Undergraduate Science Education of Pre-Service Teachers: The Relationship to Self-Efficacy of High School Chemistry and Biology Teachers

by

Holly DeBernardo

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Holly DeBernardo

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Signature:

______________________________

Holly DeBernardo, Student

Approvers:

______________________________

Sherri Lovelace-Cameron, Thesis Advisor

______________________________

Mike Serra, Committee Member

______________________________

Daryl Mincey, Committee Member

______________________________

Peter J. Kasvinsky, Dean of Graduate Studies
Abstract

This project assessed high school science teachers’ perceptions of (a) their abilities to teach science and (b) learning experiences in their own undergraduate science and education courses. Previous studies have shown that the ways in which teachers learn science often determines how they will teach science. This research points to the need for developing teacher education programs that will integrate undergraduate education and science courses in the preparation of secondary science teachers. The data collected in this project contributes to this research base and calls for changes in teacher education programs based upon teachers’ reflections upon their own experiences in learning science as an undergraduate.

A Likert questionnaire was administered to teachers in Ohio and Pennsylvania, consisting of two subscales: teachers’ perceptions of the quality of their undergraduate preparation and their self-efficacy. Two of these teachers were interviewed in order to further understand their survey responses. This study was designed to explore the differences in content preparation of teachers.

Analysis focused on whether there were any correlations between Ohio and Pennsylvania, how the states’ teacher education programs compare and whether teachers who graduated from Pennsylvania have a higher self-efficacy score than those that graduated from Ohio colleges and universities. Pennsylvania requires teachers to earn a Bachelor of Science in their subject area, whereas Ohio teachers major in secondary education and, therefore, take fewer courses in their content area. Recommendations for further research, which include a more in-depth look at perceived abilities that high school science teachers have about their teaching, are included.
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Chapter 1 Introduction

This research problem focused on teacher education programs for secondary science teachers. Specifically, the question is to what extent does the quality of learning science at the undergraduate level affect the teachers’ perceptions of their ability to teach science? Science learning at the undergraduate level refers to content knowledge. This includes not only the variety of science classes taken by these teachers, but the quality of learning experiences within these classes as well. The quality of content knowledge was analyzed for alignment with the National Science Education Standards for learning science. In contrast to content knowledge, pedagogical knowledge is gained from educational classes taken at the undergraduate level. This refers to the processes used to teach science, i.e. strategies a teacher is able to use to facilitate learning for his/her students. How well prepared the teachers feel was examined by comparing their pedagogical practices to the National Science Education Standards for teaching science. The extent to which teachers felt they could influence student learning, that is, the teacher’s self-efficacy, was analyzed by a science teacher beliefs instrument (STEBI). This helped to explain the teachers’ feelings about their preparation to teach science, both in terms of content and pedagogy.

High school science teacher education programs vary from state to state. Some states have students major in education, while others have students major in a specific area of science. This study examined specifically the differences in the science teacher education programs between Ohio and Pennsylvania. In Ohio the teacher education program allows undergraduate students to major in education with an emphasis in a
particular content area, such as biology, physics or comprehensive science; these
graduates have a degree in education. As a result most schools push for the students to
earn a comprehensive or integrated degree in education, which enables the students to
receive a certificate or license to teach all or most areas of science. In Pennsylvania, the
high school science teacher education programs have students pick a science major and
then receive a certificate or license in education by taking a certain number of education
classes. In Pennsylvania, teachers are only certified or licensed to teach the subject that
they have majored in. Looking at the way theses two states have designed their programs
one would be lead to believe that students graduating from a Pennsylvania high school
science teacher education program would have more content knowledge and more self
confidence in teaching that content than those graduating from an Ohio high school
science teacher education program. This study examined the correlations between
content and pedagogical preparation and self-efficacy in Ohio and Pennsylvania to
determine if Pennsylvania teachers had a better undergraduate experience and higher self-
efficacy scores.
Chapter 2 Literature Review

The ways in which teachers learn science often determines how they will teach science. For example, if a teacher is taught primarily through lecture, then he/she is most likely going to teach in a lecture style. At the secondary level, effective teachers of science should possess a deep understanding of the scientific disciplines that they teach. Prospective and practicing teachers must take science courses in which they learn science through inquiry, having the same opportunities as their students will have to develop understanding. Teachers will teach as they were taught; therefore, their undergraduate educators must provide opportunities to learn science through active investigation. The National Science Education Standards place priority on inquiry for high school science, however, most teachers have only experienced lecture throughout their undergraduate science courses. The labs that most undergraduate pre-service science teachers experience are largely “cookbook” labs, or verification labs in which the students follow a set of given instructions to verify a result. This does not involve any active investigation. A study by Hammrich indicates that teacher candidates need to gain an understanding of how science works. He argues that in order for reform in science education to take place, active involvement of learners in the teaching and learning process must occur. The study also explained that in order to model lifelong learning for their own students, teachers need to be able to reflect on conceptions of science learning and teaching.

The previous paragraph is an excellent description of what should occur during an undergraduate pre-service science education career, however, most of the research
indicates that pre-service science teachers do not experience learning content in this manner. Most science courses at the undergraduate level are strictly lecture and the labs are simple verification. The purpose of this study was to examine the relationship between undergraduate experience in learning content and the teachers’ belief about how well they teach that specific content. According to Howes⁴, to be prepared to teach science, one must have appropriate visions of scientific inquiry, as well as a good grasp of scientific concepts. A study by Bandura examined the correlations between undergraduate content preparation of the teachers and their self-efficacy.

According to Bandura, beliefs are thought to be the best indicators of the decisions people make throughout their lives, stating that people act upon what they believe.⁵ Clearly, science teachers possess beliefs regarding educational practices.⁶ Teacher beliefs appear to be good predictors of behavior.⁷ Riggs and Enochs used Bandura’s theory to develop the widely used Science Teacher Efficacy Beliefs Instrument (STEBI).² Researchers using the STEBI have provided evidence that the environmental context plays a role in shaping science teachers’ beliefs.⁶ Cannon and Scharmann found that cooperative field experiences increased pre-service science teacher self-efficacy.⁸ Another study found significant correlations among science teaching self-efficacy and the number of science courses taken, instructional practice and perceived teaching effectiveness.⁶ The following study expanded on these findings by examining the correlations between the undergraduate experience of the teachers that graduated with a content degree and those who graduated with an education degree. The study also looked at the number of science classes taken and examined the type of instruction that these teachers had as undergraduate pre-service teachers. Correlations between content
preparation and the self-efficacy of the teachers were also examined. Perceived self-efficacy is described to be the extent to which teachers believe they can influence student learning.6 There are two dimensions to self-efficacy: personal self-efficacy and outcome expectancy. The personal self-efficacy is the teachers’ beliefs about their own ability to affect student outcomes.2 Outcome expectancies are the teachers’ beliefs about their own ability to execute specific teaching actions. A teacher’s sense of personal teaching efficacy, or belief that one has the skills and abilities to bring about student learning is different from outcome expectancies because individuals believe that certain behaviors will produce certain outcomes. Personal self-efficacy as defined by Bandura is, “judgments about how well one can organize and execute courses of action required to deal with prospective situations that contain many ambiguous, unpredictable and often stressful elements.”5 Bandura explained that outcome expectancy is, “a person’s estimate that a given behavior will lead to certain outcomes.”5 If teachers do not believe that they can perform the necessary activities, they will not initiate the relevant behaviors.9 Teachers often teach to their strengths, and in the areas of their teaching practice where they doubt their efficacy, they may avoid teaching the content or using inquiry methods.10 In the following study the content preparation was examined to determine how well the teachers felt they were prepared to teach science and how comfortable they felt in teaching the content.

