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SEEING THE CHEMISTRY AROUND ME – HELPING STUDENTS IDENTIFY
THE RELEVANCE OF CHEMISTRY TO EVERYDAY LIFE

by

Tracy Lynn Moore

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

December 2012
ABSTRACT

SEEING THE CHEMISTRY AROUND ME – HELPING STUDENTS IDENTIFY THE RELEVANCE OF CHEMISTRY TO EVERYDAY LIFE

by Tracy Lynn Moore

December 2012

The study attempted to determine whether the use of a series of reading and response assignments decreased students’ perceptions of chemistry difficulty and enhanced students’ perceptions of the relevance of chemistry in their everyday lives. Informed consent volunteer students enrolled in General Chemistry II at a community college in the southeastern United States during the Spring 2012 semester participated in this study. Students were assigned to read a series of short articles that connect chemistry to a specific aspect of everyday life and then answer a series of questions for each article. Open-response research instruments (initial questionnaire and final questionnaire) were used. Responses for each of the research instruments were coded according to ordinal rubrics to allow for statistical analysis. A Wilcoxon Signed Ranks t-test indicated a significant difference for each of the research questions. It was found that the perception of difficulty for the subject overall decreased during the semester, indicating that the subject was either perceived to be less difficult than students feared or that, as they better understood the chemistry, the less it was disliked. Responses also indicated that students perceived greater relevance in terms of nutrition, general health, and environment, although not all to the same degree.
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SEEING THE CHEMISTRY AROUND ME – HELPING STUDENTS IDENTIFY
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by

Tracy Lynn Moore

A Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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CHAPTER I

INTRODUCTION

Background

On October 4, 1957, the focus of science education, especially chemical education, suffered a severe blow. With the launch of Sputnik 1, the prowess of the United States was challenged, and its response was the development of the National Defense Education Act signed into law on September 2, 1958. Prior to Sputnik, chemical education focused on the periodic table and the properties of elements. With the law came a radical change in chemical education, shifting to focus on the production of scientific professionals who would rapidly advance science and technology for the US. Evidence quickly appeared to indicate low enrollments in science courses for the average student and “embarrassingly low levels of scientific literacy,” leading educators to address the needs of the average citizen (Schwartz, 2006, p. 978). The very change in curriculum which helped to produce scientific professionals omitted the important societal and technological applications which were critical to helping students become informed citizens (Hofstein & Kesner, 2006).

Chemical curricula have since been criticized for failing to link those subjects to “the health, wealth, happiness, security and curiosity of humanity” and to emphasize the important contributions made by science-based technologies to society. Scientific literacy, being one of the more recent educational movements, was still suspect because students do not see the subject as useful to their lives. However, they (the students) were aware of issues and concerns of their society, such as ‘going green,’ which can drive their interest in the material (Teppo & Rannikmäe, 2003, p. 50).
Many approaches to helping students relate science to everyday situations have been tried with some success, although many were without validating statistical analysis. Singh (1995) used debates on the extent of chemistry in students’ career paths to increase student participation and to increase their awareness of the relevance of chemistry to everyday life. There were a limited number of participants indicated, but 83% of the class participated and 75% of those indicated favorable support to the idea of the usefulness of chemistry (Singh, 1995). In a later study, Singh (1999) modified the debate idea to an assignment which required the students to identify the use of chemistry in their chosen careers (or lack thereof) and justify their responses (Singh, 1999).

Stout (2000) introduced The Chemicals Project into the classroom, attempting to combat the failure to recognize relevance and the fear of chemistry. The project, a semester long series of cooperative learning assignments, focused on the properties, production, uses, and safety of chemical substances. Little statistical analysis was conducted; however, students strongly indicated it benefited their learning (Stout, 2000).

Gutwill-Wise (2001) introduced a modular course (one that is organized around one particular phenomenon) seeking to improve the understanding of chemistry and the students’ attitudes towards science in general, particularly their feelings regarding the relevance of chemistry to everyday life. The team-taught sections used traditional and modular teaching methods. Various methods of assessment found that the modular method increased students’ active learning, which lead to an increase in subject understanding. However, students’ perceptions and attitudes had conflicting results. Reassessment indicated more positive results, but further study was still ongoing.
In 2006, *Chemistry in Context* was developed specifically with student participation in mind and focused on the use of centralized topics to teach chemical concepts. Following a second round of pilot testing, a Likert-type scale survey was used to investigate students’ beliefs about the relevance of chemistry in everyday life. Statistically significant increases were indicated, but the author emphasized the need for further analysis of the design. The author also indicated the need for instruction for the teachers to be able to transcend the traditional, and strongly entrenched, ladder method of teaching to this contextual form (Schwartz, 2006).

With the internet came web-based learning in many forms. Online web-based learning (OWL) was a popular homework function, and other similar functions have been developed. One of these web-based learning programs was a website developed by Frailich, Kesner, and Hofstein (2007) which was designed to focus on curriculum activities and incorporated visual tools to enhance learning. Extensive preparation and support for teachers was made available throughout the pilot testing and research phases of the study. Various and extensive research tools were developed to study the benefits of the website. Statistical analysis performed on these tools indicated positive results for the understanding of concepts presented on the website and awareness of the relevance of chemistry to daily lives (Frailich, Kesner, & Hofstein, 2007).

**Statement of the Problem**

This study was an attempt to determine whether the use of a series of reading and response assignments decreased students’ perceptions of chemistry difficulty and enhanced students’ perceptions of the relevance of chemistry in their everyday lives. The subjects of this study were students enrolled in General Chemistry II at a community
college in the southeastern United States during the Spring 2012 semester. As part of the course, students were assigned to read a series of short articles that connected chemistry to a specific aspect of everyday life and then answered a question set for each article. Students accessed the series of assignments via the Desire to Learn® (D2L) content folder and uploaded their responses via the D2L dropbox. These assignments counted as part of every student’s course grade. This study incorporated the research questions into two of these assignments. However, only the responses from informed consent volunteers were used for this study. The answers for each of the research instruments were coded according to a rubric, which allowed statistical analysis.

Research Questions

Research Question 1: Does the use of a series of reading and response assignments affect students’ perceptions of the difficulty of chemistry as measured by an initial questionnaire and final questionnaire?

Research Question 2: Does the use of a series of reading and response assignments affect students’ perceptions of the relevance of chemistry in their everyday lives as measured by an initial questionnaire and final questionnaire?

Hypotheses

Hypothesis 1: The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as a difficult subject.

Hypothesis 2A: The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of nutrition.
Hypothesis 2B: The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of general health.

Hypothesis 2C: The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of the environment.

Definition of Terms

Desire To Learn® (D2L): an online system for enhancing the classroom or teaching classes online.

D2L Close: the file or dropbox becomes or was not available. For this study, this time was 11:59 PM on specific dates.

D2L Content: an electronic filing system for instructor issued files built into the D2L workspace.

D2L Dropbox: an electronic filing system for uploaded documents built into the D2L workspace.

D2L Open: the file or dropbox becomes or was available. For this study, this time was 12:00 AM on specific dates.

e-learning (electronic learning): the process of learning online, especially via the Internet and email.

PDF: portable document file.
Delimitations

1. This study was limited to students who completed General Chemistry II at a southeastern community college during the Spring 2012 semester without an incomplete or withdrawal.

2. Only informed consent volunteers were used as part of this study although the assignments were counted as part of the course grade for each student.

Assumptions

1. It was assumed that the instructor of these sections covered the material to similar depth as in previous semesters.

2. It was assumed that students read the course assignments and answered the questions individually, not as partners or in groups.

3. It was assumed that students answered each question honestly.

4. It was assumed that students answered each question as fully as they were able for their understanding and ability.

5. It was assumed that students took the course voluntarily, either as a requirement for graduation or as a requirement for their major.

6. It was assumed that the students did not procrastinate on the assignment, giving them time to consider their answers.

7. It was assumed that students who indicated they were 18 or older actually were.

Justification of the Study

The general scientific community agrees that the study of science should be intrinsically an active process, which shifts away from factual to more conceptual
understanding, skills, processes, application, and communication. In today's rapidly changing society, the ability to obtain data, evaluate it, and communicate it to others is far more important than the recalling of factual information. This principle takes on deeper meaning when viewed with today’s national educational goal of scientific literacy for every student, as seen in No Child Left Behind. Primary school children often had the advantage over middle school science, or beyond, because primary school science activities were often more interesting and of greater personal relevance to students, with activities leading students to observe, communicate, predict, and infer about scientific occurrences. Summers, Kruger, Childs, and Mant (2001) claimed that in light of its global impact, environmental education was so important that even primary school children should actively investigate nature as part of their education (Summers et al., 2001).

Beyond the primary school, there were much more cook-book exercises which only reinforced previous principles rather than allowing students to develop their own solutions to the problems (Arena, 1996). Van Aalsvoort (2004) indicated that relevance has many facets: personal, social, intertwined personal/social, and professional facets and encouraged the use of context based teaching to achieve the association of relevance. Regardless of the design, achieving the link between relevance and chemistry was critical in order to “clarify that chemistry contributes to the provision of social needs and adds to the quality of our lives” (Van Aalsvoort, 2004, p. 1648).

