GENERAL CHEMISTRY COURSES THAT CAN AFFECT ACHIEVEMENT:

AN ACTION RESEARCH STUDY IN DEVELOPING A PLAN TO IMPROVE

UNDERGRADUATE CHEMISTRY COURSES

by

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Abstract

Over the past 50 years, considerable research has been dedicated to chemistry education. In evaluating principal chemistry courses in higher education, educators have noted the learning process for first-year general chemistry courses may be challenging. The current study investigated perceptions of faculty, students and administrators on chemistry education at three institutions in Southern California. Via action research, the study sought to develop a plan to improve student engagement in general chemistry courses. A mixed method was utilized to analyze different perceptions on key factors determining the level of commitment and engagement in general chemistry education. The approach to chemistry learning from both a faculty and student perspective was examined including good practices, experiences and extent of active participation. The research study considered well-known measures of effective education with an emphasis on two key components: educational practices and student behavior. Institutional culture was inclusively assessed where cognitive expectations of chemistry teaching and learning were communicated. First, the extent in which faculty members are utilizing the "Seven Principles for Good Practice in Undergraduate Education" in their instruction was explored. Second, student attitudes and approaches toward chemistry learning were examined. The focus was on investigating student understanding of the learning process and the structure of chemistry knowledge. The seven categories used to measure students' expectations for learning chemistry were: effort, concepts, math link, reality link, outcome, laboratory, and visualization. This analysis represents the views of 16 faculty and 140 students. The results validated the assertion that students need some

competencies and skills to tackle the challenges of the chemistry learning process to deeply engage in learning. A mismatch exists between the expectations of students and those of the faculty. Furthermore, improving attitudes and beliefs could be a potential for bringing about successful interventions to general chemistry learning. Importantly, the role of collaboration between chemistry educators is essential to forming instructional strategies. Additionally, shifting paradigms should be given utmost attention, including differences among student engagement in general chemistry, ways in which faculty can modify practices to meet student expectations, and the role of administrators in providing the necessary tools that stimulate chemistry education and research.

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CHAPTER 1. INTRODUCTION

Introduction to the Problem

Enrollments of chemistry courses at colleges and universities have continued to rapidly grow in excess of the total higher education student population. In the United States, student enrollment in chemistry courses has come to the forefront of the higher education system over the past decade. STEM education, a new vision in higher education, students must advance in science, technology, engineering, and mathematics to pursue careers in science and technology. Higher education institutions have recognized that chemistry programs are strategically important to meet continued growth of majors encountering chemistry such as health care and STEM education. However, data presented by National Science Foundation (NSF) demonstrates that the U.S. has one of the lowest rates of STEM to non-STEM majors in the world. STEM majors accounted for 16.8 percent of all university degrees awarded in the U.S. compared to 46.7 percent in China (NSF, 2006). Furthermore, the science indicator reports of the National Science Board (NSB) presents a decreased numbers of students in STEM areas in the U.S. (National Science Board, 2006).

Looking at a central science course like general chemistry for science and none-science majors, it is a prerequisite for further chemistry courses in science and applied sciences majors, as well as, an essential course for non-science majors such as nursing. Administrators and faculty in chemistry programs are challenged to improve achievement in general chemistry courses. Their concern is that many undergraduate students lack sufficient background and practice to succeed in first-year college chemistry courses. Working collaboratively, administrators and faculty in chemistry programs can support and develop chemistry teaching and learning approaches that improve student engagement. Changes in program plans demand a process of continuous improvement of general chemistry courses.

The current action research study designed a process of developing a plan to improve student engagement in general chemistry courses at three institutions that serve the communities in Southern California. Enrollment in general chemistry courses at colleges and universities in this region is considered to be at a higher level compared to California higher education institutions statewide. But the problem is the retention rate of general chemistry courses at lower levels than other courses among the college level courses. Efforts in development of general chemistry courses are always made to best meet the needs of the students.

General chemistry courses need to be developed to answer a variety of questions that investigates the challenges to learners' expectations. It is important that an examination be done on how general chemistry courses in undergraduate education are taught. This action research study assessed inclusive descriptions of perceptions of administrators, faculty, and students in chemistry education toward general chemistry courses. The assessment of these perceptions could be used to address the expectation gaps in general chemistry courses to learn about specific areas to develop a plan for change.

Development of educational practices of chemistry education has challenged chemistry educators to reform instruction in general chemistry courses. Instructors are challenged to develop courses by utilizing good practices in undergraduate education. However, little research has been conducted on developing best practices and models in general chemistry courses based on inclusive perceptions of administrators, faculty, and students. There is also a limited number of mixed method studies that have been conducted on assessing the perceptions of academic administrators and faculty to determine the impact of chemistry education on student learning.

The need for purposeful study to propose a plan of top-down and bottom-up change to improve general chemistry courses is critical for a discipline such as chemistry where learner's achievement is currently under scrutiny. Top-down proposed plans for change can be initiated based on assessment of the analysis of faculty perceptions concerning the impact of chemical education. In light of this assessment, reviewing and reflecting on the proposed plan with administrators will assist to support long term plans to be implemented related to the proposed plan. Bottom-up plans for change can be initiated based on assessment of the analysis of students' perceptions toward their study approaches and beliefs about learning chemistry to evaluate the level of learning and studying chemistry.

Background, Context, and Theoretical Framework

The research sites serve the communities in Southern California and currently have high enrollment rates of students every semester. Given the region's size, its diverse population, and the variety of socioeconomic issues and stressors, efforts of higher education institutions must include developing the ways to change to be consistent with their mission and values.

Developing a learner-centered environment based on student satisfaction provides the foundation for understanding student assessment and accountability. Measuring student success by the degree to which the students become self-sufficient learners and contributing members of society is vital. In order to improve student engagement, higher education institutions stress an emphasis on providing quality education and services that support a diverse community of learners to become lifelong learners. Their values are based on a fundamental part of enriching learning environments that foster creativity and self-expansion.

Assessing the perceptions of administrators, faculty, and students toward chemistry education's impact on students' learning can explore measures for development of general chemistry courses. Using perceptions in action research study to illustrate theory-in-use on general chemistry courses can be important to analyze the actual behavior at the level of both espoused theory and theory-in-use (Argyris and Schön, 1996). The action of the researcher assimilated adaptive challenges to inspire attitude and behavior that could achieve the innovation to produce a proposed plan for change. This opportunity of assessing stakeholders' perceptions to propose a plan for change also could be a collaborative effort between all members involved in the change. Stinger (2007) states that all members of the group involved in the change understand that they have to be engaged with the change since their insights about the change are important.

The expectation from the administrators is to support faculty and students with resources such as advanced media technology and models guided by methodologies of effective learning to implement the change. Changes in institutional structures such as technical support and resources require shared understanding of the Department of Chemistry who must take the initiatives to develop a platform that integrates theories and best practices on undergraduate education.

Statement of the Problem

Currently, higher education has experienced many changes. Accountability and assessment require faculty to recognize that they may no longer only provide instruction, but to help students to construct base of knowledge. Additionally, the student success rate has been included in the criteria for effectiveness of teaching and learning in higher education (American Federation of Teachers, 2001). With the increasing number of students demanding introductory courses in science and technology in health care and STEM education, it is important to explore how higher education general chemistry courses are taught. Research is also needed to inclusively examine institutional culture to assess cognitive expectations of chemistry learning for high performance. There is little research on higher education chemistry courses and the extent to which administrators, faculty, and students in the Department of Chemistry share to enhance the effectiveness of chemistry education. Additionally, there is a need for shared leadership that understands the way in which system dynamics can lead to improve change success (Cox, Pearce, & Perry, 2003). The collaborative efforts could impact the success of general chemistry courses, as well as, closing of the gap between student and faculty expectations for learning chemistry.

Purpose of the Study

Development of practices of chemistry education has challenged chemistry educators to reform instruction in general chemistry courses. Prior to this research study, there was little research on developing best practices and models in general chemistry courses based on inclusive perceptions of administrators, faculty, and students. There is also a limited number of quantitative studies that have been conducted on assessing the perceptions of academic administrators and faculty to determine the impact of chemistry education on student learning.

The purpose of this study was to propose a plan of top-down and bottom-up change to improve general chemistry learners' engagement and achievement. Based on the engagement measures utilized for quality chemistry education, the plan can be the foundation for quality teaching and learning in general chemistry courses. The top-down proposed plan for change was initiated based on assessment of the analysis of faculty perceptions about the impact of student engagement and involvement in learning general chemistry courses. In light of this assessment, reviewing and reflecting on the proposed plan with administrators would assist to support long term plans to be implemented related to the proposed plan. The bottom-up plan for change was initiated based on assessment of the analysis of students' perceptions toward their study approaches and beliefs about learning chemistry to evaluate the level of learning and studying chemistry.

Research Questions

How can a proposed plan be developed to improve student engagement based on assessing perceptions of administrators, faculty, and students, with focus on the impact of chemical education on learning in general chemistry courses?

The issues questions that guide the research study to develop a plan to improve learning and teaching in general chemistry courses are:

1. To what extent are chemistry faculty members using Chickering and Gamson's (1991) Seven Principles of Good Practice in undergraduate Education?
2. What are the effects of students' approaches to learning and their beliefs about learning chemistry on the ways they engage the studying and learning process?
3. In the light of the perceptions of faculty and students, what is the role of the administrators to support a long term plans related to the proposed plan?

Rationale

Recent research in higher education has recognized the significance of data for continuous improvement. Data- informed decision-making presents the analysis of data to direct decisions that improve student achievement. Furthermore, Data has become a necessary element in developing practices and activities to promote shared collaboration and systems thinking. To successfully use the data efficiently, skills and experiences are needed to build conceptual paradigms guided by integrated literature related to theories and effective practices. To raise student achievement and engagement, system's thinking is a skill needed for educators to understand the interconnectedness of the complexity and social systems of their institutions. Practitioners who understand the significance of adopting systems' perspective will be able to move their institution toward learning and participation.

Senge (1990) claims that systems' thinking is a framework that helps practitioners to see how they make an institution change effectively to produce a learning institution. A learning institution recognizes that their stakeholders differ in the way they think, behave, and learn but "they create their reality and how they can change it" (p.12). According to Senge (1990), systems take the shape from the values and beliefs of the people in them. The mental models and theories of the people affect their action and interaction of the system. In exploring the challenges to develop a plan of change for improvement, the resulting actions belong to individuals who learn how to think together in the sense of identifying a new insight to develop the change.

The necessity of developing general chemistry courses has become clear to identify gaps in quality chemistry learning and help more students to succeed in college chemistry courses. Many students attend first year chemistry courses do not have the educational preparation to achieve their academic goals. Educational practices in chemistry involve hand-on experiences, inquiry-based, problem solving, strategic learning, and critical thinking. The background of this research study is to examine selected challenges faced chemistry instructors and learners in general chemistry courses.

The researcher based on her position has an opportunity to be involved in a cross-analysis of three research sites with the focused on faculty and students' perceptions, attitudes and approaches toward chemistry learning. Drawing upon the data found within the three institutions, it is the assumption of the researcher that the findings suggest the value of data that focused on collective and systems thinking skills for developing the practices and approaches toward chemistry learning in general chemistry courses.

Relevance

This action research sought to improve the level of engagement and commitment in general chemistry courses as it relates to the best-known engagement indicators to effective education in colleges. The study considered two key components that have contributed to student engagement and learning: educational practices and student behavior (Astin, 1993; Kuh, Kinzie, Schuh, & White, 2005). First, the "Seven Principles for Good Practice in Undergraduate Education" (Chickering & Gamson, 1987) was utilized to explore the extent were chemistry faculty members using these practices in their instruction. Second, students' perceptions and learning related attitudes were explored to examine student deep approaches to chemistry learning (Biggs, 1999, 2001; Entwistle & Waterston, 1988).

The research study focused on investigating student's understanding of the process of chemistry learning from their experiences and beliefs about learning, what skills will be required, and what are expected to do to deeply engage in chemistry learning. The seven clusters used to measure students' prior knowledge about chemistry learning and what they expect to do to learn were: effort, concepts, math link, reality link, outcome, laboratory, and visualization (Grove & Bretz, 2007).

It becomes necessary for chemistry education research to address the mismatch between students' expectation and those of faculty expectations for chemistry learning. This research study demonstrated the level of intellectual and emotional engagement in chemical education of general chemistry courses. Erickson (2007) asserts that increasing students' motivation for learning could be a potential for bringing about successful interventions to student learning. Discovering the reasons why some students struggle to engage in chemistry learning would give students an opportunity to be meaningful learners (Nakhleh, 1992). In this manner, educators can formulate instructional strategies and materials that can fit with a working cognitive model of chemistry learning.

The results validated the assertion that first-year college chemistry students need some competencies and skills necessary to tackle challenges of learning process they may face to actively engage in their learning. In this respect, the result of this study can have an impact of institutional structure and context on the approaches of stakeholders.

Significance of the Study

Mixed method was utilized to examine and analyze perceptions and expectations of student's understanding of the process of chemistry learning. The action research study is significant because limited number of mixed method studies has been conducted on exploring the inclusive perceptions of academic administrators and faculty to determine the impact of chemistry education on student's learning in general chemistry course.

In describing the role of administrators and faculty to overcome the barriers to student learning, the role of the administrators to promote system thinking in action, not only does system change, but it keeps on interacting administrators and faculty within the department to produce innovative practices that solve deep problems (Fullan 2005; Senge 1990, 2006). The importance of exploring the perceptions of participants to discover and examine criteria of the quality of education could lead to strategic learning throughout general chemistry courses.