The purpose of this study was to apply an assessment strategy designed to gauge teachers’ beliefs about their self-efficacy and correlations between content preparation and pedagogy preparation. This study was also designed to look specifically at the differences in science teacher education programs between Ohio and Pennsylvania.
Pennsylvania requires teachers to have content degrees, whereas Ohio does not. The research indicates that teachers with better undergraduate content have higher self-efficacy. This study addressed the question, do Pennsylvania teachers have higher self-efficacy scores and better undergraduate preparation in both content and pedagogy than Ohio teachers?
Chapter 3  Methodology

Methodology is a way of thinking about studying social reality and methods are described as a set of procedures and techniques for gathering and analyzing data.\textsuperscript{11} In this study various methods of collecting data were used to analyze the research question. The hypothesis was that varying levels of content knowledge affect teacher preparation. More specifically, lower levels of content knowledge lead to lower self-efficacy and that lower levels of content preparation lead to less alignment of teaching practices with the National Science Education Standards.

Research Survey – Undergraduate Preparation

The purpose of a survey is to produce statistics, quantitative descriptions about some aspects of the study population.\textsuperscript{12} The final version of the survey as administered can be found in Appendix A. Survey questions were developed to measure teachers’ perceptions of the quality of their undergraduate preparation, including the adequacy of their content knowledge, the adequacy of their pedagogy knowledge, and the extent of the integration of their content knowledge with pedagogy knowledge. The survey questions consisted of both favorable and unfavorable statements on a Likert scale of strongly agree to strongly disagree. The survey contained nine questions that measures the teachers’ perceptions of their undergraduate science learning and to how these perceptions relate to the National Science Education Standards. A discussion of each of the items on the perceptions subscale follows.
Statement 1 – My undergraduate science professors taught through lecture.

Statement 2 – My undergraduate education professors used a variety of teaching methods.

These two statements asked the teachers’ to reflect upon how their undergraduate courses in both science and education were taught. Were the classes taught in the traditional lecture style? Or, were the classes taught in a manner in which the students were participants in the learning process, such as class discussion, cooperative learning, etc.?

Statement 3 – My undergraduate science professors discussed how to learn science.
Statement 7 – My undergraduate science professors discussed science education pedagogy.
Statement 8 – My undergraduate education professors discussed science education pedagogy.

These three statements explored the extent to which teachers were taught how to learn science in their undergraduate courses. These statements measured if the teachers were explicitly taught science education pedagogy in either science or education courses during their undergraduate studies.

Statement 5 – The laboratory experiments in my undergraduate science courses were verification or “cookbook” experiments.

Statement 6 – My undergraduate science instruction included designing science experiments.

Statement 9 – My undergraduate program did not include guided or inquiry lab experiences.
These statements examined if any of the teachers’ undergraduate classes taught them how to prepare, run and clean up a lab in their own classroom. Specifically, these three statements probed to what extent the teachers were familiar with a variety of laboratory designs.

**Statement 4** – My experiences in undergraduate science courses have prepared me to be an effective teacher.

This statement was asked to determine if the teachers felt that their undergraduate programs offered them enough instruction in their content area to feel comfortable teaching the subject.

**Research Survey – Self-Efficacy**

The second scale on the survey consisted of fourteen STEBI \(^2\) questions to measure the teachers’ self-efficacy, i.e. perceptions about their ability to teach science across both previously described dimensions of outcomes and expectancies. These questions were adapted from Riggs and Enoch’s Science Teaching Efficacy Beliefs Instrument.\(^2\) The self-efficacy scale was divided into two subscales, personal teacher efficacy and outcome expectancies.

**Statement 10** – I wish my undergraduate program had required more science content courses.

**Statement 12** – I feel knowledgeable in all the science content areas which I am certified/licensed to teach.

**Statement 14** – I have mastery of my content knowledge
Statement 16 – I have the knowledge to teach an advanced level course in my content area (AP, honors, etc.)

Statement 17 – I have the skills and motivation; I can reach the most difficult students.

Statement 19 – I motivate my students to learn science.

Statement 20 – I consider myself a scientist.

Statement 21 – I have training to deal with any type of learning problem.

The above statements asked teachers about their personal teacher efficacy and what their beliefs are about their own ability to affect student outcomes.

Statement 11 – If one of my students cannot remain on task for a particular assignment, there is little that I can do to increase his/her attention until he/she is ready.

Statement 13 – When a student does better than usual, it is because I exerted an extra effort.

Statement 15 – The amount that a student can learn is primarily related to family background.

Statement 18 – When a student is having difficulty with an assignment I am able to adjust the assignment to his/her level.

Statement 22 – When a student gets a better grade the he/she usually gets, it is because I found more effective teaching approaches.

Statement 23 – Even a teacher with good teaching abilities may not reach many students.

The above items were on the outcome expectancies subscale and examined whether the teachers believe that a given behavior will lead to a certain outcome.
Research Survey - Demographics

Demographic questions were included in the survey as breakdown variables to identify meaningful characteristics of the teachers across a variety of categories. Some demographic questions were open-ended, allowing participants to write in their own responses, and some questions provided pre-determined responses. Eight demographic questions were asked, including the number of years that the educator had been teaching and the type of teaching certificate(s)/license(s) the teacher holds.

Pilot Testing

The survey was pilot tested in December 2003 with chemistry education graduate students (N=4) who were also full time science teachers. These teachers were chosen because they had a range of years of experience in teaching and they all had various levels of experience with chemistry education pedagogy. Some of these teachers were new to the chemistry education graduate program, while others had been a part of the program for a few years. Two of the four teachers were graduates from Pennsylvania schools and two were graduates from Ohio schools. The demographics of this pilot test sample were representative of teachers for the sampling plan for the research study: new to education and veteran teachers, new to science education pedagogy and veterans, and teachers from both Pennsylvania and Ohio. During the pilot testing, the survey was given to teachers individually and one page at a time. After responding to the statements on the page, teachers were asked to identify any statements which were confusing or any statements that needed to be reworded. Teachers were also asked to “think out-loud” as
to what the questions on the survey meant in order to strengthen the validity of the instrument.

**Sampling**

In studying social realities a human subject’s consent form was submitted and accepted by the Youngstown State University Institutional Review Board (IRB) before any data were collected (Appendix B). This ensured compliance with securing informed consent by the researchers and the institution. To obtain a sample of teachers, a stratified random sampling technique was used. The sample was stratified across both Pennsylvania and Ohio, by selecting two counties in Ohio (Mahoning and Trumbull counties) and two counties in Pennsylvania (Mercer and Lawrence counties). Forty teachers were randomly selected from a list provided by the Youngstown State University Chemistry Department within the two counties in Ohio, and an additional forty teachers were randomly selected within the two counties in Pennsylvania. Surveys went out to teachers through the mail along with a cover letter, two consent forms (one to return, one for them to keep) and a self-addressed stamped envelope for them to return the survey (Appendix D) and consent form (Appendix C).

Once the survey was in its final form, a table of random digits from *Introduction to the Practice of Statistics*\textsuperscript{10} was used to choose forty teachers from each of the four counties. The forty teachers from Mahoning and Trumbull county were selected by using a list of Biology/Chemistry teachers maintained by the Youngstown State University Department of Chemistry. The Pennsylvania teachers were selected in the same way, however, there were only twenty-six biology/chemistry teachers total for Mercer county and only thirty for Lawrence county. The addition of Butler county in Pennsylvania
provided four additional science teachers. In summary, sixty science teachers were surveyed in Pennsylvania and eighty teachers in Ohio.