Textbooks, as noted by the authors, typically include short articles stressing the relevance of chemistry to everyday life. However, most students, as they point out, do not read unless they are required to do so (Jones & Miller, 2001). Examination of the
literature suggested that for first-year college chemistry students, the content and structure was similar worldwide, as were the modes of delivery (Dalgety & Coll, 2005).
CHAPTER II
LITERATURE REVIEW

Chemistry was, according to the results of a European high school questionnaire, the least popular subject in natural and physical sciences as indicated by low student interest (Bartuseviča, 2004). Many students see chemistry as an exam-driven course tailored for specific career preparation although there was also the perception of the possibility of relevance in everyday life (Eilks, 2002; Kennedy, 1996). Chemophobia was believed to exist and has been blamed for low levels of achievement in chemistry (Eddy, 2000), although there was substantial research showing that students’ motivation in the acquisition of chemistry was associated with the degree of industrialization of the country (Bartuseviča, 2004). According to Holman (2001), there were utilitarian, economic, democratic, and cultural reasons for the study of science. In principle, the economic reasons carry the most weight – well-trained scientists, engineers, and doctors were essential for economic prosperity and social well-being (Holman, 2001). Curriculum development, especially in the sciences, lags behind the changes in technology and the examination system, leading to “an unsuccessful compromise between the needs of many different learners, from the future chemistry specialists to the student who will never formally study science again” (Fleming, 1998, p. 29). With the push for scientifically literate citizens, chemistry educators must investigate the perceptions of students of chemistry in terms of the relevance to their daily lives and seek to overcome their chemophobia.

Personal interest was the mitigating factor in motivation, and personal interest in a subject was highly subjective; therefore, the interaction between personal interest and the
situation generating cognitive function was critical when examining the role of relevance. Personal interest was believed to enhance cognitive functioning and learning, which may account for students’ persistence and success of science in primary school. Since relevance plays such a prominent role, learning was necessarily experimentally-based and highly individualistic, which can only be fully achieved using student-centered programs designed to advance a student's learning from his/her individual level of understanding (Arena, 1996).

In the quest to remove chemophobia and add relevance via the integration of real-world into the chemistry classroom, many approaches have been used (Amato-Wierda, 1999; Eilks, 2002; Franklin, Pienta, & Fry, 2005; Gutwill-Wise, 2001; Jones & Miller, 2001; King, 2009; Singh, 1995, 1999; Stout, 2000), with Bartuseviča (2004) claiming that only an integrated approach to environmental education will keep students interested and motivate them to learn the material.

Bou Jaoude (1992) investigated the relationships between prior knowledge, learning approaches, student attitudes, and student performance on a misconceptions text, believing that learners who were able to relate new concepts with prior knowledge were more likely to be able to correct their own misconceptions while rote learners could not. Using a small sample set of students in a chemistry classroom, the author investigated these relationships using four instruments: the multiple-choice misunderstanding test; a Likert-type scale Learning Approach Questionnaire; an Attitude toward Chemistry Questionnaire, which uses a semantic differential; and, lastly, the Differential Aptitude test, a standardized exam taken previously. The misunderstanding test was used as both a pre- and post-test. Students’ scores on the Learning Approach Questionnaire were used
to separate students into two groups, meaningful learners or rote learners. Qualitative analysis of responses indicated an increase for meaningful learners and a decrease for rote learners on nine of the 13 questions. Accordingly, the author stipulated that this indicates that meaningful learners develop a more thorough and complete understanding of the concepts on which the questions were based. Implications for future teaching included teaching students meaningful learning strategies and how to integrate information from different subject areas (Bou Jaoude, 1992).

Concerned with the idea that students perceived chemistry as both irrelevant and uninteresting, Singh (1995) elected to require students to investigate, determine, and debate the extent of the use of chemistry in their chosen careers. The debate, which would count as bonus points towards the students’ class participation, had 40 student participants with 57.5% of these participants favoring the importance of chemistry. To assist in the debate, all students in the course were given the opportunity to submit a short term paper containing support for their stand on the issue. Papers from 57 of the 68 students were received with 75% of those supporting the idea that chemistry was important to the students’ chosen careers. Five students presented arguments in favor of the importance of chemistry and four students argued against the importance of chemistry during the debate. Questions from the students’ term papers were presented during the debate and then opened for discussion. Following the debate, the students also overwhelmingly agreed that the debate benefited their learning and should continue (Singh, 1995).

Kennedy (1996) investigated the perceptions of students in New South Wales. In the study of 593 sophomores, juniors, and seniors, a survey instrument canvassed
students’ opinions and perceptions of chemistry. The sophomores were taking chemistry as part of the required curriculum. The juniors and seniors were all chemistry majors. The survey was comprised of four sections with a total of 19 questions. The first section of the survey dealt with demographics; the second with students’ perceptions or opinions on the ease or difficulty of major topics; the third part asked students to rank a series of chemistry topics; the fourth part was not outlined in the article. Results showed that, for most chemical topics, there was a mixed perception of ease or difficulty depending on the depth and length of study. Nearly 70% of the students would not study chemistry for itself, with students seeing the study of chemistry as designed for careers or exams and separate from the relevance of everyday life. Much of the students’ disenchantment may be linked with teaching methods, which may present chemistry as an abstract and isolated science. In the ranking section, students indicated a high priority for pollution, formation of oxygen, and measurement applications while ranking industrial processes, reaction rates, and formation of salts as low priorities. Implications required further study, as many educators fear that placing chemistry in everyday context will cause the subject to lose its rigor (Kennedy, 1996).

A detailed qualitative analysis of an open-inquiry program, developed by Roth and Roychoudhury, indicated considerable development of higher-order process skills, which was attributed to the integration of relevance into science. Students were able to more clearly define testable variables, formulate new hypotheses and experimentation, explain the concepts required to design experiments, communicate effectively those
concepts, and maintain greater proficiency in planning and executing the experimentation (Arena, 1996).

In 1999, Rop investigated what high school students understood about chemistry and what they perceived as success in a chemistry course within the context of a school’s culture, which has its own set of norms in society. Using two suburban Midwestern public high schools, which boasted many college-bound students, daily participant observations were conducted in one chemistry classroom per school. The two master teachers selected students for informal interviews and conversations, which were transcribed, coded, and partially analyzed between sessions to ensure continuity. The students’ perceptions were related to a set of concentric cultural spheres: the innermost was the student, followed by peer culture, family culture, institutional influence, teacher’s cultural influence, and finally the subject of chemistry itself. The research showed that most students who took chemistry did so because it was required for admission into college or their chosen fields and, therefore, they perceived that the grade was the most important result of the course. The actual depth of understanding was not relevant to most students, as their grades were based on conventional or traditional school performances and not on a true understanding of the basis of chemistry (Rop, 1999).

Amato-Wierda (1999) added theme-based exams to relate general concepts of current research and to assist students in understanding that chemistry was relevant to their lives. Student comments on end-of-course evaluations indicated that theme-based exams were successful in integrating chemistry and discipline topics. Students also realized that chemistry was relevant and important in their chosen fields, although the
data for the evaluation was within one standard deviation of each other (Amato-Wierda, 1999).

Students’ perceptions of relevance can even be altered starting on the first day of class, according to Singh (1999). In an informal study, Singh assigned a project consisting of two parts: students investigated their own majors to identify five topics that related to chemistry, and then they had to provide written explanation for one of these topics. The author noted an increase in attendance over the semester, a decrease in the attrition rate, and an improvement in grades when compared to similar semesters.

With certain perceptions behind chemophobia in mind, Eddy (2000) investigated this concept in the classroom: its extent, factors contributing to it, and the characteristics of students suffering from it. The survey used contained three anxiety factor sets: trait, mathematics, and chemistry. Trait, from the State-Trait-Anxiety Inventory, assessed how students generally felt. Mathematics anxiety was measured by the Likert-type Revised Mathematics Anxiety Rating Scale developed by Plake and Parker (as cited by Eddy, 2000, p. 514). The three factor Derived Chemistry Anxiety Rating Scale, developed and tested in previous studies by the author, was used for chemistry. The survey was administered to 480 students in an introductory chemistry course, the majority of whom were Allied Health majors. Various methods of analysis were used, including correlation, t-tests, and two-way ANOVA. The results indicated that students with no previous chemistry courses or who were females had greater anxiety concerning chemistry, which could have been a contributing factor in poor performance. Interviews
with selected students indicated that the subject in general, as well as lack of relevance to real life, also contributed to poor performance in chemistry (Eddy, 2000).

Stout (2000) indicated that the failure to connect science with everyday life and the concept of chemophobia were both the result of science ignorance or scientific illiteracy. The project consisted of a semester-long series of cooperative learning assignments focusing on a realistic understanding of chemical properties, the generation of a basic understanding of Material Safety Data Sheets, the recognition and ability to combat chemophobia, and the ability to trace a chemical substance from initial production to final use. The project was evaluated with just two questions on the standard course evaluation. One question dealt with the importance or value of the project as part of the course and the other with the perception of understanding as a result of the project. It was found that science and chemical phobias were reduced, although not completely eliminated. The perception of importance increased as did understanding. The final exam in the course contained an essay question requesting students to identify and discuss what they perceived as the most beneficial part of the course. Of the students who took the final, 75% cited the project (Stout, 2000).