The challenge of strategic learning process starts with all stakeholders open to learning from experience (John 2009). The learning experiences through the learning cycle provide the participants with support and training by formulating knowledge and strategies for high-quality program offerings that best serve the community. Greater number of students will be served at greater possible spectrum of range of needs to increase access to educational programs.

The type of learning that requires reflection on experience “leads to action, reflection, and testing the new learning with others” (p.46). Leaning from individual level to institutional level requires acceptance of the lessons learned and the change in actions becomes necessary (Argyris and Schön, 1996). Employing innovative ways to involve administrators, faculty and students in strategic learning throughout general chemistry courses can have an impact on evaluation and future of higher education

This action research can help to build core competencies to produce a learning chemistry department that is resilience and strategic at practicing the best ideas to learn. Promoting a learning environment opens opportunities to move the Department of Chemistry in the direction of resilience and innovation. Through addressing the challenges of general chemistry learners' achievement, a culture of openness with emphasis on the perceptions of stakeholders on learning will be promoted to accept open innovation in a faster way than competitors (Lei, Slocum, & Pitts, 1999). In this era the institution can benefit from this study to enhance competiveness and quality of educational services through empowering the change of chemistry instruction in a profound way.

Nature of the Study

According to String (2007), the action research study adapts theoretical model combined with best practices for planning and assessing a plan for change. This research study employed a cycle of action research to assist the researcher in adapting a model of best practices to develop a plan of change to improve general chemistry courses. The action research also helped to build core competencies to produce a learning institution that is resilience at practicing the best ideas to learn. This methodology was utilized to examine the following research question:

How can a proposed plan is developed to improve student engagement based on assessing perceptions of administrators, faculty, and students, with focus on the impact of chemical education on learning in general chemistry courses?

The issues questions that guide the research study to develop a plan to improve learning and teaching in general chemistry courses are:

1. To what extent are chemistry faculty members using Chickering and Gamson's (1991) Seven Principles of Good Practice in undergraduate Education?
2. What are the effects of students' approaches to learning and their beliefs about learning chemistry on the ways they engage the studying and learning process?
3. In the light of the perceptions of faculty and students, what is the role of the administrators to support a long term plans related to the proposed plan?

The research question was addressed from students, faculty, and administrators perceptions. All stakeholders of general chemistry course collaborated for developing the learning process to gain insight into student approaches to chemistry learning and studying. Examining the role of instructional and affective aspect in teaching and learning of general chemistry courses determined whether the learning environment would be successful for all students.

The researcher looked for every opportunity that enhanced transforming feedback loops to describe the desired transformation and influenced adaption of all part of the system (Stringer, 2007). As expected, a single feedback loop did not help the researcher to result in the transformation to drive the change to resiliency and innovation. Varieties of lengths of feedback were used to adjust effective communication to take advantage of feedback loops. The researcher looked for every opportunity that enhanced transforming feedback loops to establish a learning environment with the willingness to understand and adapt to the perspectives of participants through positive feedback.

Definition of Terms

First- year General Chemistry Course. An introduction to college-level chemistry with an emphasis on the mole concept, thermochemistry, atomic and molecular structure, interactions, periodic chart, organic chemistry, solids, liquids, and gases. This course is a lecture combined with lab each week.

Model I and II Behaviors. Argyris and Schön (1996) establish two models that describe theories-in-use that either inhibit or enhance double-loop learning. They describe as Model I behavior and it can be said to inhibit double-loop learning. Model II is where the governing behaviors associated with theories-in-use enhance double-loop learning.

Organizational Learning. Senge (1990) defines learning organization recognizes that their employees differ in the way they think, behave, and learn but “they create their reality and how they can change it” (p.12). In exploring the challenges to promote learning through planning action, the resulting actions belong not to one individual. It belongs to people who learn how to think together in the sense of identifying a new opportunity to promote an organizational learning.

Qualitative Research. Lincoln and Guba (2000) assert that qualitative research is an approach to “study things in their natural settings, attempting to make sense of, or to interpret, and phenomena in terms of the meanings people bring to them” (p. 3).

Single and Double-loop Learning. Single and double –loop learning are two forms will not occur if the organization not aware that learning must occur. Viewing the institutional context in term of fixing a single issue informs single loop learning as it attempts to address only this problem. In contrast, double loop leaning seeks to gain insight into the problem. In understanding, diagnosing, and framing of an organizational situation, not only the problem should be corrected but individuals in the institution should learn the reason why and work to avoid this in the future. Single-loop learning is present when values, frameworks, and strategies are taken for granted. According to Argyris and Schön (1996), this is Single-loop learning. An alternative learning is to question the governing variables themselves, to subject them to critical scrutiny describes as double-loop learning. Such learning may then lead to an alteration in the governing variables and, thus, a shift in the way in which values and consequences are framed.

STEM Education. A new vision in higher education, students must advance in science, technology, engineering, and mathematics to pursue careers in science and technology.

Strategic Learning. Strategic learning can be utilized to promote the deep change where active leadership is required to get the change implemented. The challenge of strategic learning has two types; one concerns teaching and learning and related methodology, second concerns changes in the culture of learning organization that access to leading practices across the whole system. John (2009) describes learning "starts with the individual being open to learning from experience" (p.45). This type of learning that requires reflection on experience "leads to action, reflection, and testing the new learning with others"(p.46). Individual learning becomes strategic learning when leaning is directed to vision and strategy of the organization and be shared to other teams.

Systems Thinking. Senge (1990) proposes the theory of systems thinking. Systems take the shape from the values and beliefs of the people in them. The mental models and theories of the people affect their action and interaction of the system. Systems' thinking is a framework that helps practitioners to see how they make an organization change effectively to produce a learning organization.

Thematic Analysis. Thematic analyses require interpretation from the researcher. Codes are developed to represent identified themes in the data. Themes are marked for later analysis (Guest, MacQueen, & Namey, 2012, p 10).

Assumptions

Stringer (2007) states that all members of the action research understand that they have to be engaged with the study since their insights about the change are important. To successfully execute this assertion, this study was developed based on key assumption that the role of ongoing dialogue between the participants and the researcher is more effective to conduct the study collaboratively.

An underlying assumption relates to the understanding of the role of perceptions in building a knowledge base for construction of quality education is a necessary component to improve the engagement of general chemistry learners emotionally and academically. By reflecting on experiences to build strength on the basis of own perceptions, everyone was engaged to look into deep information that can inspire learning. Looking to create a productive change is needed in order to build core competencies for the change in general chemistry course.

Limitations

This study may have a few limitations. There was internal limitation for the researcher. She was limited by her own interests with respect to the research questions and her experiences with teaching general chemistry course. A limitation was present within the study that makes the participants feel the researcher has a bias or opinion related to the purpose of the study and may not share their true perceptions of the topic. Furthermore, data gathered from self-evaluation instruments may become problematic due to the forthrightness of the participants.

Data generated from the surveys may not be accurate because extraneous variables could change the participant' perceptions from factors unrelated to the research. Additionally, the response rate on a 5-point scale may also have lead to bias because participants usually tend to agree than disagree with a statement (Suskie, 1996).

Delimitations

The action research sought to improve the level of emotional and intellectual engagement of general chemistry courses at three research sites in Southern California. The population of the research study has diverse background, both culturally and socioeconomically, of participants. A large sample from the three institutions located in the same geographic provides more information to broaden the findings of the study.

Mixed method was selected to analyze perceptions and expectations of participants' understanding of the factors affect the process of chemistry learning. Utilizing multiple measures within the study was necessary to produce valuable information about teaching and learning effectiveness in general chemistry courses. The impact of the action research study was used as an indicator for establishing the strategic initiatives from interpretive process of the issues related to measuring perceptions of general chemistry courses' stakeholders.

CHEMX, an instrument to evaluate students' cognitive expectations for chemistry learning, was utilized within the research study (Grove & Bretz, 2007). The seven clusters to measure students' prior knowledge and what they expect to do to learn chemistry were: effort, concepts, math link, reality link, outcome, laboratory, and visualization. CHEMX assisted the researcher to detect several quality gaps between chemistry faculty expectations and those for students. However, the current research was not in-depth study to lead for understanding of the mechanism of the learning process to help students bridge these gaps.

Despite the challenges to promote a blended system in which administrators and faculty collaborate to monitor the assessment of general chemistry course, the study sought to produce successful results to determine the factors that impact successful learning culture through utilizing collective work of thinking in decision making process.

Organization of the Remainder of the Study

This research study is organized in standard dissertation format. Chapter 1, the Introduction, presented the problem at the research sites, provided background and context, purpose for the study, stated the research question, and defined terms relating to institutional learning. Chapter 2, the Literature Review, provides a framework for the research study by reviewing literature as it relates to the chemistry education research and higher education leadership. The chapter is divided into sections focusing on the strategic approach utilized on the research study, based on understanding multidimensional teaching and learning aspects includes; the academic challenge of learning chemistry content, ongoing practices in chemistry instruction, integrating prior knowledge, misconception in chemistry learning, enriching educational practices, self-efficacy and chemistry learning, and supportive institutional environment. Chapter 3, Methodology, outlines the study's action research design and data analysis procedures. Chapter 4, Data Analysis and Results, provides a summary and detailed analysis of the results. Finally, Chapter 5, Conclusions and Discussion, provides a discussion and summary of the results, quality gaps are presented at different stages of the process of chemistry learning. Lastly, a recommendation on chemistry learning and instruction are presented and relates them to literature and future practice.

CHAPTER 2. LITERATURE REVIEW

Introduction to the Literature Review

According to U.S. Secretary of Education Margaret Spelling, "there is an urgent need for change in America's higher education system". Higher education institutions currently build their reputation on the quality of their programs and services. Low socioeconomic and minority groups are at risk to move institutions in the direction of resilience and innovation focused on student achievement. However, resiliency through establishing a student-centered learning environment enhances administrators and faculty effectiveness through continuous management innovation to promote a nimble institution.

In exploring the challenges to promote a nimble institution through management innovation, the resulting actions that support the planning of the new change belong to its individuals who think together in the sense of nurturing a new change (Collins, 2009). A student-centered learning environment needs innovative instructional leaders to test new insight systematically and discover how each of these new insights affects the new practice. Ability to recognize individuals' behavior and provide proper feedback for the behavior should be developed in everyone. The value of investigating behaviors and perceptions is to engineer transformation that includes different parts of the systems' institution based on student-centered learning. It is not expected that a single feedback loop will drive the change. Eoyang (1997) indicates that a variety of contexts and types of feedback will be used to convey the communication approach over time to increase the likelihood of change. Regular adjustment of effective communication to take advantage of feedback loops maintains system dynamics and complexity. However, the more quickly institutions can adjust to student' needs the more quickly they can learn from them and try to be a better institution.

The recent recession has many effects that led to several changes in higher education. It has become essential for twenty-first century students to pursue their baccalaureate degree and in demandable majors to work in an economically driven society such as health and STEM education. STEM education, a new vision in education, which looks at science, technology, engineering, and mathematics along with global perception as fundamental elements that students must advance at the college level (Executive Office of the President's Council of advisors on Technology and Science, 2010). All students involved in STEM initiatives are expected to build upon their prior knowledge to develop scientific and technological literacy, and also get motivated to pursue careers in science and technology fields.

Chemistry educators are faced to make chemistry courses more pleasant, as well as maintaining high academic standards. Improving learner's achievement in undergraduate chemistry is an important factor to help higher education students to actively get involved in science, technology, engineering, and mathematics (STEM) fields. Recent research has focused on the challenges to keep undergraduate students in STEM education, identification of the factors accounting for student's challenges (Kuenzi, 2008), as well as to increase the graduates of STEM careers (Tsui, 2007).

Understanding students' perception and their attitudes regarding quality science and technology education is needed for the previous initiatives. There is also a necessity to provide instructors with ongoing and sound support to construct multidimensional working models of learning and instruction to foster self-regulated learning. This study investigated students and faculty perceptions, focused on chemistry learning and teaching practices in first-year general chemistry courses to highlight the research that had been conducted over the last sixty years on chemistry education. This study provides an analysis of the impact of faculty and students who engage and get involved in chemistry learning and initiate a framework for further research to increase quality of first-year general chemistry courses.

Researchers and practitioners in chemistry education interested in student involvement in learning are focusing on the role of students' beliefs and prior skills and abilities during learning. Although these factors are vital, by themselves they are insufficient to explain academic achievement and student engagement among students of general chemistry courses. Chemical Sciences programs contribute significantly to support first year chemistry courses to develop educational experiences and practices that involve all stakeholders. Working collaboratively and actively, administrators, instructors, and students learn about how to improve student engagement and academic achievement in order to minimize the achievement gap between science and non-science majors.

Numerous research and studies have demonstrated that many factors play important role in determining the amount of effort students invest to be involved and engaged in learning (Bandura, 1986). The educational research and practice on which this research study based on follows the elements associated with student learning and engagement related to general chemistry courses. Involvement in a multidimensional approach of learning chemistry in the line of student engagement and a supportive campus environment are key factors discussed together, indicating how they effected student motivation and learning in general chemistry courses.

This chapter will review current literature, seeking to illuminate how the collaboration between faculty members, students, and administrators improve teaching and learning of first-year general chemistry courses, using the best student engagement practices in higher education. Beginning with an insight offered by chemistry education researchers, this chapter will describe thoughts of chemistry researchers and faculty members on their instructional practices to decrease chemistry misconceptions that can improve chemistry learning and teaching.

Investigating students' self-perceptions of their academic skills will be also discussed to demonstrate factors that can develop their motivation for learning. Progressing through the literature, the chapter will explore insights of chemistry education researchers to address the challenges for teaching and learning of first –year college chemistry students.