**Data Coding**

A codebook (Appendix F) was prepared to convert the information obtained from each teacher into a format that SPSS could analyze. SPSS, Statistical Package for Social Sciences, is a computer statistical program which looks for meaningful correlations and was used to analyze the data. In preparing the codebook each variable was labeled and assigned a number for each of the possible responses. The statements on the undergraduate preparation scale were grouped into two subscales. The first subscale focused on the type of instruction and the content being taught (statements 1, 3, 4, 5 and 6). The other subscale, which consisted of statements 2, 7, 8 and 9, emphasized the pedagogy within the courses and how the classes were being taught. Statements on the self-efficacy scale were grouped into two subscales as well. Statements 10, 12, 14, 16, 17, 19, 20 and 21 were placed or grouped on the personal teacher efficacy subscale. The outcome expectancies subscale consisted of statements 11, 13, 15, 18, 22, and 23.

To help prevent response bias, some statements had been worded negatively so as to have both favorable and unfavorable items on each of the subscales. Therefore, the unfavorable items needed to be reversed or recoded in the SPSS system. This was to ensure that all items were scored so that high scores indicated high levels of preparedness. On the undergraduate scale, statements 1, 5 and 9 were coded. On the self-efficacy scale, items 10, 11, 15 and 23 were recoded.

Four sub-questions were created to be analyzed:

- Do Pennsylvania teachers have higher self-efficacy scores than Ohio teachers?
- Do Pennsylvania teachers have a better undergraduate preparation than Ohio teachers?

- Do Pennsylvania teachers have more content knowledge than Ohio teachers?

- Do Pennsylvania teachers have better pedagogy preparation than Ohio teachers?

The following correlations were examined:

- Are there correlations between pedagogy preparation and content preparation?

- Are there correlations between pedagogy preparation and self-efficacy?

- Are there correlations between content preparation and self-efficacy?

- Are there correlations between pedagogy and content preparation vs. self-efficacy?

**Reliability and Validity**

The Cronbach alpha value of 0.7267 showed that the undergraduate preparation scale was reliable, however, by removing item 8 from the scale the alpha value increased to 0.7534. The alpha value for the self-efficacy scale was 0.6476 with a corrected item value for item 15 of -0.3657. After removing item 15 from the self-efficacy scale the alpha value increased to 0.7296. By deleting both statement 8 and 15, the undergraduate scale, self-efficacy scale and the total scale were reliable. Statement 8 asked teachers if they had mastery of their content knowledge. Statement 15 asked the teacher, “when a student does better than usual, is it because the teacher has exerted an extra effort.”

Histograms were prepared for the undergraduate scale, the self-efficacy scale and the total scale. Scatterplots, which are typically used to explore the relationship between two
continuous variables, were prepared to examine the relationship between the total scores on the survey and the state in which the teacher graduated.

In order to address the validity of inferences drawn from analysis of the survey responses, five teachers were chosen to be interviewed. These five teachers were chosen for divergence in their survey scores, i.e. they were at opposite ends of the survey scale. The years of teaching experience varied for the teachers chosen. Two teachers from Ohio were selected to be interviewed. One of these teachers had high scores across all three measures: the undergraduate preparation scale, the self-efficacy scale and the total score. The other teacher had high scores on the undergraduate preparation scale and the self-efficacy scale but was the lowest on the total scale of all the surveys that were analyzed. Three teachers from Pennsylvania were chosen to be interviewed. One of the teachers had high scores across all three measures. The other two teachers had low scores across all three measures. In order to further understand the survey responses, the interviews focused upon the teachers’ experiences. Questions were asked to help verify and explain why the teachers chose their responses on the survey and the science teachers’ beliefs instrument. A semi-structured interview guide was created from the survey statements (see Appendix G). The interview guide was divided into two main sections: questions about the teachers’ undergraduate education experiences and questions about the teachers’ self-efficacy. The undergraduate questions were further broken down into two subsections: questions pertaining to the teachers’ science courses and questions regarding the teachers’ education courses. Once the teachers were selected, a letter was sent to each teacher at his/her school (Appendix H). One Ohio teacher called and said that she was no longer teaching at the high school and did not feel that she would be a good
contributor. The remaining four teachers were called to schedule interviews. Two of the four returned the phone call and were eventually interviewed. One teacher from Pennsylvania and one from Ohio participated in the interview process.

The interviews were transcribed and field notes were written. The field notes for each interview allowed notation of analytic comments to record emerging ideas, themes or working hypotheses relevant to the overall research questions. The field notes permit notation of methodological comments to improve subsequent interviews. After reading each interview, codes were identified that were important to the theme of the interview (Appendix H). Similarities and differences among the codes were developed, looking for common themes among the interviewed teachers, trying to determine an underlying theme that was present in both interviews, to see if the teachers had similar experiences and/or feelings and opinions about their undergraduate preparation. To determine the quality of the results a focus on one of Guba and Lincoln’s trustworthiness criteria, specifically the criteria of credibility to examine the internal validity of the results was made. To determine how well the findings resonated with the teachers, the participants were asked member check questions, that referenced the original survey questions during the interview.
Chapter 4 Data

The data collected was both quantitative and qualitative. The quantitative data is a statistical process of gathering and interpreting data. According to Strauss, “the qualitative data is a nonmathematical process of interpretation carried out for the purpose of discovering concepts and relationships in raw data and then analyzing these into a theoretical explanatory scheme.” This chapter presents both the quantitative and the qualitative data collected in this research study.

The quantitative data included: the Likert scale scores, correlations and the reliability and validity of the scores. The quantitative data that was collected was analyzed using SPSS to look for meaningful correlations. A codebook was formulated to serve as a summary of the instructions used to convert information obtained from each subject or case into a format that SPSS could analyze (Appendix F). The codebook included information such as the definition and label of the variables. The codebook was used as a reference to enter data into the SPSS computer analysis program. The correlations of particular interest included: the correlation between content preparation levels and self-efficacy, correlations between pedagogy preparation levels and self-efficacy and comparisons of scores between Ohio and Pennsylvania.

The undergraduate scale, self-efficacy scale and the total scale were all examined for the reliability and the validity of these measures. To check the reliability of all three scales, Cronbach’s coefficient alpha test was used. These statistics provided an indication of the average correlation among all of the items that make up the scales. The values range from zero to one with higher values indicating a greater reliability. A value of 0.7 or higher indicates reliability of the scale.
Reliability

Table 1: Initial Alpha Values

<table>
<thead>
<tr>
<th>Scale</th>
<th>Alpha Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undregraduate Preparation Scale</td>
<td>0.7267</td>
</tr>
<tr>
<td>Self-Efficacy Scale</td>
<td>0.7448</td>
</tr>
<tr>
<td>Total Scale</td>
<td>0.6598</td>
</tr>
</tbody>
</table>

Removing item 8 increased the alpha value to 0.7534. Item 8 could have been misinterpreted by participants.

Table 2: Alpha Values with Item 8 Deleted

<table>
<thead>
<tr>
<th>Scale</th>
<th>Alpha Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undregraduate Preparation Scale</td>
<td>0.7534</td>
</tr>
<tr>
<td>Self-Efficacy Scale</td>
<td>0.6476</td>
</tr>
<tr>
<td>Total Scale</td>
<td>0.6398</td>
</tr>
</tbody>
</table>

Item 15 showed a corrected item value of -0.3657 and would increase the alpha if removed.