Helping students relate science to everyday situations was the focus of a study by Campbell & Lubben (2000), which analyzed the extent to which students used scientific concepts to approach answers to everyday situations. The study focused on four aspects of science usage: the students’ awareness of science’s societal and economic implications, the ability to create a practical experiment for a given dilemma, the ability to apply learned science skills to answer a given dilemma, and the course of knowledge used in each situation. Following the implementation of a contextualized science course
started to provide a link to the relevance of science, three sets of three probes were
administered to 118 ninth graders. The first set of probes dealt with a science-based
action and required students give scientific explanations as to why this action was
performed. The second set described a science-based problem for which the students
were to design an experiment to solve the problem. The final set required an awareness
of societal or economic implication, design, or application of science principles in
everyday situations. Approximately 44% of the participants implicated awareness
between science and its societal or economic implications in the first set of probes, 37%
were able to correctly design an experiment in the second set, and 31% used science
concepts to solve everyday problems. Implications for education from the author were
that a fuller and better inclusion of science from everyday situations would make students
more aware of how science is relevant in everyday lives (Campbell & Lubben, 2000).

In the 1980s and 1990s, reports from the American Chemical Society and other
professional science organizations described the ineffectiveness of the current chemistry
curriculum and the failure to yield a scientifically literate workforce, leading the National
Science Foundation to fund an approach for active and context-based learning in the form
of modular courses. Investigated by Gutwill-Wise (2001), the modular course sought to
improve students’ understanding of chemistry and their attitudes towards science in
general, while retaining equal adeptness with standardized tests. Of particular interest
were the feelings of students towards the relevance of chemistry in their everyday lives,
their personal interests, and their appreciation of the complexity of real-world issues
involving science. Using two comparative studies in different educational settings, two
sections were co-taught by two instructors who alternated between traditional and
modular teaching methods for selected topics so that both sections received each method. Using various methods of assessment, it was found that the modular topics increased the students’ active learning, as opposed to passive learning, from 15% or less of class time to approximately 45%. While it was found that students better understood the chemistry from the modular approach, the data was split on the students’ perceptions of understanding and attitudes. Subsequent semesters, which were not used for comparison, used improved modules and indicated more positive results in student attitudes, although there were indications that more study was needed (Gutwill-Wise, 2001).

Jones and Miller (2001), noting many different approaches by other authors, sought to increase interest in and the understanding of the relevance of chemistry to the real-world by including a weekly 20-minute discussion on a particular chemical compound or chemical process with practical application or implications, tying the session to the topic under study when possible. Using a short questionnaire survey instrument, data concerning the reception and students’ perceptions of the sessions were collected. Results showed that, overall, students believed that the sessions enhanced their understanding of chemistry and boosted their performance in the subject (Jones & Miller, 2001).

In 2003, Teppo and Rannikmäe examined the concept of relevance in chemical education, specifically whether linking relevance made science interesting for students. The study involved 272 students from two public schools: one in an urban university town and one in a suburban area. These schools were alternative schools that a student could opt to attend; however, these were not schools magnet dedicated to one or two subjects, such as mathematics and science. The instrument used consisted of two parts: a
set of scenarios and a questionnaire. The scenarios were developed by approximately 50 teachers during a Scientific and Technological Literacy workshop using a specific set of criteria to keep the scenarios comparable. The final scenarios fell into three categories: subject-orientated; social issue-based, focusing on the personal experience of the student; and global societal issue-based. Students were asked to read all the scenarios and identify the three most interesting and justify their choices. They were also asked to identify the least interesting scenario and explain why. The most popular scenarios were found to be those which were student-oriented, linked to their own health and well-being. The least interesting were found to be those which were more subject-based. Overall, the indication from this research was the difficulty in making learning interesting or relevant - even when everyday issues were used - if the content was heavily linked to the science curriculum (Teppo & Rannikmäe, 2003).

From his own literature review, Van Aalsvoort (2004) identified four definitions of relevance for chemical education: personal, professional, social, and personal/social. Personal relevance dealt with the connection of chemistry to students’ lives, while professional demonstrated the possibilities for career choices. Social relevance clarified the use of chemistry in human and social issues, while personal/social helped develop students into responsible citizens. The author hypothesized the use of activity theory as best for clarifying the relevance of chemistry. A detailed explanation of activity theory, which links society, its citizens, and chemistry in a complex web-like pattern involved the needs of society, its motivations and subsequent activities, the results of those activities, and evaluation of those results. The author advocated the use of social-based units, such as foods, water, and medicines, to connect students (being the citizens) to the
subject matter. Research supporting these avocations had not been published by the author as of 2004 (Van Aalsvoort, 2004).

Franklin et al. (2005) investigated whether the use of a weekly-featured molecule affected college students’ attitudes towards chemistry. This survey study focused on: (1) the students’ willingness to learn chemistry, and (2) the collection of meaningful but representative data connecting demographics, opinions, and viewpoints. The study took place over three successive fall semesters. Each semester was comprised of approximately 300 students with approximately 60% health professions majors, 20% science majors, and the remaining 20% were non-science-based majors. During the study, each Monday’s lecture began with a chemical or chemical group whose description and function were presented. The presentation included related stories to underline the *realness* of the chemical or chemical groups. The topics included a wide range of categories (medicines, flavoring, colorants), excluding illegal or industrially-based substances. The survey for this study was conducted at the end of the semester in the form of a *pop* or unannounced quiz. Students responded to both demographics and questions specifically about the study. Each semester, there were at least 90% of students who responded positively towards the inclusion of the weekly molecule, although there were some responses to it being a *waste of time* since the material was not to be included on exams. Of the overall students, 31% noted the *real-world* aspect among their comments, with 40% indicating it engaged their interest. With these results, the authors conclude that the Molecule of the Week was a successful method to enhance chemical awareness and student interest in chemistry (Franklin et al., 2005).
Dalgety and Coll (2005) investigated the learning experiences of students in three aspects of their chemical education: lecture, laboratory, and tutorial sessions. A cohort of students was monitored throughout their entire first academic year using both quantitative and qualitative methods to determine the extent of student experiences. The two courses used for the study differed in content (one focused on inorganic/aqueous chemistry and the other on organic) but were similar in structure and pedagogy. Students attended the standard three-hour lecture, a three-hour laboratory, and a one-hour tutorial session per week for the two 12-week block courses. The Chemistry Attitudes and Experiences Questionnaire, which was previously validated, was used to determine students’ learning experiences. The Likert-type scale questionnaire contained three subsets and was used as a pre-test during the beginning of the first semester and as a post-test at the end of the second semester. At the beginning of the study, 17 students participated in interviews, which sought to ascertain which components of chemistry were likely to be enjoyed and which were not. At the end of the first semester and again at the end of the study, 12 of the original 17 were re-interviewed about their experiences during the two courses.

Overall, students indicated positive learning experiences for the subject. Multivariate analysis was used to determine statistical significances, which occurred more strongly at the end of the second semester. The qualitative portion of the study varied according to the aspect. For the lecture aspect, the indication from this study was that structure and teaching method were more important than the content. Students want teachers who engage their attention and facilitate understanding. The laboratory portion, while expected to be the most enjoyable aspect, was found to be described as boring, too technical, or too difficult. Information concerning the tutorial aspect was incomplete, as
many students stopped attending the sessions once they began to understand the material (Dalgety & Coll, 2005).

In 2006, Schwartz compiled findings on the incorporation of relevance of chemistry into real life with a textbook and curriculum designed to “empower readers to respond with reasoned and informed intelligence” with relation to chemistry and its societal significance (p. 980). *Chemistry in Context*, a higher education textbook from the American Chemical Society and published by McGraw-Hill, was intentionally designed around student participation and the teaching of chemical concepts around centralized topics, such as polymers and plastics or nuclear energy. Initial studies of this curriculum design began in 1995, in the pilot study formed at the home institutions of the designers. Second round pilot studies expanded the design use to 19 test sites, with some 2000 students participating. During this second pilot study, an investigation of students’ beliefs about chemistry as a factor of everyday life was conducted, using a Likert-type scale survey. Results suggested that there were significant, favorable changes in attitude to the perception of the importance of chemistry. However, the author clearly indicated that a broader analysis of this design was critical. Schwartz (2006) also indicated much of the design success was dependent on the instructors’ ability to transcend into contextualized concepts rather than the traditional *ladder* teaching which was strongly entrenched in university curricula.

Hofstein and Kesner (2006) hypothesized that incorporating industrial contexts into chemistry curricula would contain sufficient connections to students’ daily lives as to “enhance their interest and motivation to study chemistry” (Hofstein & Kesner, 2006, p. 1019). Using this hypothesis, the authors developed a curriculum about industrial
concepts used in chemistry. The curriculum involved using a specific element, such as bromine, and branching out into its chemical processes, environmental concerns, economics, societal uses and needs, and other sections. An inventory designed specifically for this study was developed, but pilot study information was not available. The study compared students who studied the industrial chemistry versus a control with traditional chemistry curriculum. The statistical findings were not given, but the author indicated that studying chemistry using the industrial chemistry curriculum helped to provide students with a relevant and applied view of chemistry (Hofstein & Kesner, 2006).