Theoretical Framework

Faculty and students normally bring to chemistry learning environment a variety of factors that affect the process and the outcome of chemistry learning. This chapter reviews the literature underlying the factors affecting chemistry teaching and learning that aim to determine characteristics of chemistry learners such as attitudes, beliefs, cognitive style, and self-regulated effect. In a diverse context such as the context of the research study, perceptions, attitudes and cognitive expectations toward chemistry teaching and learning are essential to be investigated. Individual differences are central to the framework that differentiates behavior and attitude toward teaching and learning. The framework demonstrates individuals with high cognitive abilities have low social skills and high self- confidence to do well in science because of the favorable cognitive style and attitudes (Witkin, Moore, Goodenough, & Cox, 1977). However, individuals who develop more social skills have low cognitive abilities and are concerned more with principles of knowledge.

The individual differences whether between faculty members or students affect behavior toward teaching and learning in cognitive, metacognitive, social, and affective aspects of the instructional approach. Although this effect is multipolar, each pole has characteristics that can adjust chemistry instructors and learners to actively engage in chemistry instruction. The strategic approach utilized on the research study, based on understanding of multidimensional teaching and learning aspects includes the academic challenge of learning content, ongoing practices in chemistry instruction, integrating prior knowledge, misconception in chemistry learning, enriching educational practices, self-efficacy and chemistry learning, and supportive institutional environment.

Review of the Research Literature and Methodological Literature

The Academic Challenge of Learning Chemistry Content

Studies in chemistry education research invite researchers and practitioners to expand their investigations between process and content to better understand how students and instructors engage in more meaningful learning of chemical thinking and doing (Herron & Nurrenbern, 1991). Looking for difficulty in chemistry, the nature of chemistry content was causing problems for students in high school and still exist as students advance to college (Johnstone, 1997, 2006, 2010). Students expressed “I can’t understand chemistry” and “I will never understand chemistry”. Because many students struggle to learn chemistry, they don’t succeed in the general chemistry course and leads to dropout from chemistry courses in first year of college.

Looking for reasons of difficulty, topics and subtopics in chemistry such as Thermochemistry and chemical equilibrium require analytical and conceptual understanding in the line of problem-solving approach. Other topics such as Stoichiometry may need mathematical manipulation to support accurate analysis. Looking for the common factor, the complex analysis is apparently emerging and requires a framework to connect it together (Johnstone, 1982, 1991, 2006, 2010). Chemistry education research has provided usable models applicable for chemistry content processing to guide chemistry educators for limitations of learning.

Atkinson & Shiffrin (1968), Ausbel (1963), Ashcraft (1994), and Johnston (1991, 1993, 2006, 2010) all focus on human learning and the process of cognition to retrieve and store information for enhancing learning. The flow of information can be seen through three-stage system of perception filter, the working memory, and the long-term memory. The perception filter only admits relevant input to a busy working memory based on the information that is stored in long term memory. Ausubel, Novak, & Hanesian (1978) emphasize the notion of prior knowledge and how it enables recall information from long-term memory to interact with the new relevant information. However, the information attended working memory can be easily disrupted and retained briefly. On the other hand, information processed from the working memory can be stored in the long-term memory if it attached to prior knowledge.

When the new information integrates correctly to existing knowledge a retrievable and meaningful learning occurs. From Ausbule's view, learning can be meaningful only when the new knowledge of a concept can be linked to learner's previous knowledge related to the concept. The process of constructing knowledge in science education involves using the learner's previous knowledge and the real-world contexts to advance knowledge and understanding that will motivate meaningful learning (Ernest, 1995). Constructing a process of well integrated, retrievable, and meaningful learning is the heart of deep learning in chemistry.

Deep learning approach as described by researchers such as (Biggs, 1993; Entwistle & Ramsden, 1983; Nolen 1988), represents active learning and engagement techniques to help students connect new information with prior knowledge and master their learning. In the deep approach, students relate ideas and knowledge to examine the logic of argument in order to monitor their own learning. However, prior knowledge is not the only factor that is dependent on student engagement and learning. Students' attitudes and motives including their perceptions of learning are also essential to enhance deep learning.

The emerging framework of students' approaches to learning as student perceptions and learning-related activities is central to "student approaches to learning" (SAL) theory (Biggs, 1993; Entwistle & Waterstone, 1988). The multidimensionality approaches to learning (Biggs, 1978) include factors of student involvement that affect deep learning. Prior knowledge, abilities, and students preferred approach to learning, the nature of the content, method of teaching and assessment, the institutional climate and procedure are the factors interacting to determine the learning outcome of a particular practice or task (Figure 1).

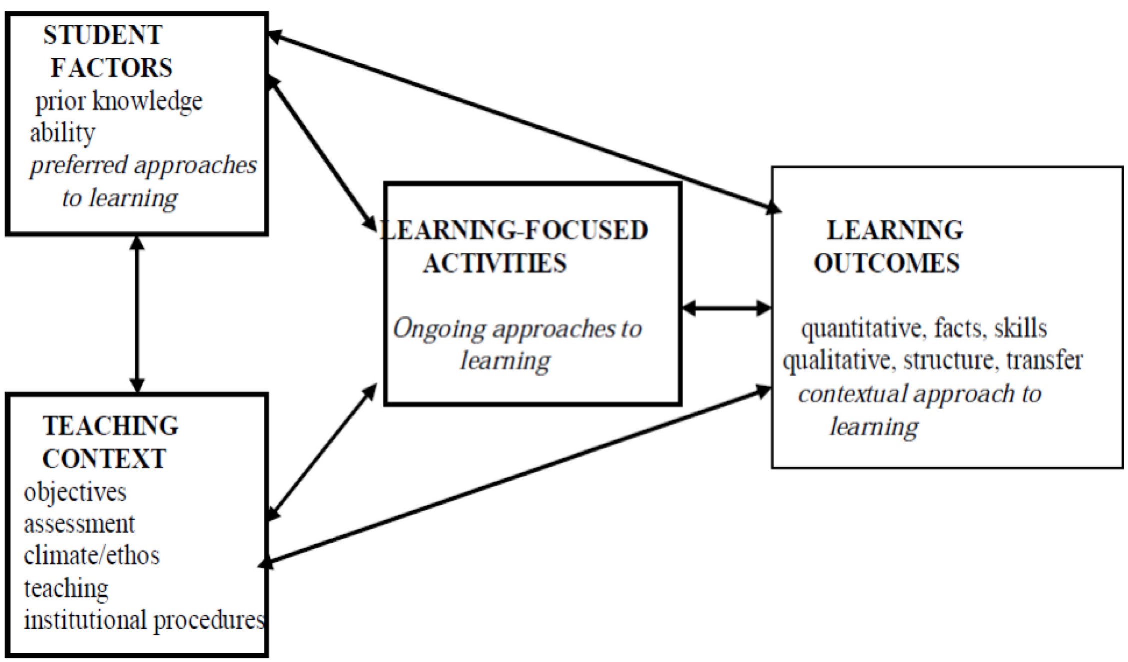

Figure 1. Biggs' Model of Teaching and Learning. From "The Revised two-factor Study process Questionnaire: R-SPQ-2F", (p. 136), by Biggs, J. B., Kember, D., & Leung, D.Y.P. (2001), British Journal of Educational Psychology.

Research in student learning led to construction of inventories to assess approaches to learning. The inventory utilized in this research study is the revised two-factor Study Process Questionnaire R-SPQ-2F that was developed to examine the multidimensionality of approaches to learning (Biggs *et al*., 2001). The questionnaire includes factors prior to engagement that affect learning. Prior knowledge, abilities, student preferred approach to learning, the nature of the content, method of teaching and assessment, the institutional climate, and procedure are the factors interacting to determine student learning outcome.

R-SPQ-2F yielded two main approach scores: Surface, and Deep, with a component Motive and Strategy score for each. The hierarchical factor structure of the revised R-SPQ-2F is shown in Table 1.

Deep Approach (DA) has two sub-scales:
Deep Motive (DM)
Deep Strategy (DS)

Surface Approach (SA) has two sub-scales:
Surface Motive (SM)
Surface Strategy (SS)

Table 1. Biggs Hierarchical Factor Structure of the Revised R-SPQ-2F. From "The Revised two-factor Study process Questionnaire: R-SPQ-2F", (p. 135), by Biggs, J.B., Kember, D., & Leung, D.Y.P. (2001), British Journal of Educational Psychology.

Deep Approach (DA)		Surface Approach (SA)	
Deep Motive (DM)	Deep Strategy (DS)	Surface Motive (SM)	Surface Strategy (SS)
Intrinsic interest Commitment to work	Relating ideas Understanding	Fear of failure Aim for qualification	Minimizing Scope of study Memorization

The major challenge of learning chemistry content is that knowledge individually reconstructed in what the student comprehends as a new material. This is affected by existing knowledge, beliefs, motives, and misconception in the mind of the student. In addition, reconstruction of chemistry knowledge requires a process of memorization where processed material is recalled from long-term memory to help with the processing of the working memory. An example of this information processing is necessary in chemistry problem solving that requires linear memorization for students to relate. But this process is not swift, needing a lot of time and effort

A type of memorization occurs in chemistry learning when students cannot relate the new knowledge leading to rote learning. Such strategies include memorizing facts and information until the material can be recalled for examination. This surface approach to learning, as described by (Biggs, 1993; Entwistle & Waterstone, 1988), can become a way to cope minimally with the course requirements, which is mainly routine memorization. If the learner sees that it is important to be stored, the information enters long term memory as rote information, which is difficult to recall.

On Going Practices of Chemistry Instruction

Johnstone (2006) discussed the fate of the information in the working memory without link to long-term memory. If the learner recognizes that it is important to be stored, the information enters long term memory but it is difficult to recall. To alleviate this challenge, Johnstone proposed a model of chemistry knowledge to be used by researchers and practitioners to help students grasp a chemical phenomena in three domains: macroscopic, submicroscopic, and symbolic. The model has three domains of knowledge:

> Macroscopic: a tangible and touchable level of understanding encompassing what students can observe such as color change.

> Particulate or sub-microscopic: refers to invisible or molecular or atomic interaction that convey two or three-dimensional information.
>
> Symbolic or representation: this refers to mathematical representations including equations, diagrams, and or tables combined with chemistry symbols used to represent elements, compounds, and state functions, etc.

Johnstone (1991, 2009) and Gilbert & Treagust (2009) assert that the domain for a concept can be represented with a triangle or the triplet relationship in which each correlates to a domain represented by the sides of the equilateral triangle. Figure 2 is an example of Johnstone's domains for representation of chemical phenomena demonstrated in a chemical research study about students' understanding of atomic emission (Mayo, 2013). In her dissertation, Ana Mayo presented Johnstone's domains to gather students' explanations during macroscopic (visible), particulate (invisible), and symbolic (diagram) levels of understanding.

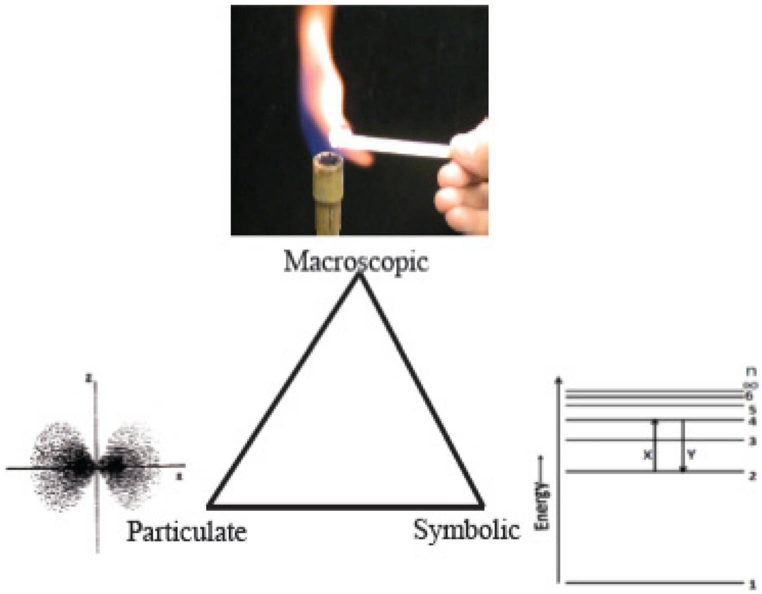

Figure 2. Johnstone's domains for a concept. From "Atomic emission misconceptions as investigated through student inventories and measured by the flame test concept inventory" (Doctoral's dissertation), (p. 6), by Mayo, A. V. (2013), Available from Ohio Link.pdf. (No. Miami 1362754897)

The notion that chemical knowledge can be represented in three main ways: macro, particulate or sub-micro, and symbolic (chemistry triplet) has become paradigmatic in chemistry education. According to (Johnstone, 1991, 2010), this triplet relationship has been the subject of different adaptations and reinterpretations that sometimes lead to confusion and misunderstanding, which complicates the analysis of the triplet's nature and scope. However, the model is still useful in the analysis, evaluation, and reflection of educational research results and teaching practices in chemistry education research.

Research has been shown that there is a difficulty in transferring the chemical knowledge between the three domains (Kelly and Jones, 2008). The interpretation of a symbolic or representation is contextualized in the field of chemistry. However, studies of teaching with multiple representations such as equations or diagrams have revealed a variety of challenges of teaching and learning to transfer understanding from one context to another. Effective pedagogies to help students develop conceptual understanding relevant to the representation are needed to interpret the representation (Ainsworth, 1999).

In her work on the functions of multiple representations in learning and teaching, Shaaron Ainsworth states that multiple representations can help practitioners to construct deep understanding, constrain and focus interpretation, or complement one another. Thus, designed instruction using multiple representations can be very effective in advancing and maintaining students' scientific knowledge.