Table 3: Alpha Values with Items 8 and 15 Deleted

<table>
<thead>
<tr>
<th>Scale</th>
<th>Alpha Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undregraduate Preparation Scale</td>
<td>0.7534</td>
</tr>
<tr>
<td>Self-Efficacy Scale</td>
<td>0.7296</td>
</tr>
<tr>
<td>Total Scale</td>
<td>0.7112</td>
</tr>
</tbody>
</table>

T-Tests

Independent t-Tests were completed for the following four questions:

Do Pennsylvania teachers have higher self-efficacy scores than Ohio teachers?

The Levene’s Test for Equality of Variances showed a value of 0.551 which indicated equal variances were assumed. The 2-tailed value of 0.756 was above 0.05, showing that there was no significant difference in the mean self-efficacy scores for teachers in Pennsylvania as compared to teachers in Ohio.
Do Pennsylvania teachers consider their undergraduate preparation to be of a higher quality than Ohio teachers do their own preparation?

The 2 tailed value of 0.467 concluded that there was not a significant difference in the mean undergraduate scores of Pennsylvania and Ohio teachers.

Do Pennsylvania teachers have more content knowledge/preparation than Ohio teachers?

The 2 tailed values were all above 0.05, which showed no significant difference in the mean scores of Pennsylvania and Ohio teachers.

Do Pennsylvania teachers have better pedagogy preparation than Ohio teachers?

The 2 tailed values were all above 0.05, which showed no significant difference in the mean scores of Pennsylvania and Ohio teachers.

Histograms and Correlations

Histograms for each individual item were prepared as well as histograms for all three scales between Ohio and Pennsylvania. None of the independent t-tests showed any significance with values above 0.05. The histograms showed mostly uniform responses to undergraduate scale items and no outliers. The histograms for the self-efficacy scale showed a wide range of feelings about the teachers’ self-efficacy with two outliers.

The reliability of the total scale was still not above 0.7, so after examining the results, item 8 was deleted and the reliability tests, correlations and histograms were calculated again along with scatterplots.

Item 8: My undergraduate education professors discussed science education pedagogy.

This item could have been misinterpreted by teachers.
When item 8 was deleted, the alpha value for the undergraduate scale was 0.7534, the self-efficacy value was much lower at 0.6476 and the total scale value was also lower at 0.6398. The correlations between pedagogy preparation and content preparation and between pedagogy preparation and self-efficacy were small and negative. There was a small to moderate positive correlation between content preparation and self-efficacy and between pedagogy and content preparation versus self-efficacy.

**Table 4:** The results for the histograms without item 8 for Ohio:

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>undergraduate mean</td>
<td>19.32</td>
</tr>
<tr>
<td>undergraduate midpoint</td>
<td>20.00</td>
</tr>
<tr>
<td>self-efficacy mean</td>
<td>40.96</td>
</tr>
<tr>
<td>self-efficacy midpoint</td>
<td>32.50</td>
</tr>
<tr>
<td>total mean</td>
<td>60.28</td>
</tr>
<tr>
<td>total midpoint</td>
<td>55.00</td>
</tr>
</tbody>
</table>

**Table 5:** The results for the histograms without item 8 for Pennsylvania:

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>undergraduate mean</td>
<td>20.54</td>
</tr>
<tr>
<td>undergraduate midpoint</td>
<td>22.50</td>
</tr>
<tr>
<td>self-efficacy mean</td>
<td>41.32</td>
</tr>
<tr>
<td>self-efficacy midpoint</td>
<td>35.00</td>
</tr>
<tr>
<td>total mean</td>
<td>61.86</td>
</tr>
<tr>
<td>total midpoint</td>
<td>52.50</td>
</tr>
</tbody>
</table>

A scatterplot of the undergraduate total and the self-efficacy total for both Ohio and Pennsylvania was completed to explore the relationship between them. The scatterplot gives an indication of whether the variables are related in a linear or curvilinear fashion \(^{11}\) (Appendix J). The scatterplot showed a moderate positive correlation between the undergraduate scale and the self-efficacy scale for both Ohio and Pennsylvania.
scatterplot of undergraduate total and self-efficacy total of Ohio versus Pennsylvania was also completed (Appendix J). This scatterplot suggested a positive relationship and a moderate correlation between Ohio and Pennsylvania teachers on both the undergraduate and the self-efficacy scale.

The reliability of all three scales still needed to be recalculated after removing item 8, so item 15 was also deleted and the tests were all calculated again. The undergraduate scale value was now 0.7534, the self-efficacy value was 0.7296 and the total scale value was 0.7112, all showing reliability. The correlations between the self-efficacy and the content preparation and between the self-efficacy and the pedagogy preparation were small and negative. The correlations between the self-efficacy and the undergraduate preparation and between the content preparation and the pedagogy preparation were small and positive.

**Table 6:** The results for histograms without items 8 and 15 for Ohio:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate mean</td>
<td>17.04</td>
<td></td>
</tr>
<tr>
<td>undergraduate midpoint</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>self-efficacy mean</td>
<td>38.08</td>
<td></td>
</tr>
<tr>
<td>self-efficacy midpoint</td>
<td>32.50</td>
<td></td>
</tr>
<tr>
<td>total mean</td>
<td>55.12</td>
<td></td>
</tr>
<tr>
<td>total midpoint</td>
<td>52.50</td>
<td></td>
</tr>
</tbody>
</table>

**Table 7:** The results for histograms without items 8 and 15 for Pennsylvania:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tr>
<td>Undergraduate mean</td>
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<td>undergraduate midpoint</td>
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Table 8: The results for histograms without items 8 and 15 for both Ohio and Pennsylvania

<table>
<thead>
<tr>
<th></th>
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<th>17.43</th>
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<tr>
<td>self-efficacy mean</td>
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<td>self-efficacy midpoint</td>
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<tr>
<td>total mean</td>
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<tr>
<td>total midpoint</td>
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The undergraduate scale showed no outliers but the self-efficacy scale and the total scale had outliers, with three outliers for the self-efficacy scale and two other outliers for the total scale. A scatterplot of undergraduate total and self-efficacy total was also completed (Appendix K). The scatterplot for the undergraduate total scale and the self-efficacy total scale for Ohio versus Pennsylvania indicated a moderate negative correlation. The scatterplot for the undergraduate total scale and the self-efficacy scale for Ohio showed a moderate negative correlation, while for Pennsylvania the scatterplot showed a moderate positive correlation. Now that all the scales were reliable, the tests were recalculated for the independent t-tests without items 8 and 15.
**Interviews**

The qualitative data was divided into two main categories. One focused on the teachers’ undergraduate preparation and the other focused on their self-efficacy. Two teachers, one from Ohio and one from Pennsylvania, were selected to be interviewed. The teacher from Pennsylvania has been teaching Chemistry I and Chemistry II for ten years. He has a Bachelor of Science degree from Grove City College in biochemistry and a Master of Science from Slippery Rock in education. He is only certified to teach chemistry grades nine through twelve. The teacher from Ohio has been teaching for twenty years and currently teaches Chemistry 1 and Advanced Placement Chemistry. She has a comprehensive science degree from Youngstown State University as well as a Masters in education. She also has a National Teachers Certification. This teacher is certified to teach any science area in grades seven through twelve. Both of these teachers wished that their undergraduate education courses spent more time on the reality of teaching in a school district. One teacher said,

“I wish my course spent more time on learning more about the everyday aspects of teaching and how to deal with things that come up everyday.” (Male, Pennsylvania)

He then said,

“I think more of what is taught is when everything is perfect and when kids are sitting there perfectly silent waiting for you, which doesn’t happen.” (Male, Pennsylvania)

