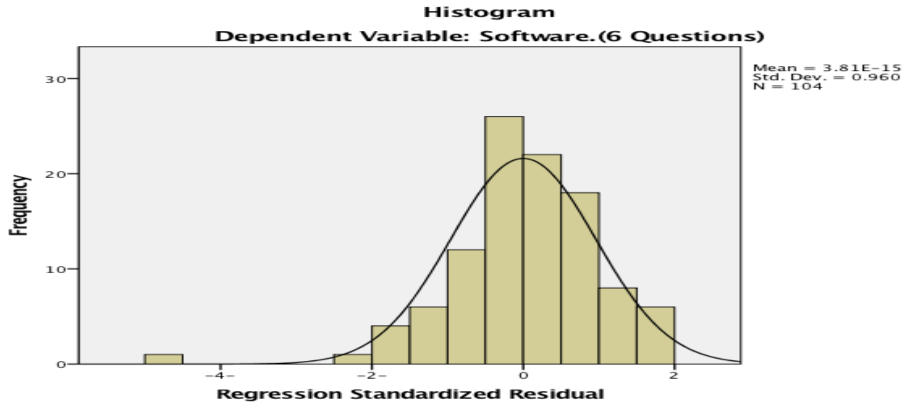
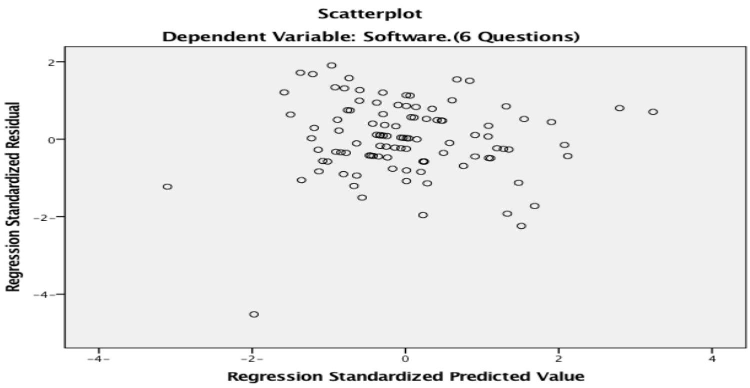
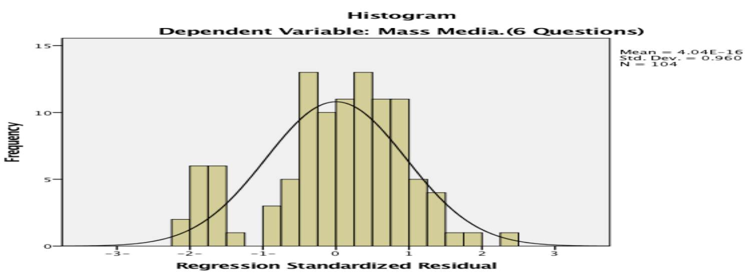
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual

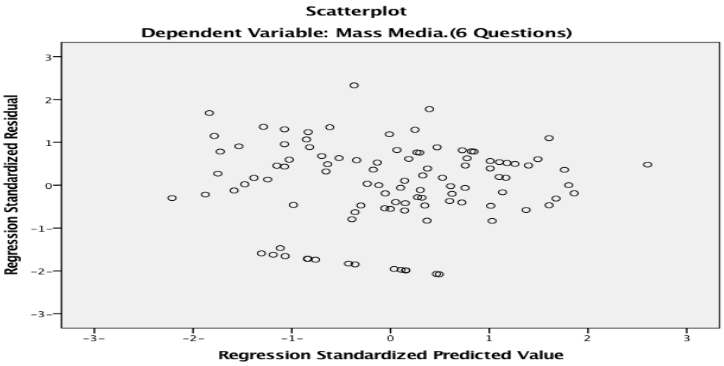

Histogram
Dependent Variable: Instructor Hardware.(6 Questions)
Mean = 7.51E-16
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual


Scatterplot
Dependent Variable: Instructor Hardware.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value


Histogram
Dependent Variable: Software.(6 Questions)
Mean = 3.81E-15
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual


Scatterplot
Dependent Variable: Software.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value


Histogram
Dependent Variable: Mass Media.(6 Questions)
Mean = 4.04E-16
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual


Scatterplot
Dependent Variable: Mass Media.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-3