Science and Math Lesson Plans to Meet the Ohio Revised Science Standards and the Next Generation of Standards for Today; Technology (Excel)

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ABSTRACT

Pre-service teachers (K-12) developed and taught lesson plans that met the state and national science and technology standards by integrating Excel and PowerPoint into their lesson. A sample of 74 pre-service teachers in our science education program were required to integrate technology (Excel) as they developed science and math lesson plans with graphing as a requirement. These students took pre-test and post-test (n=74) to determine their understanding of Excel in relation to the need of current technology for todays' science classroom. The test results showed that students obtained content gains in Excel graphing in all the inquiry-based lab experiments. They also gained experience in developing math skills, inquiry-based science lesson plans, and communication and presentation skills.

Keywords: Hands-on /Inquiry-based learning, Professional development for pre-service teachers, Technology into the classroom and Pre-and Post-test Assessment.

INTRODUCTION

With the introduction of the next generation science standards, teachers are often required to integrate technology into science lessons to help students collect and analyze data (NGSS, 2013). As a result, the Ohio's new learning science standards require students to use technology including Excel and PowerPoint to organize, analyze, and interpret data during inquiry-based science activities (ODE, 2011). Moreover, in the next two years, the state plans to replace the paper-based standardized testing with computer-based testing, making it a requirement for all schools to give the test only by computer. Yet, several in-service elementary teachers often lack the knowledge required to integrate technology into their science lessons (Chesley & Jordan, 2012). To help pre-service teachers prepare for these new assessments, students enrolled in the early and middle childhood education program at our university were challenged to use Excel in a series of chemical education inquiry-based science experiments to learn the process of entering, organizing, and graphing data in Excel.

In the first phase of the inquiry activities, students collected and evaluated data using Excel. In the second phase, students integrated PowerPoint into their lesson plans, and then taught their lesson to their fellow students in a classroom setting. The lesson plans students developed were required to meet the expectations of the state and national standards. While the inclusion of Excel within the lesson plan met the technology aspect, students still had to show their understanding of Excel by graphing their data in the form of histograms, pie charts or linear regression. For students who generated regression lines for the data, also included correlation coefficients in their graphs to illustrate the best fitting regression line. These students also took a pre- and post-test to determine the normalized content gain when using technology (Excel and PowerPoint) to analyze, interpret, and present data.

DESCRIPTION OF PARTICIPANTS

This study consists of pre-service elementary and middle childhood education students enrolled in concepts in chemistry course developed for pre-service teachers at Wright State University. The course is structured to include chemistry content, guided-inquiry experiments and teaching demonstration. This one semester introductory chemistry course is one of four science content (Chemistry, Physics, Biology and Earth Sciences) courses usually taught to pre-service teachers during the fall, spring and summer semester. Pre-service teachers with an ACT Math score of 22 can enroll in the course during the first year of being admitted into the early and middle childhood education program.

EVALUATING PRE-SERVICE TEACHERS PROFICIENCY IN USING EXCEL TO GRAPH DATA

During the pre-test, 74 pre-service teachers used Excel to generate a line graph, bar graph, histogram, polygon, pie graph, and regression of a line- determined the R^2 value. The typical topics and experiments students completed included density (mass and volume relationships of vegetable oil), heat and temperature (temperature conversions; ^{0}F versus ^{0}C), periodicity (trends in the periodic table; period versus density), acid and base titrations, water quality (temperature versus dissolved oxygen). To start the data analysis, students opened Microsoft Excel and entered the data into Column A and Column B, where Column A represents the data on the X-axis and Column B the data on the Y-axis. Once students typed in all the data, they highlighted all the cells containing the data to be graphed, then they clicked CHARTS to start the process of determining if there is a need for a column (2-D column, 3-D column, cylinder, cone and pyramid) line (2-D line and 3-D line), pie (2-D pie or 3-D pie), bar (2-D bar, 3-D bar, cylinder, cone and pyramid), area 2-D area and 3-D area), scatter (marked scatter, smooth marked scatter, smooth lined scatter, straight marked scatter and straight lined scatter), or other (stock, surface, doughnut, bubble and radar). The Chart Quick Layouts are an important aspect of the graphing process. Selecting format trend line from the list on the tool bar gives you the option of checking the box beside the display R-squared value (R^2) and the display equation of the regression line (Y=mX+b), where Y depicts the y-axis (dependent variable) on the graph, X the x-axis (independent variable), m the slope of the line, and b the intercept (where the line cuts the axis) on the y-axis. To graph temperature in Fahrenheit (^{o}F) and temperature in degree Celsius (^{o}C), students decided to plot the values of ^{o}F on the y-axis and values of ^{o}C on the x-axis (using ^{o}F= 9/5^{o}C+ 32 to convert between the two temperature units). Students could either manually determine the slope (m) of the line by using the formula= Y_2-Y_1/X_2-X_1, such that the 0^{o}C (X_1-value) = 32^{o}F (Y_1-Value) and 100^{o}C (X_2-value) = 212^{o}F (Y_2-value); hence, m= 212^{o}F-32^{o}F/100^{o}C-0^{o}C= 9/5=1.8, or they could simply check the box beside the display the equation of the chart to get the slope from the regression equation generated by Excel. After plotting the data, students used their graphs (Figure 1) to explore the interpolation and extrapolation of other values. For interpolation, students determined that the value of 70 ^{o}F was equivalent to 21^{o}C from the graph. However, for extrapolation, students determined from their graphs that the value of -50 ^{o}C was roughly -58^{o}F. Students also reported a correlation coefficient (R^2) of 1, suggesting a perfectly fitting regression line for the data.