The other teacher explained,

“I wish my course would have spent more time on the politics of teaching.” (Female, Ohio)
These two teachers also claimed that they were not well prepared to teach in a lab setting or to handle all of the aspects of having a stockroom. One teacher claimed,

“Learning how to set up and keep a stockroom and lab was not taught, it was on the job training.” (Male, Pennsylvania)

The other teacher said,

“I learned about setting up a lab and a stockroom on the job, but I don’t think that there is a way for professors to teach everything about running a classroom, new teachers have to have the desire to try to learn.” (Female, Ohio)

Both of these teachers claimed that they learned how to learn science in their undergraduate science courses. The teacher from Pennsylvania said,

“I learned to learn science more so in my science classes because sometimes, depending on the professors you have to sort of teach yourself. Try to learn science through connections.” (Male, Pennsylvania)

The Ohio teacher said,

“I learned to learn science in her science classes, by having to learn the subject matter for tests and labs.” (Female, Ohio)

When asked how they motivate their students, both indicated that they made real world connections for the students. One teacher claimed,

“I try to make real world connections and explain why things are relevant and important. Try to be enthusiastic and excited about the subject that you teach.” (Male, Pennsylvania)

The other teacher said,

“I motivate my students by making real world connections and hands-on activities that make sense to the students.” (Female, Ohio)
In explaining what inquiry based learning is, both teachers stated that they do use this type of teaching and one teacher said,

“Presenting students with a problem and having them try to solve it and then just letting them go with it.” (Male, Pennsylvania)

The other teacher said,

“Inquiry based learning consists of hands-on activities, open-ended questions and labs without procedures.” (Female, Ohio)

In describing an effective science teacher, one teacher said,

“I think being able to use several techniques and being diverse in your teaching.”
(Male, Pennsylvania)

The other teacher stated,

“An effective science teacher shares the love of learning and understanding science concepts with students and as leading students on a quest for answers.” (Female, Ohio)

When asked about what they felt well prepared to do as a teacher, the participants had different responses. One teacher indicated that he felt very comfortable in the course work. He said,

“I got my undergraduate in biochemistry from Grove City College and I think they prepared me well in terms of coursework.” (Male, Pennsylvania)

The teacher from Ohio did not mention anything about feeling prepared in content but said,

“I was very well prepared to make up assessment instruments. My Testing and Measurements professor was awesome.” (Female, Ohio)
The teachers had different answers to the question pertaining to if they felt their undergraduate program prepared them in science content courses. The teacher from Pennsylvania said,

“Yes, I felt very prepared in course work. I took all science classes in my undergraduate program.” (Male, Pennsylvania)

The teacher from Ohio said,

“I sort of felt prepared, but I think that I could have felt more prepared if I had more science classes.” (Female, Ohio)

The teachers view themselves differently in terms of being a scientist as well. One teacher said,

“Sure, I think I am a scientist, I feel that I am pretty proficient in lab work, which is what people think of when they think of a scientist.” (Male, Pennsylvania)

The other teacher claimed,

“I do not consider myself a scientist, I am an educator of science.” (Female, Ohio)

These two teachers provided sufficient information about their undergraduate experiences and how they felt as an educator. Nine emerging themes were observed, with five commonalities.
Chapter 5 Interpretation

To interpret the quantitative data, statistical analyses were carried out to look for specific correlations and significance between certain variables in order to confirm or reject the hypotheses. The interpretation and analysis of the data focused upon answering the question posed in the research problem as well as the sub-questions. Some of the data analysis focused on whether there were any correlations between the two states, how the states’ teacher education programs were aligned with the National Science Education Standards and whether teachers who graduated from Pennsylvania have a higher self-efficacy score than those who graduated from Ohio universities/colleges. These were assessed by completing the individual statistical tests.

Initially none of the scales, undergraduate, self-efficacy or total, showed any internal consistency, with Cronbach alpha coefficient values below 0.7. This indicated that the items that made up the scales were not all measuring the same underlying concept. After removing the items that were not measuring the same underlying idea as the rest of the items in the scales, internal consistency was found. All three scales then had alpha values above 0.7. Factor analysis indicated that all three scales were valid.

Once the scales were found to be reliable and valid, correlations between Ohio and Pennsylvania were completed and analyzed. The first correlation that I examined was between pedagogy preparation and content preparation. The correlation was small and positive, which indicated high scores on the content preparation statements were associated with high scores on the pedagogy preparation statements. However, there were small, negative correlations between statement 2 and statement 4 and between recoded statement 5 and statement 2.
Statement 2 – My undergraduate education professors used a variety of teaching methods.

Statement 4 – My experiences in undergraduate science courses have prepared me to be an effective teacher.

This showed that although the teachers felt their undergraduate education professors discussed how to learn science, they did not feel that their undergraduate science courses prepared them to be effective as teachers. This also suggested that the teachers believed the quality of the content they learned in their undergraduate program was not sufficient.

Statement 2 – My undergraduate education professors used a variety of teaching methods.

Statement 5 (recoded) - The laboratory experiments in my undergraduate science course were verification or “cookbook” experiments.

The small negative correlation here implied that the teachers did feel that their undergraduate education professors discussed how to learn science; however, they did feel that the laboratory experiments in their science courses were verification labs. This suggested that the teachers believed that their undergraduate teacher education programs were aligned with the National Science Education Standards.

The relationship between pedagogy preparation and self-efficacy was found to be small. Statement 7 and the total self-efficacy showed a small, negative correlation as well as statement 2 and the total self-efficacy scale.

Statement 7 – My undergraduate science professors discussed science education pedagogy.

Total Self-Efficacy Scale

Statement 2 – My undergraduate education professors used a variety of teaching methods.
This showed that the teachers with high self-efficacy scores had low scores on statements 7 and 2, which indicated that the teachers whose science professors did not discuss science education pedagogy and whose education professors did not use a variety of teaching methods, still had high self-efficacy scores overall.

The correlation between content preparation and self-efficacy was found to be small and negative, with high levels of self-efficacy associated with lower levels of content preparation. There were three content preparation statements that made small positive correlations among the total self-efficacy scale.

Statement 3 – My undergraduate science professors discussed how to learn science.

Statement 4 – My experiences in undergraduate science courses have prepared me to be an effective teacher.

Statement 6 – My undergraduate science instruction included designing science experiments.

Statements 3, 4 and 6 indicated that the teachers that had professors that discussed learning science and designing experiments also had high self-efficacy scores.

There was a small positive correlation between teachers’ undergraduate experiences in both content and pedagogy and their self-efficacy. This implied that the teachers that felt prepared in their undergraduate program also felt that they were effective teachers.

The relationship between the undergraduate scale and the self-efficacy scale in Ohio, in Pennsylvania, and comparing Ohio and Pennsylvania were analyzed using the scatterplots. In Ohio the total undergraduate scale and the total self-efficacy scale was moderate and negative. This showed that low scores on the total self-efficacy scale were associated with high scores on the total undergraduate scale. These results indicated that although some teachers in Ohio felt that they were well prepared in their content and
pedagogy in their undergraduate programs, they did not feel that they influenced their students’ learning. In Pennsylvania, the scatterplot for the total undergraduate scale and the total self-efficacy scale showed a moderate positive relationship. This showed that high scores on the self-efficacy scale were associated with high scores on the undergraduate scale, which implied that if teachers in Pennsylvania felt that they were prepared in content and pedagogy, they also felt that they were effective as educators. The scatterplot for the total undergraduate and the total self-efficacy was completed with Ohio and Pennsylvania, the overall relationship was moderate and negative.