Chemistry learning involves the use of visualization to understand and connect representations at macro level (color change, etc), particulate or submicroscopic level (atomic interaction, etc), and symbolic level (equations, diagrams, etc). However, numerous researchers note students understanding across multiple representations maybe problematic (Nakhleh, Samarapungavan, & Saglam, 2005). Novice students find linking related concepts and level of representations or symbolic a challenging endeavor (Kozma & Russel, 1996). Conceptual understanding from multiple representations is vital to integrate the learning environment to real life experiences and connect with prior knowledge to build a deeper understanding (Ainsworth, 1999, 2006).

Adding visualization with multiple representations to instructions increases chemistry learning of varying topics to help students connecting between different representations with their understanding of multiple representations (Seufert, 2003). However, students must develop the skills to read and interpret multiple representations through increasing visual fluency using effective pedagogies. Research presents visualization tools for teaching chemistry to increase student's visual fluency to use multiple representations and reasoning from multiple perspectives.

Building multiple representations is essential for chemistry learning and teaching to help students read across representations and make interpretations from a set of multiple representation categories such as symbolic, numerical, and/or schematic experimental procedures. (Johnstone, 1997, 2006) combined with (Ainsworth, 1999, 2006) provide new ways of guiding and adding multiple representations to construct deeper understanding from multiple perspectives within and across domains in the context of general chemistry learning and teaching as in Figure 3.

TABLE 19.3 • How Signs of ΔH and ΔS Affect Reaction Spontaneity

ΔH	ΔS	$-T\Delta S$	$\Delta G = \Delta H - T\Delta S$	Reaction Characteristics	Example
−	+	−	−	Spontaneous at all temperatures	$2\,O_3(g) \longrightarrow 3\,O_2(g)$
+	−	+	+	Nonspontaneous at all temperatures	$3\,O_2(g) \longrightarrow 2\,O_3(g)$
−	−	+	+ or −	Spontaneous at low T; nonspontaneous at high T	$H_2O(l) \longrightarrow H_2O(s)$
+	+	−	+ or −	Spontaneous at high T; nonspontaneous at low T	$H_2O(s) \longrightarrow H_2O(l)$

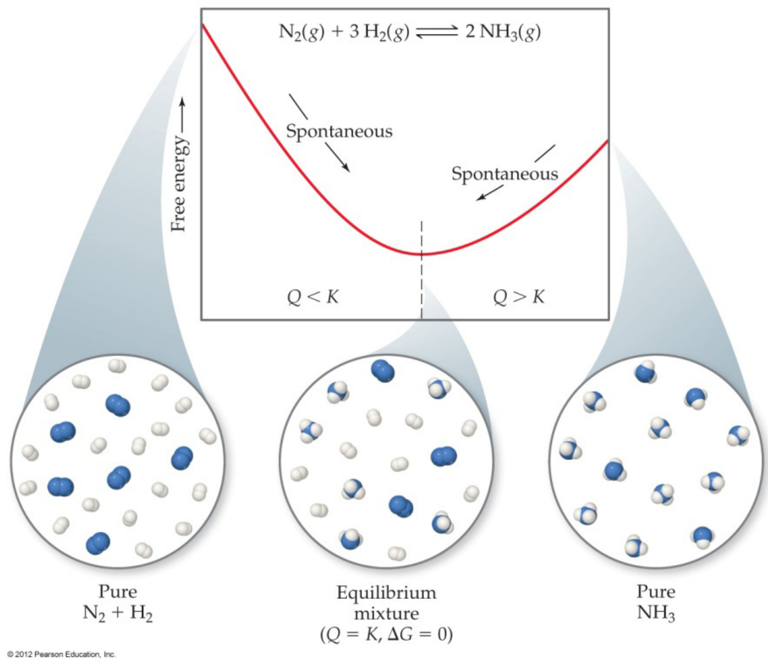

Figure 3. Multiple Representations from First-year General Chemistry Course Display Symbolic and the Particulate (Sub-micro) Representation of State Functions. From "Chemistry: The Central Science", (p 132), by Brown, T. L., Lemay, H. E., Bruce, B., Murphy, C., Woodward, P. (2012), Pearson, Prentice Hall. Available at MasteringChemsitry, www. Masteringchemistry.com

(Kosma, Chin, Russel, & Marx, 2000) assert the notion that visual literacy or fluency is the ability to read and interpret multiple representations to relate symbolic representations to basic domains to improve conceptual understanding that links the transfer of understanding between domains.

Integration of Prior Knowledge

Creating a cognitive model of learning chemistry at a college level needs to include understanding the difference between concepts. Students should know that they have to comprehend a concept at multiple levels until they clearly understand it. Chemistry education research presents several models of learning to deal with student's difficulty of learning chemistry concepts (Tasker & Dalton, 2006; Herron & Nurrenbern, 1991; and Treagust et al., 2011). If chemistry instructors do not help their students realize that specific concepts in chemistry relate to an underlying assumption of theories and models, then many subjects do not make conceptual sense and are learned by rote.

Chemistry education research in conceptual understanding of chemistry is based on a cognitive model of learning in which students actively construct knowledge or constructivism (Boudourides, 2003). According to constructivism theory, assessing student's prior knowledge is a vital factor in the process of learning (Ausubel et al., 1978). The new knowledge can be accommodated with prior knowledge if the learners are alert of any differences between what they need to know and what they already know. (Wheatly, 1991) asserted constructivism is "knowledge is not passively received but it is actively built up by the cognizing." The construction of knowledge is the major element of constructivist theory where students take responsibility to generate their own learning based on their beliefs, attitudes, and experiences (Glasersfeld, 1989). The challenge for faculty members in higher education is how to design learning models and frameworks that result in maximal learning (Herron & Nurrenbern, 1991).

Scientific researchers have seen educational constructivism and social constructivism as the two main forms of constructivism theory encompassing the domain of scientific learning. Educational constructivism views knowledge as a tool that is actively built and helps the learner understand natural phenomena (Driver & Oldham, 1986). From Ausbuel's view, learning can be meaningful only when the new knowledge of a concept can be linked to learner's previous knowledge related to the concept. The process of construction knowledge in science education involves using the learner's previous knowledge and the real-world contexts to advance knowledge by constructivist instruction that will motivate meaningful learning (Ernest, 1995).

Murphy (1997) defined learning as a process and not a product of constructing meaningful representations of the individual's experiential world. Social constructivism views each learner as a unique individual with responsibility to learning and emphasized that learners sustain their motivation to learn based on their potential for learning (Glasersfield 1989). Novak's human constructivism reveals that learners' experiences across the cognitive and affective learning domains are needed to construct meaningful learning. For meaningful learning in chemistry, prior knowledge about the topic and the learner' attitudes and beliefs about the topic are needed to build meaningful knowledge. Instructors within social constructivism have to act as facilitators to provide the learner guidelines to understand the content and establish the condition for learners to construct their own understanding (Brownstein, 2001).

On his framework, Biggs (1999) argues for the constructive alignment that stresses the importance of the outcome of the course and individual understanding of teaching and learning culture. Constructive alignment represents a marriage between a constructivist understanding of the learning process, and an alignment for outcomes-based instruction. Learners construct scientific meaning from what they do to learn and realize the importance of connecting new material to conceptual understanding.

Chemistry instructors makes an alignment between the planned learning activities and the learning outcomes. Due to the fact that learning, instruction, and assessment criteria are all connected, (Kellogh, Kellogh, 1999), it is a vital effort to provide the learner with a clearly specified outcome, well designed learning activities that are appropriate for the outcome, and a well prepared assessment criteria for giving feedback to the learner.

Misconception in Chemistry Learning

Effective learning practices in chemistry education must involve conceptual understanding of chemistry knowledge. Students may construct their own understanding of chemical concepts, sometimes differing from the one that the instructor has tried to present (Nakhleh, 1992). As such, they are not constructing basic meanings of chemistry terms in order to understand the more advanced concepts that can be constructed upon basic knowledge leading to misconceptions.

Misconception is conceptual knowledge that is inconsistent with scientific consent and unable to be interpreted via scientific phenomena. These misconceptions hinder the learning process and students connecting new information into cognitive learning that the new information cannot be connected to prior knowledge (Johnstone, 1991). Yet, weak conceptual understanding or misconceptions will occur.

According to metacognitive model of learning, misconceptions occur when students come to chemistry classes holding everyday meanings that differ from the scientific meaning. An example to explain oxidation and reduction in various terms is displayed in Figure 4, as the gain or loss of oxygen, as a change in oxidation number, or as the gain or loss of electrons. Thus, chemistry instructors should demonstrate the differences between the scientific meaning and the meanings for everyday terms for which students hold misconceptions. Through multiple representations, as demonstrated in Figure 4, they need to be precise when interpreting chemistry topics with differing aims to help their students master different meanings for the same concept.

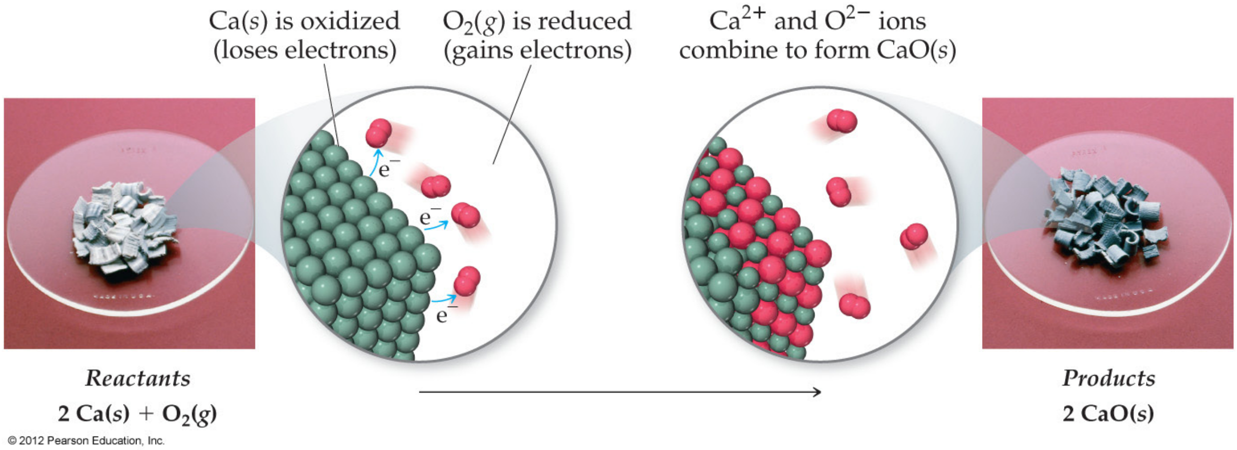

Figure 4. Oxidation-Reduction in Various Terms: as the Gain or Loss of Oxygen, as A Change in Oxidation Number, or as the Gain or Loss of Electrons. From "Chemistry: The Central Science", (p 805), by Brown, T. L., Lemay, H. E., Bruce, B., Murphy, C., Woodward, P. (2012), Pearson, Prentice Hall. Available at MasteringChemsitry, www. Masteringchemistry.com

Assessment for misconceptions includes examinations that would measure students' learning. Students also would have enhanced their critical thinking and reasoning skills for more understanding of the concepts. Conceptual understanding can be built from the macroscopic and gradually be advanced to the submicroscopic and representational aspects (Johnstone, 1997, 2010). Conceptualization can be displayed in multiple representations where a summary-diagram involved macroscopic (concepts; ionic bonding, etc), symbolic (names; KBr), and particulate (ion, molecule, polar molecule, etc) aspects. A schematic of multiple representations used to display an important concept in the general chemistry course to construct deep understanding of intermolecular forces concepts as demonstrated as in Figure 5.