Web-based chemistry began appearing in the latter 1990s and early 2000s, and Frailich et al. (2007) investigated the influence of such learning aspects on students’ perceptions, attitudes, and achievements. The development, implementation, and assessment of a web-based enrichment tool were the focus of this study. A website for high school chemistry, focusing on curriculum-based activities, was developed as part of the study. Visual tools, such as applets and animations, were incorporated to give the most benefit to students. Workshops were available for teachers prior to the implementation of the website to familiarize the teachers with the various components. The first year of implementation was used as a pilot study so that assessment methods and tools could be validated. The high schools that composed the experimental and control groups were comprised of mostly middle-class students from both urban and suburban areas. All the teachers involved in the study were master teachers (with five or more years of experience) who sought to improve their own teaching methods or who wanted to integrate new technology into the classroom. Throughout the pilot study and
research phase, support was given to ensure that successful implementation of the website occurred. The research tools consisted of the Chemistry Classroom Web-Based Learning Environment Inventory (CCWLEI), feedback questionnaires, and achievement tests. The CCWLEI was a 40 question Likert-type scale questionnaire developed and validated specifically for this study and was a modified version of a similar inventory. Likewise, the feedback questionnaire was a Likert-type scale inventory of 20 questions, developed to examine the learning contribution, degree of change in students’ perceptions of relevance to daily life of chemistry, and the difficulty of the website. Achievement tests, used as a set of initial questionnaires/final questionnaires, were traditional 10 question paper tests examining the chemical content studied via the website. Following MANOVA and ANOVA analysis of the questionnaires, the results showed an increase of the experimental group’s achievement scores over the control group’s achievement scores and an increase in the awareness of the relevance of chemistry to daily lives (Fralilich et al., 2007).

Schwartz’s study from 2006 was later followed by King (2009). The study took place at an independent boys’ high school during the spring term (March to May) of the students’ eleventh grade year. The topic addressed during the study, water pollution, occurred during the second term of chemistry. The author limited the study to a single design as to be able to investigate deeper into students’ perceptions and understanding. The data primarily collected consisted of field notes, analytical memoranda, classroom materials, and interviews, both with teacher and student participants. For the interview and classroom observations, the teacher selected two groups of students who formed a representative sample of the classroom as a whole. The design of the study focused on
water and included such topics as pH, temperature, density, dissolved particles, and water hardness. King chose to describe the students’ abilities to relate context and content via the concept of fluid transition, meaning the student could move readily between the experimental data and the underlying concepts. The high and average achieving students responded well to the context design, as least in part. However, the low achieving students may not have been sufficiently represented, as the participants in this study were English-as-Second-Language students. With many limitations on the benefit and scope of the study, the author indicated that context-based teaching encouraged students to make important connections between the science and the real-world although the author advised that teachers should select contexts which allow repetitions of a single concept (King, 2009).

Walczak and Walczak (2009) examined specifically the change in student attitudes over the progress of a general education chemistry course entitled Chemistry and the World. Employing a mixed methods approach, the study used both surveys and interviews to determine any statistical significance for the treatment. A pilot study was conducted with 10 students to validate the instruments, followed by the actual study of 36 non-science major students during a later semester. The survey used in this study was the Views on Science-Technology-Society (VOSTS) survey by permission of the authors who first developed it. The VOSTS was a non-Likert-type multiple choice questionnaire, which measures student attitudes towards science in terms of its technology and connection to society. The survey was used as a pre-test/post-test, and student responses were coded to retain privacy but allow statistical analysis. Interviews for 10 students followed the post-test. It was determined that in the particular chemistry course under
study, there were some statistically significant changes in attitudes towards science in terms of course-related topics (Walczak & Walczak, 2009).

Failing to link science to everyday life is not limited to students. Even teachers can fall prey to this failure, as seen in a study by Soudani, Sivade, Cros, & Médimagh (2000). Using word-association tests, multiple choice questions, and open questions, the study investigated 56 student-teachers and their understanding of oxidization-reduction (redox). During the word association test, respondents were asked to list words associated with either oxidization or reduction. Between 30% and 38% related the words to each other, while approximately 20% related the terms to the transfer of electrons. The multiple choice tests generated three categories of answers in relation to specific redox questions. The simpler redox reactions were recognized by 82% of respondents, most likely because this type was used for redox demonstrations. Only 46% of respondents identified corrosion as a redox process and approximately 33% recognized that the color change of a cut apple was a redox process. Combustion was only recognized as a redox process by 21% of respondents. The study also noted that approximately half of the student-teachers being investigated missed the connection between the everyday situation presented, such as the development of film (photography) and the corresponding scientific processes, such as oxidation-reduction (Soudani et al., 2000).
CHAPTER III
RESEARCH METHODOLOGY

Overview

In this study, an investigation of whether a series of reading and response assignments increased students’ awareness of the relevance of chemistry to everyday life was performed. Students enrolled in General Chemistry II, in a sufficient number to be a representative sample, participated in the research as it was part of their course grade; however, data for only those who gave informed consent were used for this study. The research instruments were composed of three parts: one demographics survey and two questionnaires. The questionnaires were used in a pre-test/post-test format. The questionnaires, which were open response, were coded with rubrics to allow statistical analysis. Students were informed of the reading and response assignments, including the research components, during the first class meeting of the Spring 2012 semester. An informed consent form was distributed for them to sign during the second class meeting. Students absent during the first class meeting had information given to them individually. Responses from students who were 18 years of age or older by January 1, 2012 and who had given their consent were used in the study. The demographics survey and the two questionnaires were available at specific times during the semester on Desire to Learn® (D2L). Although anonymity was not possible for the researcher, future publications will identify student responses as only male or female. Confidentiality was maintained by the researcher. Approval from the Institutional Review Board was received (see Appendix A), as well as from the community college (see Appendix B) prior to the start of the research phase.
Research Design

The research instruments consisted of a demographics survey and a questionnaire given at the beginning of the semester and again at the end. The demographics survey was a non-graded part of the project, but students had to complete it in order to access other course materials. The demographics survey identified status variables which can be used for group identification, such as gender, ethnicity, age, and major (see Appendix C). This study did not use these status variables for analysis. The survey was made available on the first day of class via D2L and closed, or made unavailable, two weeks later.

The initial questionnaire, Chemistry Connections Assignment 1, consisted of four open-response questions: perceptions/ideas/feelings about chemistry in general, the relationship between chemistry and food, the relationship between chemistry and health, and the relationship between chemistry and the environment (see Appendix D). The initial questionnaire was made available on D2L following the add/drop/late registration period and closed two weeks later.

During the course, students read a series of six chemically related articles: Chemistry Connections Assignments 2-7. The articles, two per topic, focused on the relationship of chemistry to food, to health, or to the environment (see Appendix E). These articles were found in the required textbook General Chemistry by Davis, Peck, Stanley, and Whitten (2007). Each reading had an accompanying set of questions (Appendixes F-K). Each of the articles and question sets had a corresponding drop-box on the D2L. The articles, questions, and drop-boxes opened and closed in sequence, giving the students approximately eight weekdays to complete a set.
The final questionnaire, Chemistry Connections Assignment 8, post-test asked students how their perceptions/ideas/feelings about chemistry in general, the relationship between chemistry and food, the relationship between chemistry and health, and the relationship between chemistry and the environment had changed since the beginning of the semester (see Appendix L). The questionnaire was available on D2L two weeks prior to the end of the semester and closed on the last day of regular instruction.

The two questionnaires were open response format and were coded with rubrics to allow statistical analysis (see Appendix M). These rubrics, developed by the researcher for this study, allowed the researcher to code student responses in an ordinal method. Each of the four rubrics consisted of five similar ordinal groups. The lowest group (coded as a 1) was assigned when the overall indication of the response was either that chemistry was a very difficult subject or that chemistry was not useful for the understanding of the environment, nutrition/food, or general health. The highest group (coded as a 5) was assigned when the overall indication of the response was either that chemistry was an easy subject or that chemistry was useful for the general public when considering the environment, nutrition/food, or general health.

Students who submitted their responses for the Chemistry Connections Assignments 1 and 8 (the initial and final questionnaires) to the drop-boxes by the deadlines were awarded 100 points (the maximum number of points) for those assignments, regardless of participation in the research project. All students were required to complete the same assignments regardless of participation in the study.
Participants

The majority of students (47.3%) indicated a mathematic/engineering major. These students needed two sciences to fulfill graduation requirements, or the course was required for their chosen majors. All students were required to participate, as the research instruments were included as part of the course grade. However, data for only informed consent volunteers who completed the course without an Incomplete or Withdrawal were used for the study. In this study, there were 57 total students who completed the course without an Incomplete or Withdrawal. The demographics survey indicated the total makeup of the complete group to be 61.4% male and 38.6% female. Students had a variety of backgrounds. The three sections together comprised a close representative sample for the makeup of the student gender and ethnic populations of the college. In terms of ethnic groups, there was 82.5% Caucasian and 17.5% other ethnic groups. These groups cannot be identified further due to anonymity precautions. All of the students identified themselves as traditional (24 or younger) students and age 18 or older as of January 1, 2012.