To determine the distribution of the scores for the total undergraduate scale, the total self-efficacy scale and the total for both scales, histograms were plotted and analyzed. In Pennsylvania, the undergraduate total scale showed a positively skewed distribution. This indicated that most teachers in Pennsylvania felt comfortable with their preparation in their undergraduate program. There were no outliers present. In the self-efficacy total scale, the scores were normally distributed. This showed that the majority of the scores were centered in the middle, which suggested that most of the teachers felt the same way and there were no outliers present. The total scale was positively skewed which implied that most of the teachers in Pennsylvania felt comfortable with their undergraduate preparation and their ability to communicate their knowledge to their students. There were also no outliers present in this histogram.

In Ohio, the undergraduate total scale was negatively skewed, which indicated that most of these teachers did not feel confident that their undergraduate program prepared them. There were no outliers present. The self-efficacy total scale showed a normal distribution of scores, which suggested that the majority of the teachers felt
similar in their ability to teach. There were two outliers present, these were not extreme outliers, but ID 31 had the highest overall self-efficacy score and ID 48 had the lowest self-efficacy score. The total scale for Ohio was normally distributed and also had outliers. These were no extreme outliers, but ID 17 and ID 2 had the highest overall score on the survey and ID 48 and ID 24 had the lowest overall scores on the survey.

Independent t-tests were completed and analyzed to compare the mean scores of all three scales in both Ohio and Pennsylvania. Before completing these analyses, the data were inspected to ensure no assumptions inherent in the individual tests were violated. This was done by generating descriptive statistics regarding the characteristics of the sample, by looking at normalities of some of the data which showed frequencies of scores and finally by assessing the normality of the distribution of scores. The tests showed no significant difference in the mean undergraduate scale, self-efficacy scale or the total scale. The teachers in Ohio and in Pennsylvania did not have significantly different scores overall. This suggested that teachers in Pennsylvania do not have higher self-efficacy than teachers in Ohio. Teachers in Pennsylvania do not have a better undergraduate preparation than teachers in Ohio. Pennsylvania teachers do not have more content knowledge/preparation than Ohio teachers and Pennsylvania teachers do not have better pedagogy preparation than Ohio teachers.

The qualitative results consisted of interviews from two teachers, one from Ohio and one from Pennsylvania. Both of these teachers explained that they wished their undergraduate programs had spent more time on the reality and day to day aspects of teaching. They also described not feeling prepared to have a laboratory in their classroom or how to set up a stockroom in the classroom. Both of the teachers claimed
that they learned to learn science in their undergraduate science courses. However, this was not because of the professors or the classes, instead it was due to the lack of teaching on the professors part. They indicated that they learned science because they had to know the material for class and learned how to make connections for themselves.

The results of analyzing the data showed self-efficacy was not directly correlated with the undergraduate preparation in either the content or the pedagogy. This showed that teachers who did not feel their undergraduate program prepared them, still had high self-efficacy scores in both Ohio and Pennsylvania. In Pennsylvania, the teachers’ responses indicated higher values on the undergraduate scale than in Ohio. However, there was no significant difference between the teachers’ experiences in their undergraduate programs and/or their perceptions about their ability to teach. Content preparation, although, was briefly mentioned by the Ohio teacher as lacking, was not listed as something that either the Ohio or the Pennsylvania teacher wished that their professors would have spent more time on. Learning to learn science was not a major part of either states educational curriculum as indicated by the correlations presented earlier and through the interviews of both teachers who claimed that they learned how to learn science on their own. In both the quantitative and qualitative data analysis, the results suggested that the quality of learning science at the undergraduate level does not affect the teachers’ perceptions of their ability to teach science.

Revisions that would make this research study more conclusive include a larger sample size for both the surveys and the interviews. The surveys were intended to be sent to an equal number of teachers in Ohio and Pennsylvania within the same number of counties. The sample should have included more counties in both states to maximize the
number of participants and to help ensure that equal number of Ohio and Pennsylvania surveys were completed and returned. The sample size for the interviews was intended to be larger but it was difficult to get teachers to commit to the interview. Some type of incentive could have been offered to the teachers for their time. The biggest revision that I would have made, would have been the timeline between sending out the surveys in February 2004 and then conducting the interviews, which didn’t take place until April and May of 2005. This gap in time increases the likelihood that the teachers’ views had changed since responding to the survey. This could also be a possible reason as to why more teachers did not want to be interviewed. In analyzing the data, statement 8 and 15 were deleted to help ensure that the scales were reliable and valid. If I were to continue this research, I would omit statements 8 and 15 from the survey and possibly redirect both statements to the interview guide. This would help to confirm that the teachers understood the question that they would be responding to. There are still numerous questions about teachers’ undergraduate education programs and their perceived abilities to teach that should be examined. A further in-depth look, possibly focusing on only one state, should be explored. High school science teachers are held accountable for how well they prepare their students based on standardized tests and grades. If teachers are not being given the best opportunity to be prepared to teach in a manner which enhances maximum learning for their students, shouldn’t state teacher education programs be held accountable for improving the curriculum offered to future science educators?
Chapter 6 References


Appendix A

Approval Form for Human Subjects
October 8, 2003

Dr. Stacey Bretz, Principal Investigator  
Ms. Holly DeBernardo, Co-investigator  
Department of Chemistry  
UNIVERSITY  

RE: HSRC PROTOCOL NUMBER: 30-2004  
TITLE: The Relationship Between High School Teachers’ Self-efficacy and Their Learning Experiences in Undergraduate Science and Education Courses  

Dear Dr. Bretz and Ms. DeBernardo:

The Human Subjects Research Committee has reviewed the abovementioned protocol and determined that it is exempt from full committee review based on a DHHS Category 1 exemption.

Any changes in your research activity should be promptly reported to the Human Subjects Research Committee and may not be initiated without HSRC approval except where necessary to eliminate hazard to human subjects. Any unanticipated problems involving risks to subjects should also be promptly reported to the Human Subjects Research Committee.

The HSRC would like to extend its best wishes to you in the conduct of this study.

Sincerely,

Peter J. Kaswinsky  
Dean, School of Graduate Studies  
Research Compliance Officer  

PJKE/CE  

cc: Dr. Timothy Wagner, Interim Chair  
Department of Chemistry
Appendix B

Cover Letter for Survey
Dear High School Science Teacher,

I am graduate student under the direction of Dr. Stacey Lowery Bretz in the Chemistry Department at Youngstown State University. I am conducting a research study on the relationship between high school teachers' self-efficacy and their learning experiences in undergraduate science and education courses.

I am requesting your participation, which will require about 15 minutes of your time to complete a questionnaire concerning science teacher education programs with regard to preparation of high school science teachers. Your participation is completely voluntary. You can choose not to participate or withdraw at any time. Your responses to the questions will be kept confidential and your name will not appear on any of the study documents or the final report.

If you have any questions concerning the research study, please call me at 330-941-1562 or Dr. Bretz at 330-941-7112.

Thank you,

Holly DeBernardo
Appendix C

Consent Form for Survey
Consent to Participate in Research Study

The Relationship between High School Teachers' Self-Efficacy and their Learning Experiences in Undergraduate Science and Education Courses

I __________________________ have agreed to participate in this research study (name) investigating the relationship between high school science teachers' perceptions of their teaching and their learning experiences in undergraduate science and education courses. I understand that the purpose of this research is to study undergraduate science teacher education programs.

I understand that I will be asked questions about my college education and my teaching experiences. I understand that I do not have to complete the survey; it is strictly voluntary.