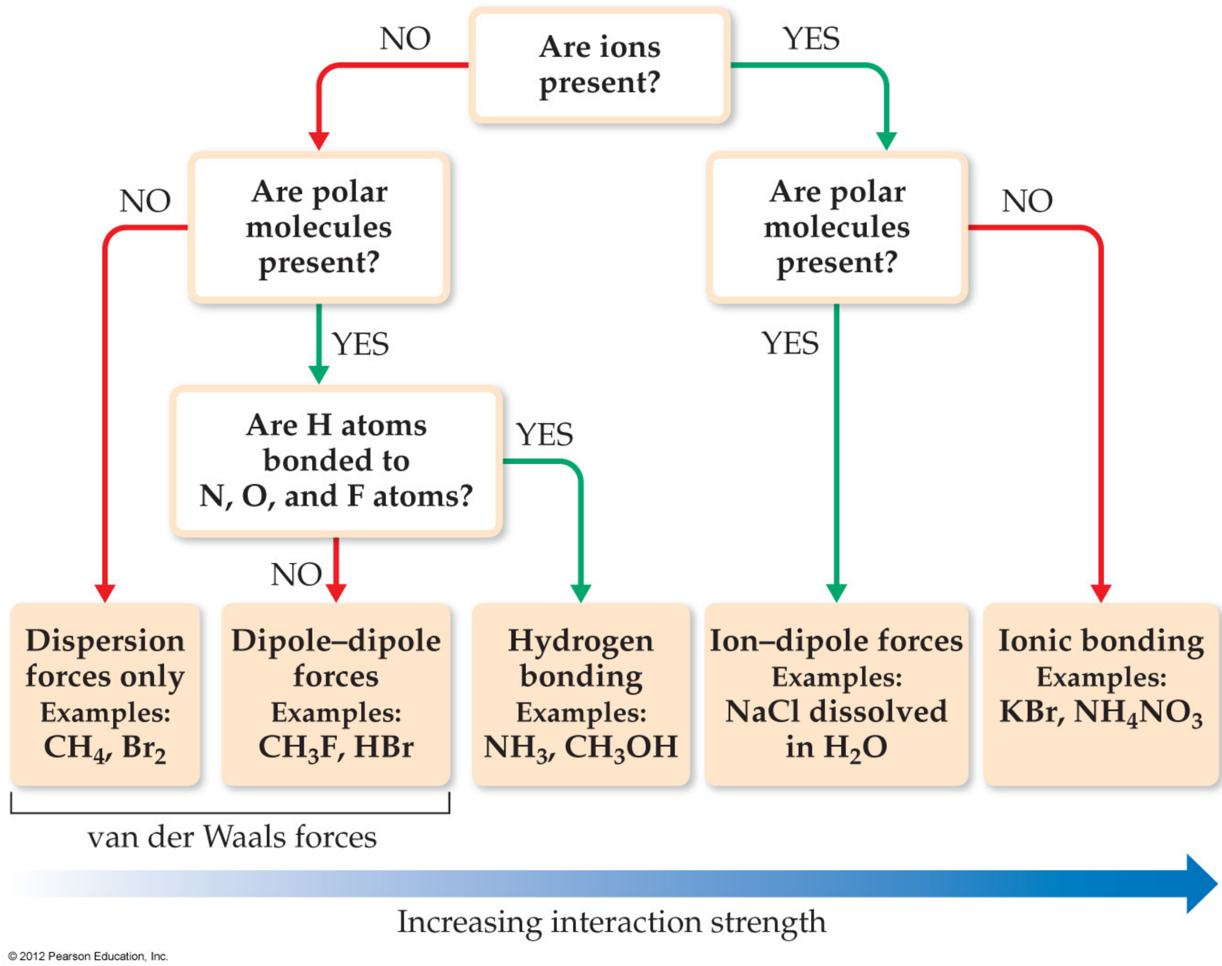

Figure 5. Summary of Multiple Representations Displays Concepts of Intermolecular Forces. From "Chemistry: The Central Science", (p 435), by Brown, T. L., Lemay, H. E., Bruce, B., Murphy, C., Woodward, P. (2012), Pearson, Prentice Hall. Available at MasteringChemsitry. www. Masteringchemistry.com

However, multiple macroscopic, microscopic, and representational aspects of chemistry concepts could lead to misconception because of the load of information on students' long term memory during the process of learning chemistry. Although the aspects of a concept in chemistry can be presented with a triangle in which each corner corresponds to a certain aspect, the connections between aspects are represented by the sides of an equilateral triangle, which may be problematic for students' understanding of the connection between the three aspects.

One assumption of the traditional instruction such as lecture format is that students had an opportunity to learn the concepts, but did not grasp them. This model of instruction is focused more on factual knowledge with the goal of content coverage and memorization without understanding. Chemistry researchers apply the theory of constructivism to engage students in meaningful learning experiences, increase students 'motivation to learn, and promote self-efficacy for learning chemistry.

Shifting the instructional focus to conceptual understanding using related critical thinking and problem solving could value student inquiry to support meaningful learning. Meaningful learning occurs when learners know how to relate new factual knowledge to other stored knowledge in contrast to rote learning where they memorize without understanding because the new factual knowledge does not relate to other stored knowledge.

Considering multidimensional domain of chemistry education, which includes a shifting of chemistry instruction in multiple ways based on cognitive, metacognitive, social, and affective domains of learning, offers potential impacting learners in general chemistry courses. This approach in teaching and learning relies on student-centered and active learning, helping students to construct deep understanding of factual knowledge in the context of conceptual learning and application of chemistry disciplines.

Academic achievement for all students has been a major challenge in chemistry teaching and learning endeavors. To alleviate this challenge of student success, changes in chemistry learning approaches are needed to promote a supportive culture that ensures effective educational practices that have touched a large number of students in meaningful ways. This is vital to get a sense of the extent to which chemistry faculty members adapt certain instructional practices for their unique environments and context. To attain such a goal, chemistry departments in higher education institutions look into effective models in learning chemistry that support the development of chemistry education as well as activities that integrate all stakeholders as students, faculty, and administrators.

Enriching Chemistry Educational Practices

Chemistry faculty members recognized the difficulties with their students and wondered why they got into this situation of uncomprehending students. An example such as formal power point presentation does not allow students to interact and display their misconceptions of chemistry topics. If students are presented with methods that are only based on short-term memory, it is difficult to search for differences between students' knowledge and misconceptions about chemistry topics after instruction.

The starting point should begin to meet the students where they are, with their interests and knowledge, and lead them to explore new thoughts among their experiences. Instructors need to try to find the way they present the chemistry subject so that students will learn chemistry with enjoyment. The challenge will be to incorporate teaching and learning methodology that can help instructors be sure that students have comprehended and reexamined what is taught so students are not put off by general chemistry courses early.

When chemistry faculty members confront academic challenges of chemistry instruction in general chemistry courses to motivate learning, the obstacle becomes students coming with expectations of learning that are divergent from that of faculty. According to Maitland Schilling and Schilling (1999), these expectations are formed by high school experiences where students are not expected to put effort and time on learning. Chemistry education researchers have stated that cognitive expectations on learning chemistry play a vital role in student achievement in any particular course.

Specifying expectations in cognitive learning of chemistry is important to identify expectations' gap between faculty members and students. Grove& Bretz (2007) have developed the Chemistry Expectations Survey (CHEMX) that consists of seven clusters, each representing a distinct dimension of expectations about learning chemistry (effort, concepts, math link, reality link, outcome, laboratory, and visualization). Utilizing CHEMX to measure students' knowledge about what they will be expected to do to learn chemistry can detect gaps between faculty expectations for learning and those of students, as well as measure changes in students' expectations across chemistry courses.

Technology is helpful to communicate higher expectations for students and in emphasizing time and effort on task to sharpen their skills and cognitive abilities. Such institutions examine data from faculty and students on academic expectations to assure faculty expectations are embedded into institutional culture (Maitland Schilling and Schilling, 1999). Communicating high expectations of knowledge, skills, and abilities of student learning shape the pedagogy and prepare students for the chemistry classroom (Barrowman, 1996).

Chickering and Gamson (1987) summarized seven principles of good practice in undergraduate education, which build on the foundation of student engagement. The seven principles of good practice in education provide a framework for student-centered learning. The first principle is student-educator interaction, which promotes interaction between the student and the educator to develop the learning process. The second principle is cooperation among students, which promotes learning from interaction among peers. The third principle is active learning, which encourages the learner to be actively involved with the learning process, thus learning faster and maintaining knowledge longer. The fourth principle is time on task, which ensures that the learner is spending sufficient time engaged in the course materials to obtain objectives and outcomes. The fifth principle is feedback, which includes meaningful interactions between learners and peers and educators. The sixth principle is high expectations, which are communicated by the educator to the learner to have ambitious goals toward success. The seventh principle is respect for diverse talents, which facilitates learning while learners and educators respect different ways of learning styles and cultural values.

The lliterature shows that increased faculty-student contact increases student performance and satisfaction with college experience. At the blackboard, faculty-student contact prepares the students for instruction, interesting demonstrations, and increases performance. An early connection between faculty and students helps to know the students, answer their questions, and confront their academic challenge. Emails and discussion boards have allowed students to openly communicate and improve faculty-student interaction (Chickering & Ehrmann, 1996). It also has been found that students in the sciences tend not to value faculty interaction as highly as those in other disciplines such as psychology (Neumann & Finaly-Neumann, 1990). However, students need prompt feedback on performance especially at the beginning of a semester and frequent feedback throughout the course.

Technology can be an effective tool to provide feedback in many ways such as email for faculty-to-student contact. Email can be used for asking questions and for receiving grades and comments to provide an access for prompt feedback. In addition, effective time management skills are essential to improve student learning. Students are likely to be engaged during laboratory and group work and therefore time on task was found to increase during academic challenges of chemistry learning and teaching.

Cooperative Learning

Research has suggested study groups, collaborative learning, and group work can all be utilized through face-to-face interaction, email, and discussion boards. Light (2001) suggests that chemistry curriculum requires incorporating small group work after lab experiments to promote more attraction with other students. Michaelsen (1998) identified three ways to use group work effectively: "1) promoting individual and group accountability; 2) using assignments that link and mutually reinforce individual work, group work, and total class discussions; and 3) adopting practices that stimulate give-and-take interaction within and between groups"(p. 1). The extent to which group work stimulates students to new perspective from their peers depends on the degree to which the instructor uses assignments such as worksheets to foster group interaction.

The instructor's role is to choose diverse groups and assign them according to individual strength and weaknesses. Studies were conducted to assess undergraduate student perception of suitable instructional methods that will increase their knowledge and skills. Many practitioners suggest ideas for effective instructional methods. Cooperative learning has been used as an effective and successful instructional method to positively affect student achievement and social development. Millis and Cottell (1998) provide step-by-step strategies for using cooperative learning in the classroom. They also involve ideas for using cooperative technology to encourage deep learning. In their book, Millis and Cottell (1998) provide examples for how technology can be emerged with cooperative learning to build electronic learning communities and enhance learning.

The theory of constructivism gives rise to a 'community of learners' model within educational settings. A model of a community of chemistry learners where students in search of conceptual understanding communicate current thinking with others by formulating and reformulating their thoughts based on peer and expert feedback and by reflecting on that feedback. This model proposes a definition of knowledge as dynamic and socially constructed and rejects a definition of knowledge as static. “Community of learners” model also requires a platform on the part of the instructor to maximize the likelihood that meaningful learning will occur. Some level of dissonance must be established either through peers’ sharing diverse perspectives or through teacher prompts to highlight sources of cognitive dissatisfaction. The task must be within the reach of the learners, yet more advanced than any individual’s ability within the group to likely complete independently.

Active Learning

Bonwell & Eison (1991) defines active learning as student involvement in their learning to develop skills and attitudes. Examples of active learning strategies in chemistry are discussions, cooperative learning, visual-based instruction, problem solving-based instruction, computer-based instruction, and incorporating reading and writing to get students involved in higher critical thinking skills. Active learning permits for improvement in both faculty and students. As faculty members learn new strategies of implementing active learning, students will benefit and faculty recognizes materials from multiple perspectives.

Respect for Diverse Talents and Cultural Differences.

Chemistry instruction needs careful instructor knowledge of demonstration techniques such as questioning and discussions designed to challenge students. Instructors should have awareness of the learning style of their students as well as their own actions related to their students’ cultural experiences. Recent research has been conducted on learning styles, attitudes, and beliefs, but it has been found that students learn in environments matching their experiences and expectations. There are multiple ways to multidimensionally approach chemistry courses.

Laboratory is an outstanding method of chemistry instruction that focuses on student-centered learning to create supportive climate and motivate students to learn.

Studies in chemistry education research invite researchers and practitioners to expand the scope of their investigations between processes and content to better understand how students and instructors engage in more meaningful learning, thinking and performing. Researchers and practitioners in chemistry education, who are interested in student learning, are focusing on the role of students' beliefs and prior skills and abilities during learning. Although these factors are vital, by themselves they are insufficient to explain academic achievement among students of general chemistry courses.

Gutierrwz & Rogoff (2003) propose two culturally responsive teaching strategies for planning instruction based on cultural styles and repertoires of culturally-based experiences. Analysis presented in the literature demonstrates the inferences that students of specific ethnic groups have the same learning style. For example, Jordan & Eleanor (1995) presented a suggestion that the conclusion from literature is that African-Americans and Hispanic-Americans are field-dependent learners. However, an important question may arise: does their analysis demonstrate that students of specific ethnic groups have the same learning style?

It has been shown that many factors play a role in determining the amount of effort students invest in learning (Bandura, 1986). The educational research and practices on which this research study is based follows key factors associated with educational practices and effectiveness related to general chemistry courses. Involvement in a multidimensional approach to teaching along with a supportive campus environment are discussed together for three institutions, showing how these factors affect motivation and learning in general chemistry courses and providing strong answers to the research questions.

Self-efficacy and Chemistry Learning

The current research study focuses on the role of student's thought and beliefs while learning to enhance motivation and improve learning. Self-efficacy refers to "beliefs in one's capabilities to organize and execute the courses of actions required producing given attainments" (Bandura, 1997, p.3). According to self-efficacy theory, the behavior is determined by individual's expectations of self-efficacy. Efficacy expectations are cognitive products of social learning effects resulting from expectations of personal capability to a particular academic task.

Expectations can be seen as being formed based on information gained through experience or action. Many students suffer from lower self-efficacy for improving their chemistry learning and it may be difficult to determine improvement. Students with a lower self-efficacy may also view increased effort as an indicator of low ability and be drawn to the simplest of tasks to avoid failure (Dweck,1999). Research has demonstrated the effect of self-efficacy on student's academic learning and achievement (Schunk, 1995). Self-efficacy for learning chemistry emphasizes the effect of learner's performance and expectations about learning. Students usually rely on their instructors' feedback for progress.

Supportive Institutional Environment

The need for change in higher education is related to accountability pressure within the current system. As undergraduate education continues to grow to provide access to diverse educational opportunities, traditional lectures might be adjusted to recognize that learning is not a one-format-fits-all. According to Smith (2005), the challenge for educators is to transform their practices and gain the appropriate knowledge and skills necessary to become successful practitioners. But, faculty and leaders overlook the major challenge of teaching and learning; lower student achievement in science courses versus none-science courses.