Procedures

During the first class meeting, students were informed, both orally and via the consent form of the inclusion of the research project related to Chemical Connections, a component of the course (see Appendix N). Students who were absent the first class meeting or who added the course after the first class meeting received information concerning the research project on an individual basis. Students were given the consent form and instructed to read and be prepared to sign one of the options at the next class meeting. This first form was the student’s copy of the consent form. There were three
options on the consent form: of age (18 or older by January 1, 2012) and consent to participate, of age (18 or older by January 1, 2012) and decline to participate, and not of age (18 or older by January 1, 2012) and therefore ineligible. Students were assured of confidentiality for all parts of the study and anonymity in any study publication as outlined on the consent form. During the second class meeting, time between being allowed for participation consideration, students were given an informed consent form to sign and return to the researcher. Only students who indicated that they were of age 18 or older by January 1, 2012 and who consented were included in the study. All students were given the same assignments regardless of participation in the study. The demographics survey was available on D2L on the first day of class and closed two weeks later. The initial questionnaire, Chemical Connections Assignment 1, opened on D2L following the add/drop/late registration period for the course and closed approximately two weeks later. The final questionnaire, Chemical Connections Assignment 8, opened on D2L approximately two weeks before the end of the semester and closed on the last day of regular instruction. Due to the nature of the Chemical Connections D2L drop-boxes, there was no anonymity for the student to the researcher. However, any student responses that may be used in future publications will be identified as only male or female. Following the drop-box deadlines for the two questionnaires, the researcher downloaded and printed all of the student responses, removed those from ineligible or nonconsenting students, and coded the questions for the others. Once statistical analysis was completed, hardcopy responses were shredded for confidentiality purposes. All demographics surveys were kept or archived on the researcher’s computer.
Student electronic (D2L) submissions for the Chemical Connection assignments will be archived on the researcher’s computer for five consecutive semesters and then be deleted.

**Limitations**

1. Ordinal scale rubrics were used to code student responses. To ensure that student responses were coded without experimenter bias, selected colleagues coded approximately 10% of students’ responses, with anonymity ensured. Students’ names were removed and each student assigned a student identifier known only to the researcher. The colleagues chosen were two biology instructors, one mathematics instructor, and one physics instructor from the same community college. All of the selected raters had a Master’s degree in their fields. One biology instructor and the physics instructor had chemistry teaching experience. The researcher also coded these same responses independently of the other raters. The sets for the each rater were then analyzed by the project statistician who verified that the coding agreed between the raters by 70% or better.

2. Because students submitted the questionnaires only for participation points, their answers may be skewed, vague/insufficient for coding, etc.

3. There was no control group for this study.

**Data Analysis**

For each Research Question, a specific rubric was used to code the responses as to allow statistical analysis. For the first Research Question (Did the use of a series of reading and response assignments reduce students’ perceptions of the difficulty of chemistry?), the rubric was used to code the responses in a one-to-five ordinal scale. For the second Research Question (Did the use of a series of reading and response
assignments enhance students’ perceptions of the relevance of chemistry in their everyday lives?), the rubrics were used to code the responses in a one-to-five ordinal scale, with a specific but similar rubric for each of the three areas of investigation (environment, nutrition/food, general health). Following the coding of the responses, Wilcoxon paired sample t-tests were used to identify any significant differences.
CHAPTER IV
RESULTS OF DATA ANALYSIS

Introduction

Data consisted of students’ responses to an initial questionnaire, six reading response assignments, and a final questionnaire. The two questionnaires consisted of open response questions, which were coded by a group of five instructors (including the researcher) using a rubric. There were 57 students who completed the course without an Incomplete or Withdrawal. Only three students chose not to participate in the research phase of the course. There were 47 valid submissions on the initial questionnaire except for the environmental question (resulting in 46) and seven invalid submissions (those with missing data or nonsense answers) on the initial questionnaire. There were 40 valid submissions and 14 invalid on the final questionnaire.

The demographics survey indicated the makeup of the complete group was 61.4% male and 38.6% female. In terms of ethnic groups, there were 82.5% Caucasian and 17.5% other ethnic groups. All of the students identified themselves as traditional (24 or younger) students and age 18 or older as of January 1, 2012. The majority of students (47.3%) indicated a mathematic/engineering major.

The students’ responses for the two questionnaires were submitted electronically to the Desire to Learn® (D2L) and printed by the researcher following the closing date for each one. The submissions were coded using rubrics and then analyzed using a Wilcoxon paired sample t-test. Students who were missing data or submitted answers which could not be coded were assigned a value of zero to indicate missing data. The analysis was performed by SPSS (Version 20, June 2012).
Descriptives

For the first Research Question (Does the use of a series of reading and response assignments affect students’ perceptions of the difficulty of chemistry as measured by an initial questionnaire and final questionnaire?) statistics indicated that cumulatively 78.7% of responses ranked three or lower on the initial questionnaire compared to 37.5% on the final questionnaire. For rank four, the valid percent of responses increased from 19.1% on the initial questionnaire to 60.0% on the final questionnaire, resulting in a 41.2% positive change overall. The initial questionnaire and final questionnaire frequencies for this question are shown in Figure 1. Rank one indicated that perception that the study of chemistry has the most difficulty and rank five the perception of the least difficulty.

![Figure 1. Perceptions of Difficulty Histogram. Frequency for each ordinal rank for the initial questionnaire and final questionnaire for the first research question, which investigates the perception of difficulty (n=47).](image-url)

For the second Research Question (Does the use of a series of reading and response assignments affect students’ perceptions of the relevance of chemistry in their
everyday lives as measured by an initial questionnaire and final questionnaire?), the three variations (nutrition, general health, and environment) are examined individually. For the first variation (The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of nutrition), statistics indicated that 80.9% cumulative of responses ranked three or lower on the initial questionnaire compared to 37.5% on the final questionnaire. For rank four, the valid percent of responses increased from 19.1% on the initial questionnaire to 57.5% on the final questionnaire, resulting in a 43.4% positive change overall. The initial questionnaire and final questionnaire frequencies for this question are showed in Figure 2. Rank one indicated the least amount of perception of relevance and rank five the most.

![Figure 2. Perceptions for Nutrition Histogram. Frequency for each ordinal rank for the initial questionnaire and final questionnaire for the second question, which investigates the perception of relevance. These responses are for the perception of relevance to nutrition (n=47).](image)

For the second variation (The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of the general health.), statistics indicated that 83.0% of cumulative responses ranked
three or lower on the initial questionnaire compared to 70.0% on the final questionnaire. For rank four, the valid percent of responses increased from 17.0% on the initial questionnaire to 22.5% on the final questionnaire, resulting in a 13.0% positive change overall. The initial questionnaire and final questionnaire frequencies for this question are shown in Figure 3. Rank one indicated the least amount of perception of relevance and rank five the most.

Figure 3. Perceptions for General Health Histogram. Frequency for each ordinal rank for the initial questionnaire and final questionnaire for the second question, which investigates the perception of relevance. These responses are for the perception of relevance to general health (n=47).

For the third variation (The use of a series of reading and response assignments did not affect students’ perceptions of chemistry as important for everyday life in terms of the environment.), statistics indicated that 80.4% of cumulative responses ranked three or lower on the initial questionnaire compared to 67.5% on the final questionnaire. For rank four, the valid percent of responses increased from 19.6% on the initial questionnaire to 30.0% on the final questionnaire, resulting in a 12.9% positive change overall. The initial questionnaire and final questionnaire frequencies for this question are
shown in Figure 4. Rank one indicated the least amount of perception of relevance and rank five the most.

![Figure 4](image_url)

**Figure 4.** Perceptions for Environment Histogram. Frequency for each ordinal rank for the initial questionnaire and final questionnaire for the second question, which investigates the perception of relevance. These responses are for the perception of relevance to environment (n=46).

Table 1 gives the test statistics results for each hypothesis. Table 2 shows the results of the ranks from the Wilcoxon Signed Ranks Test.

**Table 1**

*Wilcoxon Signed Ranks Table for Test Statistics*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Difficulty</th>
<th>Nutrition</th>
<th>General Health</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-3.784\textsuperscript{b}</td>
<td>-3.795\textsuperscript{b}</td>
<td>-2.942\textsuperscript{b}</td>
<td>-2.295\textsuperscript{b}</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.001</td>
<td>.001</td>
<td>.003</td>
<td>.022</td>
</tr>
</tbody>
</table>
Table 2

*Wilcoxon Signed Ranks Table for Ranks*

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Rank Type</th>
<th>N</th>
<th>Mean Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty</td>
<td>Negative Ranks</td>
<td>2</td>
<td>12.50</td>
</tr>
<tr>
<td></td>
<td>Positive Ranks</td>
<td>23</td>
<td>13.04</td>
</tr>
<tr>
<td></td>
<td>Ties</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Nutrition</td>
<td>Negative Ranks</td>
<td>3</td>
<td>9.00</td>
</tr>
<tr>
<td></td>
<td>Positive Ranks</td>
<td>22</td>
<td>13.55</td>
</tr>
<tr>
<td></td>
<td>Ties</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>General Health</td>
<td>Negative Ranks</td>
<td>3</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>Positive Ranks</td>
<td>15</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>Ties</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Negative Ranks</td>
<td>4</td>
<td>8.00</td>
</tr>
<tr>
<td></td>
<td>Positive Ranks</td>
<td>13</td>
<td>9.31</td>
</tr>
<tr>
<td></td>
<td>Ties</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

**Statistical Analysis**

*Research Question 1:* Does the use of a series of reading and response assignments affect students’ perceptions of the difficulty of chemistry as measured by an initial questionnaire and final questionnaire?

*Hypothesis:* The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as a difficult subject.

A Wilcoxon Signed Ranks Test was conducted to evaluate whether students showed a change in their perceptions of the difficulty of chemistry. The results indicated a significant difference: \( Z = -3.78, p < .05 \). The mean of the ranks in negative results
(students found chemistry to be a very difficult subject) was 12.50, while the mean of the ranks in positive results (students found chemistry to be a less difficult subject) was 13.04. There were eleven ties (no change in perception of difficulty). Therefore, the hypothesis was rejected: the use of a series of reading and response assignments did affect students’ perceptions of chemistry as a difficult subject.