I understand that my participation in this study is completely voluntary and that I can withdraw at any time. I can refuse to answer specific questions at any time. If I withdraw from the study, the information I have given up to the time of my withdrawal will be retained for the study unless I request that it not be used.

I understand that my participation in this study will require about 15 minutes of my time. My responses to the survey questions will be kept confidential and my name will not appear on any of the study documents or in the final report. I understand that only group results will be reported. The information I provide may be used for additional research but because my name is not used, my identity is protected.

I have had the opportunity to ask questions and they have been answered to my satisfaction. I agree to participate in this study.

Date

Signature

Dr. Stacey Lowery Brettz
Associate Professor of Chemistry
Youngstown State University
330-941-7112

Holly DeBernardo
Graduate Student Department of Chemistry
Youngstown State University
330-941-1562
Appendix D

Survey
The Relationship between High School Teachers’ Self-Perceptions and their Learning Experiences in Undergraduate Science and Educational Courses

Please return the following items by no later than March 1, 2004
  • This completed survey
  • One signed copy of the informed consent form (the other is for you to keep)

to Ms. Holly DeBernardo, Youngstown State University, Department of Chemistry, One University Plaza, Youngstown, Ohio 44555

A self-addresses, stamped envelope is provided for your convenience.

Questions 1 through 9 ask you to think about your undergraduate courses in science (chemistry, biology, geology, physics, etc.) and your undergraduate courses in education. Please indicate the degree to which you agree or disagree with each of the following statements by circling the appropriate response about your descriptions of your undergraduate experiences.

1. My undergraduate **science** professors taught by lecture method.
   
   Strongly Disagree  Disagree  Agree  Strongly Agree

2. My undergraduate **education** professors used a variety of teaching methods.
   
   Strongly Disagree  Disagree  Agree  Strongly Agree

3. My undergraduate **science** professors discussed how to learn science.
   
   Strongly Disagree  Disagree  Agree  Strongly Agree

4. My experiences in undergraduate **science** courses have prepared me to be an effective teacher.
   
   Strongly Disagree  Disagree  Agree  Strongly Agree

5. The laboratory experiments in my undergraduate **science** courses were verification or “cookbook” experiments.
   
   Strongly Disagree  Disagree  Agree  Strongly Agree
6. My undergraduate science instruction included designing science experiments.

   Strongly Disagree  Disagree  Agree  Strongly Agree

7. My undergraduate science professors discussed science education pedagogy.

   Strongly Disagree  Disagree  Agree  Strongly Agree

8. My undergraduate education professors discussed science education pedagogy.

   Strongly Disagree  Disagree  Agree  Strongly Agree

9. My undergraduate program did not include guided or inquiry lab experiences.

   Strongly Disagree  Disagree  Agree  Strongly Agree

Now we are going to shift focus. Questions 10 through 23 ask you to think about yourself as a current high school science teacher. Please indicate the degree to which you agree or disagree with each of the following statements by circling the appropriate response which describes your opinion regarding your abilities as a science teacher.

10. I wish my undergraduate program had required more science content courses.

    Strongly Disagree  Disagree  Agree  Strongly Agree

11. If one of my students cannot remain on task for a particular assignment, there is little that I can do to increase his/her attention until he/she is ready.

    Strongly Disagree  Disagree  Agree  Strongly Agree

12. I feel knowledgeable in all the science content areas which I am certified/licensed to teach.

    Strongly Disagree  Disagree  Agree  Strongly Agree

13. When a student does better than usual, it is because I exerted an extra effort.

    Strongly Disagree  Disagree  Agree  Strongly Agree
14. I have mastery of my content knowledge.

   Strongly Disagree   Disagree   Agree   Strongly Agree

15. The amount that a student can learn is primarily related to family background.

   Strongly Disagree   Disagree   Agree   Strongly Agree

16. I have knowledge to teach an advanced level course in my content area (AP, honors, etc.)

   Strongly Disagree   Disagree   Agree   Strongly Agree

17. I have skills and motivation: I can reach the most difficult students.

   Strongly Disagree   Disagree   Agree   Strongly Agree

18. When a student is having difficulty with an assignment I am able to adjust the assignment to his/her level.

   Strongly Disagree   Disagree   Agree   Strongly Agree

19. I motivate my students to learn science.

   Strongly Disagree   Disagree   Agree   Strongly Agree

20. I consider myself a scientist.

   Strongly Disagree   Disagree   Agree   Strongly Agree

21. I have training to deal with any type of learning problem.

   Strongly Disagree   Disagree   Agree   Strongly Agree

22. When a student gets a better grade than he/she usually gets, it is because I found more effective teaching approaches.

   Strongly Disagree   Disagree   Agree   Strongly Agree

23. Even a teacher with good teaching abilities may not reach many students.

   Strongly Disagree   Disagree   Agree   Strongly Agree
Please answer questions 24-31 in order to provide more information about you as a science educator.

24. In what school district do you currently teach?

25. How many years have you been teaching?

26. What is the highest level of education that you have completed? (check only one)
   _____ BS in education
   _____ BS in another field; Please specify___________________
   _____ MS in education
   _____ MS in another field; Please specify__________________

27. From what college(s)/university(ies) did you graduated?

28. What area(s) does your teaching certificate/license allow you to teach?

29. How many classes of each of the following content courses did you have in your undergraduate program?
   _____ Geology     _____ Physics
   _____ Biology     _____ Other; Please Specify
   _____ Chemistry

30. Have you ever worked professionally outside of the education field? If yes, please specify.

31. How many times did you take the state content certification/licensure test before passing?
Appendix E

Scoring Key for Survey
Scoring Key for Survey

This was a 4 point scale

1 = Strongly Disagree  2 = Disagree  3 = Agree  4 = Strongly Agree

Items that were negatively worded were recoded to ensure highest possible score.

Total Scale

The total scale consisted of 23 statements, with a value range of 23 – 92.

**Low score range (23 – 46)** – Indicating low scores on both the undergraduate scale and the self-efficacy scale.

**Middle score range (47 – 70)** – Indicating median scores on both the undergraduate scale and the self-efficacy scale.

**High score range (71-92)** – Indicating high scores on both the undergraduate scale and the self-efficacy scale.

Undergraduate Scale

This scale was broken down into two categories:

a. Content Preparation – Statements 1, 3, 5 and 6 (with recoded #5)

b. Pedagogy Preparation – Statements 2, 7, 8 and 9 ( with recoded #9)  
   (later omitting #8)

**Content Preparation** consisted of 4 statements, with a value range of 4 – 16.

**Low score range (4 – 11)** – Indicating low content preparation.

**High score range (12 -16)** – Indicating high content preparation.

**Pedagogy Preparation** consisted of 4 statements, with a value range of 4 – 16.

**Low score range (4 – 11)** – Indicating low pedagogy preparation.

**High score range (12 – 16)** – Indicating high pedagogy preparation.
Self-efficacy Scale

The self-efficacy scale consisted of 13 statements, with a value range of 13 – 52.

Low score range (13 – 26) – Indicating low perceptions of teaching ability.

Middle score range (27 – 40) – Indicating an average perception of teaching ability.

High score range (41 – 52) – Indicating high perceptions of teaching ability.
Appendix F

Codebook
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<td></td>
<td></td>
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<td>Highest Level of Education</td>
<td>ED</td>
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<td></td>
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<td>2=BS in another field</td>
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<td></td>
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<td>3=MS in education</td>
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<td></td>
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<td>4=Earth science</td>
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<td></td>
<td></td>
<td>6=Physics</td>
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<td></td>
<td></td>
<td>7=Comprehensive science</td>
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<td>Number of classes in Geology</td>
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<td>S10 to S23</td>
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Appendix G

Interview Guide
Interview Questions

- Describe for me what you think it means to be an effective science teacher.
  o Could you give me some examples of what an effective science teacher does or says?