Promoting a collaborative effort to create productive practices that improve learners' achievement in general chemistry courses begins with assessing perceptions of administrators, faculty, and students to develop innovative ideas that could produce sustainable accountability. Shephard (2008) suggests that not only educational theories could benefit education for sustainability but also perceptions and attitudes related to educational endeavors help educators reflect on how to use effective learning and teaching approaches. According to Shephard (2008), it is recommended to "draw some generic conclusions from multidisciplinary literature to identify key aspects of effective domain teaching that could apply to education for sustainability" (p. 82). He interprets four areas of interest: "assessment and evaluation, academic credit for effective outcomes, role for role models, and designing learning outcomes in the effective domain" (p. 82).

Synthesis of Research Findings

Chemistry Education Research (CER) has recognized the significance of reforming practices into a developed platform to foster teaching and learning in chemistry. Maintaining the prolific and developing additional practices produces quality ideas on an ongoing basis. For example, in the past a substantial number of students were able to complete their education with exposure to computers since some of these students preferred this route, while others did not have access to computers (Treadway, 1996). In today's academic setting the availability of highly developed computers and multimedia instructional approaches has broadened the prospects of students and also has changed the means educators can approach teaching and learning.

Advancements in technologies have an impact on faculty to expand the education process. According to Keengwe & Kidd (2010), it is critical for faculty not only to learn the technologies associated with learning, but also, understand the need for changing their pedagogical strategies to meet the needs of students. It is also important to remember that higher education courses require a great deal of time from instructors. Chemistry instructors must be able to commit to putting time on course preparation, course management, and student assistance. Without such commitment from instructors and administrators, the course itself and students will not be successful.

The theoretical framework that informs this research project represents examples of developed practices to address the gap in chemistry teaching and learning of general chemistry courses. Learning about specific areas to improve the current teaching and learning systems inspires a collaborative effort to achieve new experiences that improve learners' engagement in general chemistry courses. An example of a specific quality standard for good practices in teaching proposed by the American Federation of Teachers is higher education should introduce and implement a discrete and specific quality assurance plan for teaching and learning.

For measuring student satisfaction, three important factors should be considered: satisfaction with the instructional methods, satisfaction with the quality of the course, and satisfaction with the outcomes of learning. Instructional methodology is a major factor affecting the performance of students. Undergraduate students see general chemistry as a challenging science course. The performance of students is often not up to the expectations of the instructors. Maitland Schilling and Schilling (1999) state that few higher education institutions have communicated clear expectations of the knowledge students are to grasp. Therefore, conduction of quantitative and qualitative studies of student-expectation versus experience survey to assess how much teaching and learning met student' expectations can be helpful to measure the success of a general chemistry course.

Qualitative interviews are also needed to measure the effectiveness of the course. Examining students' experiences and expectations to provide a learning environment can be a determining influence in their learning. Barrowman (1996) states when instructors face problems with implementing instructional methodologies to focus on student learning. A major difficulty is that faculty expectations for the student are defined beyond the institutional level. She suggests making public their expectations for student learning and to use these expectations to develop instructional approaches. This notion results in student learning that can be assessed and students will understand what they are to learn when instructions are prepared to align with those expectations.

Chapter 2 Summary

Learning in general chemistry courses requires students to be actively involved in all stages of the learning process. Active learning inspires cognitive skills such as critical thinking and analysis (Bevis, 1989). Bonk and King (1998) used constructivism theory to guide learning that can occur as learners actively build on a student-centered approach. Areas of difficulty were causing problems for students to advance to college. Because many students struggle to learn chemistry, they don't engage in a general chemistry course and this leads to dropout from chemistry courses in the first year of college.

Chemistry education research (CER) in conceptual understanding of chemistry is based on a cognitive model of learning in which students generate their own learning based on their beliefs, attitudes, and experiences. Students may construct their own understanding of chemical concepts sometimes differ from the one that the instructor has tried to present. Therefore, they are not constructing basic conceptual meanings of chemistry terms in order to understand the more advanced concepts that must be constructed upon basic knowledge (Nakhleh,1992). This leads to misconceptions, which hinder chemistry learning because new information cannot cognitively connect to prior knowledge.

Creating a cognitive model of learning chemistry at the college level needs to include understanding the difference between concepts. Students should know that they have to comprehend a concept at the molecular level, helping them to clearly understand it. According to the cognitive model of learning, misconceptions occur when students come to chemistry classes holding everyday meanings that differ from the scientific meaning. Thus, chemistry instructors should demonstrate the scientific meaning for which students hold misconceptions. They have to help their students master different meanings for the same concept and need to be precise when interpreting chemistry topics that have different definitions.

Assessment for misconceptions that include examinations would measure students' learning, and students would have more understanding of the concept. Chemistry faculty members should recognize these difficulties with their students and wonder why they got into this situation of uncomprehending students. They should believe that their enthusiasm would transfer to their students and produce college students who enjoyed chemistry subject to pursue a career in chemistry. An example such as formal PowerPoint presentations does not allow students to interact and display their misconceptions of chemistry topics.

If students are presented with methods that are only based on short-term memory, it is difficult to search for differences between students' knowledge and misconceptions about chemistry topics after instruction. The starting point should begin to meet the students where they are, with their interests and knowledge, and lead them to explore new thoughts and experiences. Instructors need to try to find the way they present the chemistry subject so that students will learn chemistry with enjoyment. The challenge will be to incorporate teaching and learning methodology that can help instructors be sure that students have comprehended and reexamined what is taught so students are not put off by general chemistry courses early.

Conceptual understanding can be built from the macroscopic and gradually be advanced to the submicroscopic and representational aspects (Johnstone, 1997, 2010). However, multiple macroscopic, microscopic, and representational aspects of chemistry concepts could lead to misconception because of the load of information on students' long term memory during the process of learning. The aspects of a concept in chemistry can be presented with a triangle in which each corner corresponds to an aspect and the connections between aspects are represented by the sides of the equilateral triangle. But, students' understanding of the connection between the three aspects may be still challenging (Johnstone, 1997).

One assumption of the traditional instruction such as lecture format is that students have an opportunity to learn the concepts, but do not grasp them. This model of instruction is focused more on factual knowledge with the goal of content coverage and memorization without understanding. Shifting the instructional focus to conceptual understanding using related critical thinking and problem solving could value student inquiry and cognitive learning and support meaningful learning. Meaningful learning occurs when learners know how to relate new factual knowledge to other stored knowledge in contrast to rote learning. Students memorize without understanding because the new factual knowledge does not relate to other stored knowledge.

Considering multidimensional domain of chemistry education, which includes a shifting of chemistry instruction in multiple ways based on cognitive, metacognitive, social, and affective domains of learning offer potential impacting learners in general chemistry courses. This approach in teaching and learning relies on student-centered and active learning help students to have deep understanding of factual knowledge in the context of conceptual learning and application of chemistry disciplines. A multidimensional approach to learning also provides a conceptual basis to instructors' teaching.

Self-directed efficacy learning is often embraced as an important educational goal, although for quite different reasons, from the improvement of school learning to the critical assessment of the claims of democracy. Most reasons imply that self-direction is important in learning throughout life. Therefore process-oriented teaching, which aims to foster self-directed lifelong learning, needs a broad and multidimensional theoretical basis. The important role of experiences in the social and cultural context, prior knowledge, and the emotional aspects of learning are highlighted, and related to self-directed learning in life.

Multiple research databases in chemistry education yield numerous researches and practices on theoretical frameworks and models focused on improving chemistry learning. For most researchers in chemistry education, generating working frameworks and models of learning chemistry to apply them to real classrooms situation stands as a vital component underlying most studies (Herron & Nurrenbern, 1991). Because such approach to learning chemistry involves both learning of chemistry content and the process of learning, it is important to shift instruction toward multidimensional views of instruction. An example of developing a process-oriented approach in teaching presents a major challenge for teachers as well as for Chemical Science programs to adjust instruction and curriculum.

The effective educational practices in chemistry education must involve conceptual understanding of chemistry including technological literacy for every student. Academic achievement for all students has been a major challenge in chemistry teaching and learning endeavor. To face the challenge of student success, changes must be implemented in chemistry education to promote a supportive culture that ensures effective educational practices that have touched a large number of students in meaningful ways. This is vital to get a sense of the extent to which chemistry faculty members adapt certain instructional practices for their unique conditions and context. To attain such a goal, Chemical Sciences programs in higher education institutions look into effective models in learning chemistry that support the development of chemistry education as well as activities that integrate all stakeholders as students, faculty, administrators.

CHAPTER 3. METHODOLOGY

Introduction

Culture is the sum of many parts of institution dynamic that have important impact on the mission of an institution: student learning. It can spread around an institution from the instruction to technology adopted in the classroom; from data revealing student satisfaction to the kind of student learning that applies in classrooms. Improving an impacting matter as institution culture takes careful analysis and planning.

Action research considered as a problem solving approach that was utilized in the current research to better understand the nature of producing new practices or to improve existing practices. Stinger (2007) introduces the action research is based on studies that "focus on the need to understand how things are happening, rather than merely on what is happening" (p.19). Inquiry in action research usually seeks to clarify an issue investigated to reveal the way participants describe their actual experience of the practice. By integrating the actual experience of key stakeholders as essential part of the research, a collaborative approach of the situation provides the foundation for understandings that lead to understand the way that participants interpret to activities related to the issue investigated.

Stinger (2007) asserts the notion of community-based action research seeks to change the personal dynamics of research process. Understanding the four key elements that are perceptive to action research including relationships, communication, participation, and inclusion helped the researcher to formulate activities that extend the understanding toward developing a cultural change for a learning institution. It was crucial to create inclusive culture where members of institution community work together effectively. The research participants built a network of collaborative relationships to emerge sustainable solutions. Looking to build a culture of participation and collaboration recognized the value of stakeholders' contributions.

Purpose of the Proposed Study

The current action research was designed to collaboratively assess perceptions of students, faculty and administrators regarding the impact of chemical education on student's learning in general chemistry courses. The assessment of these perceptions broadened the knowledge for the benefit of all concerning the delivery of instruction to produce a plan of change. Top-down plan for change was initiated based on assessment of the analysis of faculty perceptions concerning the impact of chemical education to illustrate the extent to which faculty teach with institution expectations for all students. Reviewing and reflecting on the results with administrators can assist to support long term plans to be implemented related to the proposed plan. Bottom-up plan for change was initiated based on assessment of the analysis of students' perception toward their study approaches and beliefs about learning chemistry. This helped to evaluate the level of chemistry expectations that student's prior knowledge had on learning and studying chemistry.

The goal of administrators and faculty who are working together to develop a change is to produce quality policies and practices on an ongoing basis. (Fullan, 2005) suggests that administrators are aware that in order to change the larger system it is also important to have awareness at all levels of the system to practice thoughts and actions on the system as a whole. Fullan (2005) claims these thoughts and actions involve commitment to improve the environment within and beyond the institution. To achieve this, administrators interact beyond their own context in order to change the culture for getting things done. David Hargreaves (2003) describes an indicator of collective effort (horizontally and vertically) when individual administrator becomes concerned about success of others; greater system knowledge is the outcomes.

Research Question

The main question guided this study: How can a proposed plan is developed to improve student engagement based on assessing perceptions of administrators, faculty, and students, with focus on the impact of chemical education on learning in general chemistry courses?

The issues questions that guide the research study to develop a plan to improve learning and teaching in general chemistry courses are:

1. To what extent are chemistry faculty members using Chickering and Gamson's (1991) Seven Principles of Good Practice in undergraduate Education?

2. What are the effects of students' approaches to learning and their beliefs about learning chemistry on the ways they engage the studying and learning process?

3. In the light of the perceptions of faculty and students, what is the role of the administrators to support a long term plans related to the proposed plan?

Research Design

The researcher employed naturalistic approach to study administrators, faculty experiences and explored their perspectives using action research (Stringer 2007). As an adjunct chemistry faculty teaches general chemistry at the three research sites, there was an opportunity to reveal a sustainable study of relationship between factors and outcomes through assessing the actual practices into explanation of theories of action. Assessing the perceptions of general chemistry course 'stakeholder regarding the impact of chemistry education on student's learning was carried out by using mixed methods of research, a cycle of action research has developed, evaluated, and reviewed (Kuhne & Quigley, 1997).

Viewing the issue of building a collaborative culture through systems thinking perspectives, new insights can be tested and systematically viewed how each of these new insights affects practice. Senge (1990) claims that systems' thinking is a framework that helps practitioners to see how they make an institution change effectively to produce a learning institution. A learning institution recognizes that their stakeholders differ in the way they think, behave, and learn but "they create their reality and how they can change it" (p.12). According to Senge (1990), systems take the shape from the values and beliefs of the people in them. The mental models and theories of the people affect their action and interaction of the system. In exploring the challenges to develop a plan of change for improvement, the resulting actions belong to individuals who learn how to think together in the sense of identifying a new insight to develop the change.

The collaborative vision provides a framework in which all decision are made including educational process, student success, community relations, professionals development, instruction, students services, academic support, and curriculum. All stakeholders need to be included; administrators, instructors, and the students. They all commit to the task of building a dynamic culture that puts learning first. The dynamic culture always has significant impact on the mission of educational institution: student learning. Keeping the focus on student learning maintains a vision in understandable term "learning to all".

Population

The populations of this study were six administrators, sixteen faculty and hundred–forty students within general chemistry courses at three institutions located in South California. Starting with a large sample to perform an analysis to develop categories in order to find uncovered categories was an example of theoretical saturation (Gall, Gall, & Brog 2007).

However, all the members of the population under study were included to assure detailed coverage.

The goal was not to detail concepts for a theoretical field, but to cover relevant diversity in an empirically –defined population. Selecting purposively a diversity sample of administrator, faculty and students to cover all existing relevant varieties of fact and event was an effective sample to represent the diversity of the facts and aspects under study within the targeted population. Comparing a variety of aspects with each another and bringing them into theory achieved theoretical saturation.