*Research Question 2:* Does the use of a series of reading and response assignments affect students’ perceptions of the relevance of chemistry in their everyday lives as measured by an initial questionnaire and final questionnaire?

*Hypothesis 2A:* The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of nutrition.

A Wilcoxon Signed Ranks Test was conducted to evaluate whether students showed a change in their perceptions of chemistry as important for everyday life in terms of nutrition. The results indicated a significant difference: \( Z = -3.80, p < .05 \). The mean of the ranks in negative results (students found chemistry to be more relevant in terms of nutrition) was 9.00, while the mean of the ranks in positive results (students found chemistry to be less relevant in terms of nutrition) was 13.55. There were eleven ties (no change in perception of relevance in terms of nutrition). Therefore, the hypothesis was rejected: the use of a series of reading and response assignments did affect students’ perceptions of chemistry as important for everyday life in terms of nutrition.

*Research Question 2:* Does the use of a series of reading and response assignments affect students’ perceptions of the relevance of chemistry in their everyday lives as measured by an initial questionnaire and final questionnaire?
**Hypothesis 2B:** The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of general health.

A Wilcoxon Signed Ranks Test was conducted to evaluate whether students showed a change in their perceptions of chemistry as important for everyday life in terms of general health. The results indicated a significant difference: $Z = -2.94, p < .05$. The mean of the ranks in negative results (students found chemistry to be more relevant in terms of general health) was 7.00, while the mean of the ranks in positive results (students found chemistry to be less relevant in terms of general health) was 9.31. There were eighteen ties (no change in perception of relevance in terms of general health). Therefore, the hypothesis was rejected: the use of a series of reading and response assignments did affect students’ perceptions of chemistry as important for everyday life in terms of general health.

**Research Question 2:** Does the use of a series of reading and response assignments affect students’ perceptions of the relevance of chemistry in their everyday lives as measured by an initial questionnaire and final questionnaire?

**Hypothesis 2C:** The use of a series of reading and response assignments did not affect students’ perception of chemistry as important for everyday life in terms of the environment.

A Wilcoxon Signed Ranks Test was conducted to evaluate whether students showed a change in their perceptions of chemistry as important for everyday life in terms of the environment. The results indicated a significant difference: $Z = -2.30, p < .05$. The mean of the ranks in negative results (students found chemistry more relevant in
terms of the environment) was 8.00, while the mean of the ranks in positive results (students found chemistry to be a less relevant in terms of the environment) was 9.31. There were eighteen ties (no change in perception of relevance in terms of the environment). Therefore, the hypothesis was rejected: the use of a series of reading and response assignments did affect students’ perceptions of chemistry as important for everyday life in terms of the environment.
CHAPTER V

DISCUSSION

Introduction

The study attempted to determine whether the use of a series of reading and response assignments decreased students’ perceptions of subject difficulty and enhanced students’ perceptions of the relevance of chemistry in their everyday lives. Informed consent volunteer students who were enrolled in General Chemistry II at a southeastern community college during the Spring 2012 semester participated in this study. The treatment for this study was part of the existing course material known as the Chemical Connections Assignment. Students were assigned to read a series of short articles that connect chemistry to a specific aspect of everyday life and then answer a question set for each article. Access to the assignments was given via the Desire to Learn® (D2L) content folder, and students uploaded their typed responses to the D2L drop-box corresponding to the article. These assignments counted as part of every student’s course grade, regardless of participation. This study incorporated the research questions into two of these assignments, and answers for each of the research instruments were coded according to a rubric. The coding allowed for statistical analysis using a Wilcoxon Signed Ranks T-test. The statistical analysis indicated a significant difference for each of the Research Questions and Hypotheses.

Discussion and Conclusions

Chemical curricula, having long been criticized for failing to show students the relevance of chemistry to their everyday lives, has been revised over time to correct this problem. With federal laws pushing for scientifically literate citizens, science, in
particular chemical, educators must achieve the goal of making relevant for students all scientific subjects, especially chemistry, as it is the most feared of the sciences. The development of *Chemistry in Context*, an attempt to reduce *chemophobia* and increase relevance, specifically focuses on student participation and the use of centralized topics to teach chemical concepts. Schwartz (2006) investigated the validity of this method and found favorable changes in students’ perceptions by using such techniques around topics with which students were more likely to have some familiarity, such as polymers or nuclear energy.

Another approach required students to investigate and determine the extent of the use of chemistry in their chosen careers. Investigated by Singh (1995), students presented their findings concerning the use of chemistry in their majors and debated whether chemistry was important as a subject. Overall, it was found that students at least began to realize the extent of chemistry in their lives or career choices. Jones and Miller (2001) attempted to increase the understanding of the relevance of chemistry to the real-world by incorporating a weekly 20-minute discussion on a particular chemical compound or chemical process. Data from a short questionnaire survey instrument indicated that, overall, students believed that the sessions enhanced their understanding of chemistry and boosted their performance. Regardless of the design, achieving the link between relevance and chemistry is critical for clarifying that chemistry contributes to the quality of our lives. Even textbooks, as noted by Jones and Miller (2001), typically include short articles stressing the relevance of chemistry to everyday life, although students typically do not read the textbook or such articles unless they are required to do so.
With these thoughts in mind, this study was developed to investigate two facets of chemophobia: the perceptions of the difficulty of chemistry and the lack of relevance of chemistry to everyday lives. For the first Research Question (Does the use of a series of reading and response assignments affect students’ perceptions of the difficulty of chemistry as measured by an initial questionnaire and final questionnaire?), it was found that the perception of chemistry as a difficult subject decreased overall during the semester. Having rejected the Hypothesis (The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as a difficult subject), it is difficult to clearly know whether the decrease in the perception of difficulty is because students found that the subject was either less difficult than they had feared (their chemophobia) or that, as they understood the material more, it lessened their dislike for the subject. It is believed by the researcher to be a little of both. Once students reach the second semester, the topics typically covered during the semester are likely to be either more appealing to students (colligative properties or how antifreeze works) or more easily seen as relevant to their everyday lives (electrochemistry or battery chemistry).

The second Research Question (Does the use of a series of reading and response assignments affect students’ perceptions of the relevance of chemistry in their everyday lives as measured by an initial questionnaire and final questionnaire?) was sectioned into three parts (nutrition, general health, and environment), which the researcher believed would help students identify chemistry as a more relevant subject. Each of the Hypotheses (The use of a series of reading and response assignments will not affect students’ perceptions of chemistry as important for everyday life in terms of nutrition, general health, or environment) for this Research Question were rejected. In terms of
nutrition, students indicated that there are uses for chemistry in food development, preservation, and enhancement that they had not been aware of before this study and that chemistry does take part in their nutrition intake and energy usage. In terms of general health, the results indicated that students realized that there are uses for chemistry in general health (the bath and beauty aspect of their lives) that may not have been comprehended prior to this study. For these two closely related topics, as with the previous Research Question, it is difficult to clearly know whether the increase in the acknowledgement of the relevance is due to natural progression of the chemistry course or if it is due to the reading and response assignments given. The researcher believes it is more likely due to the reading and response assignments, since at this stage in a student’s chemical life as such topics might not be normally introduced and linked to students’ everyday lives. Topics relating to nutrition and general health are typically not introduced until a student reaches Biochemistry, if at all.

In terms of the environment, the researcher believed, from previous literature findings on the subject, that students would be less likely to miss the relevance of chemistry, especially given the predominance of global warming, the ozone hole, and going green found in social media. However, it was found that students did increase their perceptions of the relevance of chemistry to environmental concerns over the course of the semester but, as with the previous topics, it is difficult to know whether the increase in the awareness of relevance is due to the course material generally covered during General Chemistry II or if it is due to the reading and response assignments given. The researcher believes the reading and response assignments more likely influenced the change in perception since true environmental chemistry is a specialty area of chemistry
and students are not likely to learn more hardcore science from the social media at their age(s).

Limitations of the Study

1. Though there were many advantages in the implementation of the study, one should also be aware of the following limitations:

2. There was no control group for this study. Therefore, it cannot be determined if the changes are due in part or completely to the reading and response assignments or if the changes are due in part or completely to accumulation of chemical knowledge.

3. Only General Chemistry II students participated in this study.

4. Because students were submitting the questions for participation points, their answers may be skewed, vague/insufficient for coding, etc.

5. Rubrics were not shown to students so that responses would not be tailored to the rubric. Therefore, responses may be vague/insufficient for coding, etc.

6. Ordinal scale rubrics were used to code student responses.

Recommendations for Practice

The following are the recommendations for practice:

1. Articles selected can be identified from the textbook, podcasts, news articles, etc. With the vast amount of electronic resources available, articles or reading assignments are not limited to those available in the textbook.

2. Article selection can be expanded to include other relevance links, such as career choices, areas of study, etc. Depending on the topics covered in a course, reading assignments can be adapted to include other concepts in chemistry or the use of chemistry
in a student’s career choice. For example, an art major may enjoy reading about how different glazes are achieved through chemical manipulation of different compounds.

3. Article reading and responses may be incorporated into existing course assignments. These assignments may include a separate assignment, as it was in this study, or be added in the form of test questions or bonuses, understanding check on exams or laboratory reports, etc.

Recommendations for Future Research

The following are the recommendations for future researchers in this field of study:

1. Future studies can develop Likert-type survey instruments for use as an initial questionnaire and final questionnaire to eliminate any bias or problems that may occur with the use of coding via rubrics.