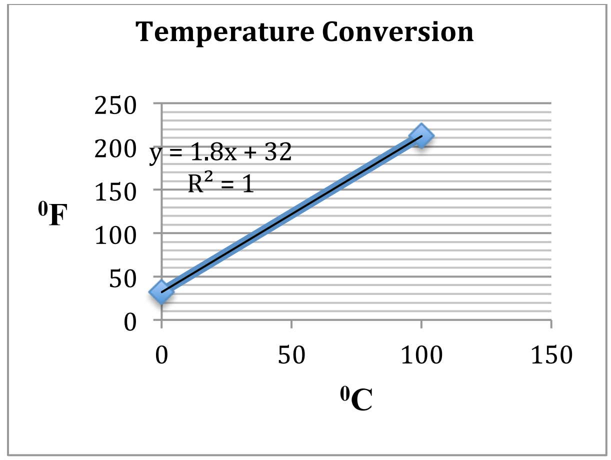

Figure 1 Relationship between temperature in ^{o}F and ^{o}C.

Similarly, in another experiment, students used Excel to graph the mass of vegetable oil on the y-axis and the volume on the x-axis to discover the relationship between mass and volume of vegetable oil. After graphing the data, students observed that as mass increase volume increase as well (directly proportional), so they determined the equation of the regression line and correlation coefficient (R^2). Although the value of R^2 was unequal to 1 as found in the temperature conversion graph (Figure 1), students still obtained a slope of 0.89 g/mL, which represents the density of vegetable oil, and this value was quite close to the actual density of vegetable oil (0.91 g/mL). This graphing activity reinforced students understanding of density as a ratio of mass to volume. Students also used the equation of the regression line to predict the volume of vegetable oil when given a specific mass of vegetable oil and vice versa.

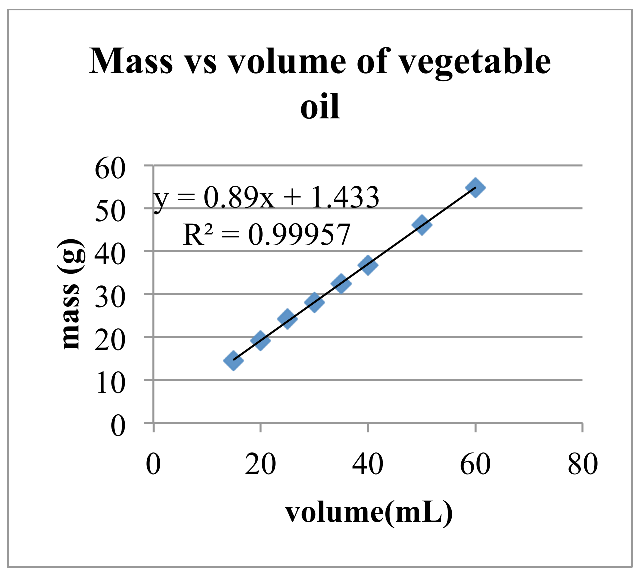

Figure 2 Relationship between mass and volume of vegetable oil.

Another example to illustrate the success of our students learning how to graph by Excel involved an activity where the pre-service teachers determined the percentage of fine sand (5%), coarse sand (42%), gravel (53%) and 0% silt and clay in a given sample. The pie chart showing the distribution of these sand types appear in Figure 3.

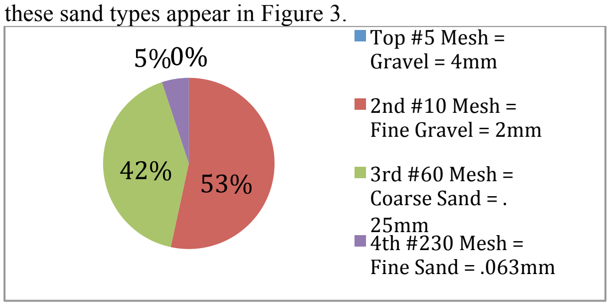

Figure 3 Distribution of the types of sand in a sample of soil

Pre-service teachers pretest and posttest Results

The pre-test and the post-test scores for these students showed that the integration of Excel in the inquiry-based experiments enhanced their content knowledge. The pre-test average score was 38%, while the post-test was 90%. To determine the content gain for these students, we used the R.R. Hake method (1998), which is expressed as the ratio of the actual average gain (% posttest - % pretest) to the maximum possible average gain (100 - % pre). In this study, we obtained an average Normalized Gain of 0.84 for our 74 participants. Typically, normalized gains greater than 0.7 occur in inquiry-based/problem solving learning labs, therefore our value of 0.84 suggests a high content gain for our pre-service teachers involved in the inquiry-based science activities as documented by R.R. Hake (1998).

CONCLUSION

In the past, several of our pre-service teachers could not use the subscript and superscript function in Microsoft office to write chemical equations. For this reason, pre-service teachers' who participated in this inquiry science class not only enhanced their mathematical and computer skills in using Excel and PowerPoint; they also improved their written and communication skills. Our hope is that many of them will now feel confident to integrate technology into their science lessons so that their students can develop computer skills to meet today's highly competitive job market. "Computer technology has transformed all aspects of our lives and many education reformers agree that it can and must be an important part of current efforts to personalize education and students must gain the competencies to function in a 21st century society and workforce" (Christensen et al., 2008; and Collins and Bronte-Tinkew, 2010). We also hope that our pre-service teachers will network with other teachers to encourage them to integrate technology into their science lesson plans to meet the goals of the NGSS.

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