Saturation is based on the kind and the degree of diversity that is determined relevant. In a description of diversity, start with a small sample; perform an analysis to develop patterns; and find uncovered patterns. Saturation in this study was experimental not theoretical

By comparing a variety of aspects with each another and bringing them into theory, the researcher knew when to achieve theoretical saturation. Data for the quantitative approach collected by administrating a survey to 16 faculty members and two questionnaires to140 students to examine their approaches to chemistry education and whether they benefited from the good practices and experiences or not to actively engage in general chemistry courses. Data for the qualitative approach collected by interviewing six administrators and twenty students to answer research question 3, were collected to explore thoughts and ideas to support long term plan for improvement to develop general chemistry course.

Instrumentations

It was important to determine the impact of quality standard for good practices in teaching and learning to answer the research question. The impact of the action research study was used as an indicator for examining the strategic initiatives established from interpretive process of the issues related to measuring perceptions of general chemistry courses' stakeholders. Using multiple measures yields the best information about teaching and learning effectiveness.

A quantitative Survey "The Faculty Inventory of the Seven Principles for Good Practice in Undergraduate Education from the Wingspread Group." was used. This instrument was designed from experiences and publications for choosing items from examples to get faculty perspectives on which practices they performed or did not perform (Gamson, 1999). The inventory was constructed and "published in fall 1989 by the Johnson Foundation" (Gamson, 1999, p. 10). Understanding key perceptions of college chemistry faculty in general chemistry courses regarding teaching and learning was crucial to study to what extent were faculty utilizing best practices in quality undergraduate education.

A quantitative survey instrument "CHEMX", was written to be about learning chemistry, was utilized to measure the effects of students' prior knowledge upon learning chemistry (Grove & Bretz, 2007). According to the developers, CHEMX is "an easy-to-use tool" to evaluate student' cognitive expectations for learning chemistry. There are 47 statements divided into seven clusters (effort, concepts, math link, reality link, outcome, laboratory, and visualization) include 5-points scales. Two opposing dimensions describe each cluster. The chemistry faculty expectation about learning chemistry is designated as "favorable" while the opposite view is designated as "unfavorable". The possible total score on CHEMX ranges from minimum 47 to maximum of 235. The higher the student's score on CHEMX, the more the student's expectations align with favorable views. Evidence for both the reliability and validity of CHEMX was revealed.

A quantitative questionnaire “The revised two-factor study process questionnaire” (R-SPQ-2F) is the title of the questionnaire that includes 5-points scales and open-ended 20 questions (Biggs, 1993). The questionnaire describes thorough perspectives on surface and deep strategies and motives of the studying attitudes and learning styles. According to (Biggs, et al, 2001), the questionnaire assists faculty to evaluate their own teaching and the learning styles for their students. Testing demonstrates that the questionnaire “has very good psychometric properties” (p.145). The questionnaire also had “acceptable Cronbach alpha values for scale reliability. Confirmatory factor analysis indicated a fit to the intended two factor structure” (Biggs et al., 2001, p.133). Summary instruments are shown in Table 2.

Table 2: Summary Instruments with Description of Variables

Instruments with Their Major Scales

Instrument	Scales	Subscales
Faculty Perception		
The Faculty Inventory of the Seven Principles for Good Practice in Undergraduate Education	Seven Principles for Good Practice in Undergraduate Education	Principle 1 Encouraging Student-Faculty Contact Principle 2 Encouraging Student-Student Contact Principle 3 Encouraging Active Learning Principle 4 Giving Prompt Feedback Principle 5 Emphasizing Time on Task Principle 6 Communicating High Expectation Principle 7 Respecting Diverse Ways of Learning
Students' Perception		
CHEMX Assessing students Cognitive Expectations for Learning Chemistry	Seven Clusters to Assess the Expectation about Learning Chemistry	Cluster 1 Effort Cluster 2 Concepts Cluster 3 Math Link Cluster 4 Reality Link Cluster 5 Outcome Cluster 6 Laboratory Cluster 7 Visualization
R-SPQ-2F Revised Study process Questionnaire Two Factor	Deep Approach (DA)	Deep Motive (DM) Deep Strategies (DS)
	Surface Approach (SA)	Surface Motive (SM) Surface Strategies (SS)

Qualitative Data Sources

The purpose of the qualitative data utilized in this research study was two-fold. First, qualitative analysis allowed the researcher to become familiar with the fact and experience being studied; second, it allowed the researcher to frame a new explanation by examining interrelationships between facts and experiences (Corbin & Strauss, 2008). The qualitative approach was used in the action research to understand stakeholders' perceptions of quality chemistry education and the factors, which influence their perceptions.

A qualitative approach was utilized by taking field notes to reflect on student perspectives that were presented in the questionnaire and the survey. The approach supported both instruments utilized is to examine student' perceptions. Recording students' reactions and inviting comments about the surveys maintained some degree of conservation with students to promote discussions about areas in chemistry learning and studying approaches that initiate dialogue to suggest improvement.

A qualitative approach was utilized by carrying out eight interviews with administrators regarding their perceptions of quality education and the factors that influence their perceptions. Text presented outcome measurements including indicators to assess existing general chemistry course; and text presented suggestions to improve the course. This helped the researcher to construct guiding principles to prepare a plan of change for improving general chemistry course with the assistance of administrators through providing educational support services.

Utilization of Data to Answer Research Question

In order to answer the research question, there were issues questions guided the research study and supported the main question regarding the development of a proposed plan in general chemistry courses.

1. To what extent are chemistry faculty members using Chickering and Gamson's (1991) Seven Principles of Good Practice in undergraduate Education?
2. What are the effects of students' approaches to learning and their beliefs about learning chemistry on the ways they engage the studying and learning process?
3. In the light of the perceptions of faculty and students, what is the role of the administrators to support a long term plans related to the proposed plan?

Assessing stakeholders' perceptions regarding the impact of chemistry education on learning was accomplished by using mixed methods. According to (Gall,2003; Creswell, 2005), triangulation gives credibility and reliability to the research. Collecting the data from different perspectives substantially enriched the findings of the research.

Data Collection Procedures for Proposing a Plan from Faculty Perspectives

Assessing faculty perceptions was accomplished through collecting data through conducting paper survey to sixteen chemistry faculty on teaching and learning in general chemistry course. The title of the survey is "Faculty Inventory of the Seven Principles for Good Practice in Undergraduate Education" (Chickering and Gamson 1991) from the Wingspread group on Higher Education is used without modification. The survey includes 5-point Likert scales and open-ended questions. There was a one-week return time, which determined in the cover letter and an email sent out for non-respondents. Demographics included full-time /part-time status, highest degree awarded, ethnicity, and gender. The results from the survey illustrated the extent to which faculty teach with institution expectations for all students and to effectively help them to meet those expectations. Evaluation of the faculty perceptions was vital to know whether the findings in agreement with those published by American association of Higher Education and Accreditation (AAHEA).

Analysis of data collected from the "Faculty Inventory of the Seven Principles for Good Practice in Undergraduate Education" research question, a was answered: to what extent are chemistry faculty members using Chickering and Gamson's (1991) Seven Principles of Good Practice in undergraduate Education? Statistical analysis of data using frequencies and percentages for the scale responses for each question rests on assumptions that are satisfied to make the data analysis valid.

Understanding statistical inference of data began with the research question. The research question, a was answered based on faculty perspectives using statistical analysis to illustrate to what degree were chemistry faculty using Chickering and Gamson's (1991) seven principles of Good practices in undergraduate Education. This was analyzed using frequencies and percentages for the Likert scale responses for each question, For example, for survey item 1 "I advise my students about career opportunities in their major field". If 60% of respondents answered often or very often did that, it would be assumed that most faculty members performed this activity. All ten-survey items per principle were analyzed in this way showing which survey items chemistry instructors performed or did not perform.

To understand if there was a significant difference in principle utilization by type of principle, means of each set of survey items were compared to compare each of the seven principles. Comparing the seven principles, each set of ten survey items per principle was summed for each individual. This provided a total score with range of 10 to 50 for each principle. Means and standard deviations of the total scores for each principle were determined.

Data Collection Procedures for Proposing a Plan from Students Perspectives

Assessing students' perceptions toward chemical education using mixed methods was carried out to answer question, b. Data for the quantitative research approach were collected through two paper instruments to assess students' learning approaches for 140 students respectively. Data for the qualitative research approach were collected through field notes for 20 students out of the participants to get perspectives on their answers to surveys and their performance. This assessed the correlation between students' approaches and beliefs to learning chemistry and their grades.

Quantitative Approach: Operationalization of Variables

The first quantitative instrument is CHEMX Survey. CHEMX assessed students' cognitive expectations for learning chemistry and was administered to 140 students using 5-points Likert scales. There are 47 statements divided into seven clusters (effort, concepts, math link, reality link, outcome, laboratory, and visualization) include 5-points scales. The Likert scale responses range from 5 (strongly agree) to 1 (strongly disagree). Two opposing dimensions describe each cluster. The chemistry faculty expectation about learning chemistry is designated as "favorable" while the opposite view is designated as "unfavorable". The items that associate with each cluster are listed in Table 2.

Data Analysis

Of the 47 items, 25 are worded negatively (presented by bold face numbers in Table 3). Favorable view of these items are indicated by answering strongly disagree and disagree. These bold items in Table 3 were recorded for data analysis. The possible total score on CHEMX ranges from minimum 47 to maximum of 235. The higher the student's score on CHEMX, the more the student's expectations align with favorable views presented in Table 3.

Table 3. Favorable and Unfavorable Dimensions of the Seven CHEMX Clusters. From "CHEMX: An Instrument to assess students' cognitive expectations for learning chemistry", (p. 1525), by Grove, N. and Bretz S. (2007), Journal of Chemical Education.

Cluster	Favorable View	Unfavorable View	CHEMX Items
1. Effort	Makes the effort to use information available and makes sense of it	Does not attempt to use available information effectively	2, 6, 8, 19, 22, 31, 34, 38, 41
2. Concepts	Stresses understanding of the underlying concepts	Focuses in memorizing and using formulas	4, 28, 36, 37, 43
3. Math Link	Considers mathematics as a convenient way of representing physical phenomena	Views chemistry and mathematics as independent with little relationship between them	5, 9, 11, 21, 29
4. Reality Link	Believes ideas learned in chemistry are relevant and useful in a wide variety of real contexts	Believes ideas learned in chemistry have little relation to experiences outside the classroom	14, 26, 30, 35, 42
5. Outcome	Believes learning chemistry is essential to ultimate career goals	Believes chemistry is simply another obstacle to endure before getting to the important material	7, 15, 16, 17, 25, 40, 45, 47
6. Laboratory	Stresses importance of understanding chemical concepts behind experiments	Views laboratory experiments as steps to follow and data to collect with little connection to lecture	1, 12, 13, 23, 32, 39, 44, 46
7. Visualization	Considers visualization of atoms and molecules in 3-D essential to learning chemistry	Views visualization as unnecessary for learning chemistry	3, 10, 18, 20, 24, 27, 33

*Items are worded negatively (presented by bold face numbers)

"The revised two-factor study process questionnaire", (R-SPQ-2F) was the title of the second instrument that described the studying attitudes and learning styles (Biggs, 2003). Data from the questionnaire illustrate to what degree students were utilizing surface or deep approach in learning general chemistry course. The instrument that includes 5-points Likert scales and open-ended questions was administrated to 140 students. The responses are as 5 meaning "always", 4 meaning "frequently", 3 meaning "half the time", 2 meaning "sometime", and 1 meaning "never". The questionnaire has two main scales: Deep Approach (DA) and Surface Approach (SA).

Deep Approach (DA) has two sub-scales:
Deep Motive (DM)
Deep Strategy (DS)

Surface Approach (SA) has two sub-scales
Surface Motive (SM)
Surface Strategy (SS)

Student favorable view of sub-scale Deep Motive (DM) articulates interest in chemistry subject and commitment to studying and learning chemistry where unfavorable view focuses on doing the minimum work to build necessary knowledge to complete the task. Student favorable view of sub-scale Deep Strategy (DS) conveys student's abilities to create self-learning approach to understand and solve complex chemistry problem where unfavorable view shows lack of engagement with chemistry subject. Student favorable view of sub-scale Surface Motive (SM) conveys student's capabilities to seek meaning of what is learned through understanding chemistry concepts where unfavorable view shows viewing learning chemistry as accumulation of necessary information to pass the course. Student favorable view of sub-scale Surface Strategy (SS) conveys student's capabilities to analyze and synthesize knowledge for understanding chemistry where unfavorable view shows focuses on memorization and rote of chemistry concepts.

Data Analysis

Data from the CHEMX questionnaire using frequencies and percentages for the Likert scale responses for each question demonstrated students cognitive expectations of chemistry learning in general chemistry course. For example, for questionnaire item 2 "I go over class notes carefully to prepare for tests in this course", it would be favorably answered and assumed that most students performed this activity if 60 % of respondents answered "strongly agree" and "agree". All forty-seven items were analyzed in this way showing which survey items students performed or did not perform in learning chemistry. Understanding students' perception toward their cognitive expectations of chemistry learning addressed deficiencies to improve learner engagement and achievement (see table 3).

Data from the questionnaire (R-SPQ-2F) using frequencies and percentages for the Likert scale responses for each question demonstrated to what degree students were employing surface or deep approach in learning general chemistry course. For example, for survey item 4 "I only study seriously what's given out in class or in the course outlines". For deep approach, if 60% of respondents answered "always" and "frequently", it would be favorably answered and assumed that most students performed this activity. For surface approach, if 60 % of respondents answered "sometimes" and "never", it would be unfavorably answered and assumed that most students did not perform this activity. All twenty-survey items were analyzed in this way showing which survey items students performed or did not perform in learning chemistry. Understanding students' perception toward their studying attitudes and learning approaches addressed deficiencies to improve learner engagement and achievement (see table 4).