2. This study examined only the use of articles in the course text. Future research could expand the reading to web-based articles, podcasts, news articles, etc.

3. This study covered only the change in perception for one college during one semester. Future research could use a broader spectrum of colleges and could give the initial questionnaire during the beginning of the students’ first semester (General Chemistry I) and the final questionnaire at the end of the second (General Chemistry II), third (Organic Chemistry I), and fourth (Organic Chemistry II) semesters (and beyond) to show changes as students’ chemical knowledge increases.
APPENDIX A

IRB NOTICE OF COMMITTEE ACTION

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.6820 | Fax: 601.266.4377 | www.usm.edu/irb

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.

Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 11101704
PROJECT TITLE: Seeing the Chemistry Around Me - Helping Students Identify the Relevance of Chemistry to Everyday Life
PROJECT TYPE: Dissertation
RESEARCHER(S): Tracy Lynn Moore
COLLEGE/DIVISION: College of Science & Technology
DEPARTMENT: Science/Mathematics Education
FUNDING AGENCY: N/A
IRB COMMITTEE ACTION: Exempt Approval
PERIOD OF PROJECT APPROVAL: 10/26/2011 to 10/25/2012

Lawrence A. Hosman, Ph.D.
Institutional Review Board Chair

10-28-2011
APPENDIX B

MGCCC APPROVAL FOR CONDUCTING RESEARCH

Mississippi Gulf Coast Community College

Request to Conduct Research at MGCCC

DIRECTIONS: Individuals who wish to conduct research utilizing MGCCC students or employees must complete this application and email to jason.gough@mgccc.edu.

Purpose – This application must be completed and approval granted by the MGCCC Executive Council prior to conducting any research utilizing college students or employees. The purpose of this application is to ensure that the researcher complies with the following conditions:

(1) requires the researcher to summarize the proposed research and provide supporting documentation ensuring that research is performed in compliance with all applicable laws, regulations, and institutional and federal policies regarding human subjects research,

(2) ensures the proposed research has institutional support or will have such support through IRB approval and the endorsement of a qualified research advisor (i.e., faculty member) who assumes responsibility for the project,

(3) provides the applicant with appropriate documentation that the MGCCC Executive Council has reviewed the proposed study.

Principal Investigator (PI) Contact Information – The PI for the purposes of this application is the individual who will personally conduct this research study. Under most circumstances, the PI will be the student researcher.

<table>
<thead>
<tr>
<th>Name</th>
<th>Tracy Lynn Moore</th>
<th>Phone:</th>
<th>x6377</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td><a href="mailto:tracy.moore@mgccc.edu">tracy.moore@mgccc.edu</a></td>
<td>Fax:</td>
<td>x8946</td>
</tr>
<tr>
<td>Address</td>
<td>Science Dept</td>
<td>City:</td>
<td>Perkinston</td>
</tr>
<tr>
<td></td>
<td>PO Box 548</td>
<td>State:</td>
<td>MS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zip:</td>
<td>39571</td>
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Research Advisor (RA) Contact Information – The RA for the purposes of this application is the individual who will personally supervise and oversee this research study. Under most circumstances, the RA will be the faculty member working with the student researcher.

<table>
<thead>
<tr>
<th>Name</th>
<th>Sherry Herron, PhD</th>
<th>Phone:</th>
<th>601-266-4739</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td><a href="mailto:Sherry.Herron@usm.edu">Sherry.Herron@usm.edu</a></td>
<td>Fax:</td>
<td>601-266-5145</td>
</tr>
<tr>
<td>Address</td>
<td>USM</td>
<td>City:</td>
<td>Hattiesburg</td>
</tr>
<tr>
<td></td>
<td>118 College Dr #5087</td>
<td>State:</td>
<td>MS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zip:</td>
<td>39406</td>
</tr>
</tbody>
</table>

Sponsoring Institution or Agency: University of Southern Mississippi

Sponsoring Academic Division/Department: Center for Science & Mathematics Education

Has the study obtained IRB approval from sponsoring institution?

☐ Yes, Approve Date _11-3-11_  ☐ Exempt or Expedited (deemed minimal risk to human subjects)
☐ No  ☐ Full Board (deemed greater than minimal risk or work with special populations of human subjects)
☐ Not Applicable, Explain:

IRB approval pending

Received: OCT 13 2011

Vice President for Instructional Affairs
**Signatures**

**Principal Investigator** – I certify that the information in this request is complete and correct. As Principal Investigator, I have the ultimate responsibility for protecting the rights and welfare of human participants, secure conduct of the research, and the ethical performance of the project. I will comply with all applicable federal, state, and local laws regarding the protection of participants in human research.

![Signature]

<table>
<thead>
<tr>
<th>Signature of Principal Investigator</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davy Lynn Moore</td>
<td>10/10/2011</td>
</tr>
</tbody>
</table>

**Research Advisor** – I certify that the information in this request is complete and correct, and that this proposed research has been approved by the IRB of the sponsoring institution or will be approved before the research is conducted. As Research Advisor, I confirm that the student researcher under my guidance is knowledgeable about the regulations and policies governing research with human subjects, and has sufficient training and experience to conduct the research outlined in this application.

I further agree to regularly meet with the student researcher to monitor his or her progress; and if problems arise, I will become personally available to help the student researcher resolve those problems. As an advisor of this project, I will assure the protection of the rights and welfare of human participants, secure conduct of the research, and the ethical performance of the project. I will comply with all applicable federal, state, and local laws regarding the protection of participants in human research.

![Signature]

<table>
<thead>
<tr>
<th>Signature of Research Advisor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sherry E. Herson</td>
<td>10/10/2011</td>
</tr>
</tbody>
</table>

**Vice President of Instruction, Student Services, and Related Technologies** – I acknowledge that the IRB of the MCCC Executive Council has reviewed the research proposal and that this research has been reviewed and has subsequently received the following recommendation with consensus of the Executive Council in meeting.

![Signature]

<table>
<thead>
<tr>
<th>Signature of Vice President of Instruction, Student Services, and Related Technologies</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10/10/2011</td>
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</table>

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Also see attached email regarding M number collection.
APPENDIX C

DEMOGRAPHICS SURVEY

The following survey questions will be included in the D2L CHE 1224 shell (session) in electronic question format.

Question 1
I am a …
   o Male student
   o Female student

Question 2
I am …. 
   o African American/Black
   o Asian American
   o American Indian
   o Hispanic American
   o Caucasian/White
   o Other or Prefer not to say

Question 3
Are you a …
  o Traditional (24 or younger) student
  o Non-Traditional (25 or older) student

Question 4
My Major is …. 
   o Pre-Vet or Pre-Med or Pre-Pharmacy
   o Engineering
   o Chemistry or chemical education
   o Pre-nursing
   o Other science major
   o A Humanities major
   o A Social Science major
   o Other or Prefer not to say
APPENDIX D

CHEMISTRY CONNECTIONS ASSIGNMENT 1

Answer the following questions honestly and completely. Submit your answers in a word document to the “Chemical Connections 1” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!!

1) Is chemistry required for your major? (Yes or no is fine here)

2) Give your perceptions/ideas/feelings about taking a chemistry course.

3) Give your perceptions/ideas/feelings about the relationship between chemistry & your food.

4) Give your perceptions/ideas/feelings about the relationship between chemistry & your health.

5) Give your perceptions/ideas/feelings about the relationship between chemistry & the environment.
APPENDIX E
LIST OF ARTICLES USED FOR THIS STUDY

Chemical Connections 2 Article

Chemical Connections 3 Article

Chemical Connections Article 4

Chemical Connections Article 5

Chemical Connections Article 6
Chemical Connections Article 7

APPENDIX F
CHEMISTRY CONNECTIONS ASSIGNMENT 2

Read Chemistry in Use: Our Daily Lives (Red Wine) on page 538 in your textbook and then answer the following questions. Answer these questions completely & honestly without reading or researching further! Submit your answers in a word document to the “Chemical Connections 2” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!

1) Explain, in your own words, why “red wine goes with red meat” and “white wine goes with fish/chicken.”

2) Hypothesize which would go “best” with pork and explain why.

3) A “blush” wine (technically a Rosé wine) is typically a pink color. Hypothesize how this is made.

4) The tannins are a dark color with bitter or tart taste and appear naturally in other foods/drinks. Choose one food and one drink which you think might have tannins and explain why you think they would.

5) Tannins in food & drink interfere with the absorption of minerals (like iron). What problems might develop with heavy or extended use? Explain.
APPENDIX G

CHEMISTRY CONNECTIONS ASSIGNMENT 3

Read Chemistry in Use: The Development of Science (Trace Elements) on page 862-863 in your textbook and then answer the following questions. Answer these questions completely & honestly. Further researching may be needed! Submit your answers in a word document to the “Chemical Connections 3” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!!

1) Pick one of the elements – known to be essential – discussed and explain, in your own words, what it does (including where you get it).

2) Pick one of the elements – substantial evidence for essentiality – discussed and explain, in your own words, what it does (including where you get it).

3) Pick one of the elements – weak evidence for essentiality – discussed and explain, in your own words, what it does (including where you get it).

4) Identify a major biological element & explain, in your own words, what it does and where we get it.