Undergraduate Education:

- As you look back at your undergraduate experiences, what do you feel you were well prepared to do as a teacher?
  o In what ways did you feel prepared to teach science when you graduated?
  o Can you describe an example where you felt unprepared with regard to teaching science?
  o Which part of your undergraduate education (science or educational course work) has been more important for you as a science teacher?

Education Classes:

- Tell me about the best education professor you had?
  o What types of things did you learn from him/her? About tests?
  o Would you say that you find yourself emulating things from him/her into your own classroom?
  o Could you give an example?

- What types of things do you wish your education professors had taught you or perhaps spent more time on?
  o How do you think that would have helped you?

- How did your education classes prepare you to teach in a lab setting?
  o Where did you learn topics such as designing experiments, safety, stockrooms, demonstrations, etc.?

Science Classes:

- Describe the best science professor that you had.
  o What did you learn about science teaching from him/her? About tests?
  o Would you say that you try to incorporate their teaching style, techniques in your classes?
  o Could you give an example?
- How would you describe inquiry based learning?
  o What did you learn about inquiry based learning?
  o Do you use this type of teaching in your classroom?
  o If yes, can you give some examples of how you use this in your classes?
    How does it affect the students?
  o If no, there are many reasons why teachers do not use this type of teaching technique, could you describe some of the reasons you do not use it?

- Did you learn how to learn science in your education or science classes
  o Can you describe a time when you were taught how to learn science, or when you felt that you were learning science?
  o How would knowing how to learn science allow a teacher to be more effective for his/her own students?

Self-Efficacy Questions:

- What areas are you currently certified/licensed to teach?
  o How comfortable do you feel in teaching these areas?
  o What could help you feel more comfortable?

- Do you feel that your undergraduate program prepared you in science content courses?
  o How many science content courses were you required to take?
  o How would have taking more/less of these courses increased your comfort level for teaching science classes?
  o Would you change the types of science content courses that you were required to take (ex: Chemistry, Biology, etc.)? If so, what would you change?
    ▪ How do you think that these changes would affect your teaching?

- Would you consider yourself a scientist?
  o If yes, describe for me an example of something you do or know that makes you say yes.
  o If no, what does a scientist do or know that you don’t?

- How do you motivate your students to learn science?
  o Can you give me a specific example?
  o How does this work for your students?

- What training have you had in learning to deal with learning problems?
  o When did you receive this training (pre-service, college, in-service workshops, etc.)?
How would you adjust an assignment for a student who is having difficulty?
  - Can you give/think of any specific incidences when this occurred?
  - Can you explain this?

Think of those times when students earn better grades than they usually get.
  - Please explain why you think this happens.
  - To what extent do you believe your teaching contributes to such events?

**Demographic Questions:**

- Where do you teach?
- How long have you been teaching?
- What do you currently teach?
- What is the highest level of education that you have?
- What college/university did you graduate from?
- What area(s) does your teaching certificate/license allow you to teach?

Thank you for your time.
Would I be able to follow up with you if I had any additional questions?
Thank you
Appendix H

Cover Letter for Interview
February 28, 2005

Dear High School Science Teacher,

I am a graduate student under the direction of Dr. Stacey Lowery Bretz in the Department of Chemistry at Youngstown State University. I would like to thank you for your participation in completing a survey I sent you a year ago. I am conducting a research study on the relationship between high school science teachers' self-efficacy and their learning experiences in undergraduate science and education courses.

As a follow-up to your responses, I would like to request your participation in an interview which will require no more than one hour of your time to be scheduled at your convenience. The interview will focus on experiences in your undergraduate program as well as your current teaching practices.

Your participation in this study would be completely voluntary. You can choose not to participate or withdraw at any time. The interview will be tape recorded and transcribed to ensure what you say is represented accurately in the study. Your responses to the interview questions will be kept confidential, and your name will not appear on any of the study documents or in the final report.

I would appreciate your cooperation in completing this study. If you have any questions concerning the research study, please call me at 330-744-7923 or Dr. Bretz at 330-941-7112.

If you do not want me to contact you to schedule an interview please call me at 330-744-7923, by no later than March 10th, and I will remove your name from our group of potential research participants. Otherwise, I will call you to schedule an interview.

Thank You,

Holly DeBernardo
M.S. Candidate, Chemistry Education
High School Chemistry Teacher at Youngstown Early College
Consent to Participate in Research Study

The Relationship between High School Teachers’ Self-efficacy and their Learning Experiences in Undergraduate Science and Education Courses

I __________________ have agreed to participate in this research study investigating the relationship between high school teachers' perceptions of their teaching and their learning experiences in undergraduate science and education courses. I understand that the purpose of this research is to study undergraduate science teacher education programs.

I understand that I will be asked questions about my college education and my teaching experiences. I understand that I do not have to answer all questions; it is strictly voluntary.

I understand that my participation in this study is completely voluntary and that I can withdraw at any time. I can refuse to answer specific questions at any time. If I withdraw from the study, the information I have given up to the time of my withdrawal will be retained for the study unless I request that it not be used.

I understand that my participation in this study will require about an hour of my time. My responses to the survey questions will be kept confidential and my name will not appear on any of the study documents or in the final report. I understand that only group results will be reported. The information I provide may be used for additional research but because my name is not used, my identity is protected.

I have had the opportunity to ask questions and they have been answered to my satisfaction. I agree to participate in this study.

Date __________________ Signature __________________

Dr. Stacey Lowery Bretz
Professor of Chemistry
Youngstown State University
330-941-7112

Holly DeBernardo
Graduate Student Department of Chemistry
Youngstown State University
330-941-1562
Appendix I

Category System for Interviews
Final Category System with Codes

Category #1 - Effective science teacher
   Code #1 - specific examples

Category #2 - Prepared in undergraduate experience
   Code #1 - Prepared to teach
   Code #2 - Science or Education courses more important

Category #3 - Best education professor
   Code #1 - Items learned
   Code #2 - Emulate this professor

Category #4 - Spent more time on in education classes
   Code #1 - How would this have helped

Category #5 - Prepared for Lab setting
   Code #1 - Designing experiments, safety and stockroom set up

Category #6 - Best science professor
   Code #1 - Items learned
   Code #2 - Incorporate any of this

Category #7 - Inquiry based learning
   Code #1 - Specific examples
   Code #2 - Affect on the students

Category #8 - Learning science
   Code #1 - Science or education classes

Category #9 - Science content courses
   Code #1 - Comfort level

Category #10 - Prepared in content
   Code #1 - Number of classes

Category #11 - Considered a scientist
   Code #1 - Specific examples

Category #12 - Motivating students
   Code #1 - Specific examples

Category #13 - Training for learning disabilities
   Code #1 - When
Category #14 – Adjusting assignments
Code #1 – How

Category #15 – Students getting better grades
Code #1 – Teaching contribute
Appendix J

Scatterplot with Deleted #8
Correlations
Graph: UTotal vs. STotal Overall (Ohio and Pennsylvania)

Graph: UTotal vs. STotal (Ohio Vs. Pennsylvania)

- Pennsylvania N=28
- Ohio N=25
Appendix K

Scatterplot with Deleted #8 and #15
Graph

20 w/o #3 and #5

PA w/o #8 and #5
Graph

On vs Pa

Deleted 8 and 15

COLLEGE

- 2.00 = Pennsylvania
- 1.00 = Ohio

utotal vs stotal

utotal

stotal

66