5) Many nutritionists claim that even obese people can be malnourished. Explain, in your own words, why this is true or false.
APPENDIX H

CHEMISTRY CONNECTIONS ASSIGNMENT 4

Read Chemistry in Use: The Environment (Ozone) on page 646-647 in your textbook. Answer these questions completely & honestly. Further research is allowed! Submit your answers in a word document to the “Chemical Connections 4” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!!

1) Explain, in your own words, how the O₂ to O₃ & reverse processes work (use the generic UV instead of researching the exact frequency).

2) How long have we known about the ozone “hole” & what exactly is it?

3) Explain, in your own words, what the Chlorine radicals from Freon (& other CFC) do.

4) Discuss one problem which might occur if the ozone “hole” continues to expand.

5) Do you think global warming & the ozone hole are related? Explain why or why not.
APPENDIX I

CHEMISTRY CONNECTIONS ASSIGNMENT 5

Read Chemistry in Use: Butter, Margarine, and trans Fats on page 1010 in your textbook. Answer these questions completely & honestly. Further research is allowed! Submit your answers in a word document to the “Chemical Connections 5” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!

1) Compare & contrast, in your own words, butter and margarine.

2) Compare & contrast, in your own words, HDL & LDL.

3) What were trans-fats and from where do we get them?

4) Explain, in your own words, what you can do to change your cholesterol level.

5) Are fats good for you? Explain why or why not.
APPENDIX J

CHEMISTRY CONNECTIONS ASSIGNMENT 6

Read Chemistry in Use: Our Daily Lives (Everyday Salts) on page 359 in your textbook and then answer the following questions. Answer these questions completely & honestly. Additional research may be required! Submit your answers in a word document to the “Chemical Connections 6” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!!

1) Think about one of the previous Chemistry Connection Assignments (Trace Elements). If calcium is so important for our teeth & bones, why can’t we just eat “raw” calcium metal?

2) Select a compound from this article. From the internet (www.webelements.com is a good site), give a brief history for the METAL listed in the compound.

3) For the same element: give the biological use.

4) For the same element: give two additional uses

5) CaCO₃ in food gives us calcium. Li₂CO₃ is used for a medicine. (NH₄)₂CO₃ is an ingredient in smelling salt. Are Na₂CO₃ and NaHCO₃ edible? Explain why or why not.
APPENDIX K

CHEMISTRY CONNECTIONS ASSIGNMENT 7

Read Chemistry in Use: The Environment (Nitrogen Oxides) on page 897 in your textbook. Answer these questions completely & honestly. Further research is allowed! Submit your answers in a word document to the “Chemical Connections 7” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!!

1) Theorize what natural process releases NO$_x$ into the atmosphere.

2) Why is the production of NO$_x$ by humans/cars so much worse in urban areas?

3) What ways could be used to reduce production of smog in urban areas?

4) Looking at the PAN example, explain what a peroxide compound actually is.

5) Explain the purpose of the catalytic converter on a car (research may be required).
Answer the following questions honestly and completely. Submit your answers in a word document to the “Chemical Connections 8” dropbox. There is a minimum of 5 grammatically correct sentences per question for full credit. NO CREDIT after the dropbox closes!!!

1) Explain how chemistry might be useful in your chosen major.

2) Explain how your perceptions/ideas/feelings about taking a chemistry course have changed since the beginning of the semester.

3) Explain how your perceptions/ideas/feelings about the relationship between chemistry & your food have changed since the beginning of the semester.

4) Explain how your perceptions/ideas/feelings about the relationship between chemistry & your health have changed since the beginning of the semester.

5) Explain how your perceptions/ideas/feelings about the relationship between chemistry & the environment have changed since the beginning of the semester.
APPENDIX M

RUBRICS FOR RESEARCH QUESTIONS

Rubric for first Research Question: Does the use of a series of reading and response assignments reduce students’ perceptions of the difficulty of chemistry?

<table>
<thead>
<tr>
<th>Code Value</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Overall indication that chemistry is a very difficult subject; too difficult for anyone (why study this course).</td>
<td>Overall indication that chemistry is a difficult subject; too difficult for anyone except chemistry majors.</td>
<td>Overall indication that chemistry is a difficult subject; too difficult for anyone except science majors who were required to take it.</td>
<td>Overall indication that while chemistry is a difficult subject, diligent study habits will help anyone understand the subject.</td>
<td>Overall indication that chemistry is an easy subject; easy enough for anyone.</td>
</tr>
</tbody>
</table>

Rubric for second Research Question on following page.
Rubric for second research question: Does the use of a series of reading and response assignments enhance students’ perception of the relevance of chemistry in their everyday lives?

<table>
<thead>
<tr>
<th>Code Value</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environment</strong></td>
<td>Overall indication that chemistry is not useful to any purpose when considering the environment.</td>
<td>Overall slight indication that chemistry could be somewhat useful when considering the environment although not certain how.</td>
<td>Overall indication that chemistry is somewhat useful when considering the environment although at least partially uncertain how.</td>
<td>Overall indication that chemistry is useful when considering the environment for scientists; only scientists would understand the processes involved.</td>
<td>Overall indication that chemistry is useful when considering the environment for the general public because anyone could understand the processes involved.</td>
</tr>
<tr>
<td><strong>Nutrition/Food</strong></td>
<td>Overall indication that chemistry is not useful to any purpose when considering nutrition/food.</td>
<td>Overall slight indication that chemistry could be somewhat useful when considering nutrition/food, although not certain how.</td>
<td>Overall indication that chemistry is somewhat useful when considering nutrition/food, but only in terms of calories, etc….</td>
<td>Overall indication that chemistry is useful when considering nutrition/food, but only in terms of biological processes, etc…</td>
<td>Overall indication that chemistry is useful when considering nutrition/food, for the general public should be aware of the complex uses of chemistry in food preparation, preservation, etc…</td>
</tr>
<tr>
<td>Description</td>
<td>Overall indication that chemistry is not useful to any purpose when considering general health.</td>
<td>Overall slight indication that chemistry <em>could be</em> somewhat useful when considering general health, although not certain how.</td>
<td>Overall indication that chemistry <em>is</em> somewhat useful when considering general health, although at least partially uncertain how.</td>
<td>Overall indication that chemistry is useful when considering general health, but only for medical or medicinal fields.</td>
<td>Overall indication that chemistry is useful when considering general health, for the general public should be aware of the complex processes of chemistry in the body, medicine, etc…</td>
</tr>
</tbody>
</table>


APPENDIX N

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

CONSENT FORM

AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

Consent is hereby given to participate in the study titled: Seeing the Chemistry Around Me – Helping Students Identify the Relevance of Chemistry to Everyday Life.

Purpose: The purpose of this study is to identify whether activities designed to increase students’ awareness of chemistry in their everyday lives succeeds or not.

Description of the Study: This research project consists of three parts. The first part is a demographics survey. This survey is a non-graded part of the project but students must complete it to access certain portions of required course materials. The second part is an initial questionnaire focusing on the students’ current perceptions of chemistry in terms of difficulty and the everyday concepts of the environment, nutrition/food, and general health. This part has been incorporated into existing course assignments as “Chemical Connections 1.” The third part is a final questionnaire focusing on the students’ current perceptions of chemistry in terms of difficulty and the everyday concepts of the environment, nutrition/food, and general health after having completed existing course requirements. This part has been incorporated into existing course assignments as “Chemical Connections 8.” All questions for parts two and three are open response format and will be coded for statistical research purposes according to a rubric. Completion of parts two and three, by the deadlines on the drop-boxes, are automatic “100’s” for those Chemical Connections assignments, regardless of participation in the research project. All students will be given the same assignments regardless of participation in the study.

Benefits/Risks: Benefits of this study may be an increased awareness of the relevance of chemistry in everyday life. There are no identifiable risks of this project.

Anonymity & Confidentiality: Due to the nature of the Chemical Connections (D2L drop-boxes), there will be no anonymity for the student to the researcher. However, any student responses used in study publications will be identified only as “male student” or “female student.” All demographics surveys will be kept or archived on the researcher’s computer. Student submissions for the Chemical Connection research assignments will be kept or archived on the researcher’s computer for five consecutive semesters and may then be deleted.
Participant’s Assurance: Whereas no assurance can be made concerning results that may be obtained (since results from investigational studies cannot be predicted) the researcher will take every precaution consistent with the best scientific practice. Participation in this project is completely voluntary, and participants may withdraw from this study at any time without penalty, prejudice, or loss of benefits. Questions concerning the research should be directed to Tracy Moore at 601-928-6377. This project and this consent form have been reviewed by the Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive # 5147, Hattiesburg MS 39406-0001, (601) 266-6820. A copy of this form will be given to the participant.

Signature: Read each statement below. Sign and date the one you chose.

OPTION 1: I, the undersigned, have read the above consent form and, being age 18 or older by January 1, 2012, agree to participate in this research project.

___________________________________________ M_____________________
Printed Full Name of the Student GCID

___________________________________________ _______________________
Signature of the Student Date Signed

OPTION 2: I, the undersigned, have read the above consent form and, being age 18 or older by January 1, 2012, decline to participate in this research project.

___________________________________________ M_____________________
Printed Full Name of the Student GCID

___________________________________________ _______________________
Signature of the Student Date Signed

OPTION 3: I, the undersigned, being NOT of age 18 or older by January 1, 2012, am not eligible to participate in this research project.

___________________________________________ M_____________________
Printed Full Name of the Student GCID

___________________________________________ _______________________
Signature of the Student Date Signed
REFERENCES