Table 4: Favorable and Unfavorable Dimensions for the R-SPQ-2F. From "The Revised two-factor Study process Questionnaire: R-SPQ-2F", (p. 135), by Biggs, J.B., Kember, D., & Leung, D.Y.P. (2001), *British Journal of Educational Psychology.*

Scale	Subscale	Favorable View	Unfavorable View	Items
Deep Approach (DA)	Deep Motive (DM)	Interest in the chemistry subject Satisfaction and commitment to learning and understanding chemistry	Focuses on necessary information to complete the task	1, 5,9,13,17
	Deep Strategies (DS)	Builds self -learning abilities to solve complex chemistry problems	Lack of engagement with the chemistry topic	2,6,10,14,8
Surface Approach (SA)	Surface Motive (SM)	Makes the efforts to seek meaning of what is learned	Views learning chemistry as accumulation of sufficient knowledge to pass the course	3, 7, 11, 15, 19
	Surface Strategies (SS)	Identifies and analyzes concepts for studying and understanding chemistry	Focuses on memorizing concepts Difficulty in solving chemistry problems	4, 8, 12, 16, 20

Qualitative Approach

The perceptions of students were evaluated using mixed methods to answer research question b, what are the effect of student' approaches to learning and their beliefs about learning chemistry on the ways they engage the studying and learning process? Field notes from R-SPQ-2F questionnaire and CHEMX survey related to students' views and expectations about learning chemistry for a sample of 20 students were collected. For each student the results of both the R-SPQ-2Fquestionnaire and CHEMX survey were discussed with the researcher and correlated with the grade.

Possible scores for CHEMEX from 47 to 235 and calculated of the 47 statements. The higher the score, the higher student's expectation associated with the favorable views determined during CHEMX survey. Deep Approach Score and Surface Approach Score for R-SPQ-2F were summed for each student as following:

Deep Approach Score: Σ All Deep Motive scores + all Deep Strategy scores
Surface Approach Score: Σ All Surface Motive scores + all Surface Strategy scores

Analysis of field notes was practical qualitative approach to develop new ideas for in-depth explorations of perceptions of students for researcher interest to develop a proposed plan for improvement. Data from 20 students' performance were collected and correlated with students' approaches to learning and their beliefs about learning chemistry.

Reviewing a Plan from Faculty and Students Perspective with Administrators

Reflecting on faculty and students' perceptions and the factors, which influence their perceptions can support long term plan for improvement to develop general chemistry course. Text presented outcome measurements including indicators to assess existing general chemistry course; and text presented suggestions to improve the course. The following outcomes measurements including indicators that demonstrate the guiding principles to prepare a plan of change with the help of administrators that can impact teaching and learning throughout general chemistry course.

1. Commitment to provide opportunities for educational and support services
2. Commitment to a safe, culturally learning-centered environment
3. Commitment to help students succeed in their educational and career goals.
4. Commitment to standards of accountability, continuous improvement, and resource management.
5. Commitment to an educational environment, which utilize technological advancement.

Field test

The researcher conducted a field test of interview questions before administering them to participants. A group of five faculty and administrators read each question to signify whether or not the questions were designed to provide effective and informative information.

Population

A qualitative approach was utilized by carrying out six interviews with administrators and facilitators regarding their perceptions of quality education.

Approach Sampling: Identifying Key People

The role of the researcher as facilitator was to determine significant individuals involved to develop understandings of the context that investigated the nature of the opportunity to understand the process to develop general chemistry course. Such opportunities as meeting with those in positions of authority like Dean of Science, Chemistry Chair, Success Center Facilitator, Vice President of Instruction, Director of Institutional Research, Faculty and relevant stakeholder. A qualitative sample using interview approach represents the diversity of the fact and event under study within the targeted population (Gall et al., 2007). This usually be reached by a large random sample, but this method would not be efficient in the current study. It was more efficient to purposively select a diversity sample to cover all existing relevant varieties of fact and event (saturation).

Saturation is based on the kind and the degree of diversity that is determined relevant. In a description of diversity, start with a small sample; perform an analysis to develop patterns; and find uncovered patterns. Saturation in this study was experimental not theoretical. The goal is not to detail concepts for a theoretical field to cover theoretical models, but to cover relevant diversity in an experimentally –defined population. Therefore, a qualitative sample represented the diversity of all aspects under study (saturation).

By comparing a variety of aspects with each another and bringing them into theory, the researcher knew when to achieve theoretical saturation. Data for the qualitative approach collected by interviewing six administrators to answer research question 3, were analyzed to explore thoughts and ideas of administrators to support long term plan for improvement to develop general chemistry course.

Interview Questions

1. What are the fundamental principles of a learning college?
2. How does a learning college contribute to create a learning culture focused on student achievement?
3. How do our individual and collective actions contribute to student learning?
4. Explain the college commitment to an expansive "learning outcomes" agenda?
5. How does the current leadership within our institution resolve conflicts between the mission of the organization and the needs of the students?
6. What is needed to achieve sustainable continuous quality improvement level for evaluating institutional effectiveness?
7. What types of changes would you implement within the department of chemistry to improve creating of a culture of learning?
8. How does the department recognize the role of its faculty in assuring quality of instruction?
9. How does the department seek to meet the educational needs of its students?
10. How can you assist instructors using teaching methodologies that reflects the diverse needs of the students?
11. Has the curriculum process been streamlined over the past three years?
12. Do you encourage faculty to get involved through committees such as outcomes-based assessment committee?

The process of interviewing was simple and straightforward. An Interview time was pre-set and conducted at each individual office. Each interview lasted less than thirty minutes in length. Interview questions were based on a combination of those contemporary educational factors suggested in the literature. The questions employed neutral language and gave the participants opportunities to express themselves in their own terms. The use of tape recorder had the advantages to get detailed and accurate information. The issues of the quality of student learning and achieving student success were the main factors to discuss by interviewees through the interviewing process.

In the qualitative research, the analysis is categorized "in terms of depth ranging from superficial description to theoretical interpretation" (Corbin & Strauss, 2008. p.50). Qualitative approach that grasps the meaning of the events and experiences for participants was part of the reality needed to be understood for this research study. A level of description and explanation was achieved; description synthesizes categories into more theoretical concepts and explanation relates descriptive categories to institutional context (social, political, etc.). Therefore, description and explanation were interconnected in the research analysis.

Evaluation of qualitative approach was made whether the process of data gathering and analysis was presented to provide answer to the research question c, in the light of the perceptions of faculty and students, what is the role of the administrators to support a long term plans related to the proposed plan?

Data Analysis

Data analysis in generic qualitative analysis was conducted. Thematic analysis is an effective tool to conduct an analysis of qualitative data. The tool for conducting the analysis of data when using the generic qualitative inquiry method for developing a dissertation at Capella was that of applying a thematic analysis. The advantages of doing qualitative approach provided flexibility to follow unexpected ideas from the administrators and explored institutional processes effectively.

Analysis of administrators' interviews was a practical qualitative approach to develop new ideas for in-depth explorations of administrators' expectation to develop a proposed plan for improvement. Reviewing the proposed plan with administrators to promote long-term plans was based on interpretations and recommendations of stakeholders. This has answered research question c. What is the role of the administrators to support a long term plans related to the proposed plan?

Limitation of the Research Design

The research design introduced to this study is inclusive and all-encompassing procedure. Assessing the perceptions of general chemistry course 'stakeholder regarding the impact of chemistry education on student's learning was carried out by using mixed methods of research, a cycle of action research has developed, evaluated, and reviewed (Kuhne & Quigley, 1997). However, the research study may have a few limitations. There are internal limitations with respect to the research questions which were selected based on the researcher's knowledge and experiences with teaching general chemistry. A limitation of the participants may feel the researcher has a bias or opinion related to the purpose of the study and may not share their true perceptions of the topic.

Additionally, the response rate on a 5-point scale may also have lead to bias because participants usually tend to agree than disagree with a statement (Suskie, 1996). Data generated from the surveys may not be accurate and extraneous variables could change the participant' perceptions from factors unrelated to the research.

But the validity and reliability of the survey instruments were compromised. The study may be limited to a sample of institutions in one geographic area. However, a larger sample from three institutions located in the same geographic area provided valuable information to broaden the findings of the study. The study may also hindered by the possibility that the researcher did not identify essential questions regarding the topic of general chemistry course and chemistry education's impact on teaching and learning in higher education.

Conceptions of the Validity and Reliability of the Study

According to Gall (2008), assessing the quality of action research by validity and reliability of the instrument is crucial. Checking the validity of the factor analysis instruments used in the research project was essential to measure the mechanism of the concepts and factors being studied. Two types of validity were considered; external validity is the "extent to which the findings can be generalized to similar cases" (p. 477), and internal validity is the extent to which the researcher has demonstrated a causal relationship between factors by showing that plausible factors could not have caused to one of the factors. The measure of internal validity is not applicable to descriptive action research such as the current research study because it does not seek to identify causal patterns in phenomena.

Reliability is "the extent to which other researchers would arrive at similar results if they studied the same case using exactly the same procedures as the first researcher", (p.477). Other researchers would arrive at similar results if they studied the same case using exactly the same procedures as my research. Based on research, practice, and other documents filed and stored, validity and reliability of the instruments used in the study are justified. However, this could be assessed with the production and distribution of the action research report.

Rigor

The core for rigor was founded for establishing the reliability and validity of the research. This means that the results did not reflect particular prospects, bias of the researcher. Checking for rigor includes checking the credibility of the project. This allows the researcher to trust integrity of the research process to make commitments to the inquiry:

Triangulation: using range of sources of quantitative and qualitative approaches. The perspectives from range of sources enabled the researcher to identify different ways the research was being perceived.

Diverse case analysis: engaging key stakeholders including faculty, students, and effective leaders in the study increased its credibility. Stringer (2007) concludes "researchers enhance the credibility of the study by ensuring that the perspectives of all stakeholders are incorporated into the study" (p. 58).

Persistent observation: field notes obtained from the research site and through internet search that took place over a period of two months.

Prolonged engagement: interviews with potential administers were each thirty minutes in length, and this enabled sufficient exploration to develop and support a plan of change to improve general chemistry course.

Rigor in the action research was founded on the results that do not reflect particular prospects, bias of the researcher. However, the rigor in action research basically is based on checks to ensure that the outcomes of research are trustworthy (Stringer, 2007). Checks for rigor within the action research of the study included the following:

Credibility. Checking the credibility within the action research allowed the researcher to trust integrity of the research process. Using a range of sources including interviews accompanied with survey and questionnaire enhances the credibility of the research. The perspectives incorporated from range of sources enabled the researcher to identify different ways the research was being perceived. Ensuring that the perspective of leaders, faculty, and students were incorporated from variable sources provided new insights concerning implementation of good practices in educational process, as well as enhancing the credibility of the study (Stringer, 2007).

Transferability. The outcomes of the research study can be relevant elsewhere. A series of dialogues between the researcher and the department chair and faculty members took place to understand the department goals and its role to faculty learning. Discussion of the primary elements of the action research study and the nature of instruments assisted the researcher to facilitate dialogue for suggesting improvements. It was also possible for people who were not part of the study to make judgment about whether or not the situation is similar to their context to be applied.

Dependability. A summary of information to check the accuracy with relevance stakeholder and compared it with documents such as reports, statements, and evaluation reports obtained through the process provided dependability that assessed more rigorous to the study. However, the results of faculty survey and student questionnaire are considered dependable and the dependability assess more rigorous with the production and distribution of the action research report.

Confirmability. The confirmability of the data was clearly apparent based on learning reports, brochures, and other documents filed and stored in the college. Also an audit trail assisted the researcher to review data collected.

Expected Findings

The current action research was designed to collaboratively examine perceptions of students, faculty and administrators regarding the impact of chemical education on student's learning in general chemistry courses. The assessment of these perceptions broadened the knowledge for the benefit of all concerning the delivery of instruction to produce a plan of change. The plan for change was expected to be initiated based on assessment of the analysis of faculty perceptions to illustrate the extent to which faculty teach with institution expectations for all students. Reviewing the results with administrators was implemented to support long term plans to be implemented related to the proposed plan. The plan for change based on assessment of the analysis of students' perception toward their studying and learning approaches was expected to evaluate the level of chemistry expectations that student's prior knowledge had on learning and studying chemistry.

The results could reveal some of the current practices used in chemistry learning extending the learning gap of general chemistry. Addressing the gaps by improving student engagement in chemistry learning enables students to meet the expectations for chemistry learning. From multiple perspectives, detailed analysis of perceptions of students, faculty, and administrators, this study could make several recommendations for improvement.

Ethical Consideration

Sensitivity to ethical issues was crucial to make successful researcher. As a chemistry instructor, the role of the researcher required to share with participants their personal experiences and actions. Gall et al. (2007) defines personal involvement of researcher, who used data, is the extent to which the personal experience, feelings, and beliefs to deal with participants through data collection. However, to ensure data quality and accurate analysis, qualitative and quantitative approaches were utilized to grasp the meaning of the experiences have for participants and were also part of the reality needed to be understood. This avoided qualitative faults that could include lack of broad description of research observations; lack of data verification by colleagues; lack of data verification by stakeholders.

Following appropriate procedures and explanation, the purpose of the research study assured the participants confidentiality. The aspects of CITI training that provided research ethics education were utilized in carrying out data gathering and analysis.

Chapter 3 Summary

The impact of the action research study was used as an indicator for examining the strategic initiatives established from measuring perceptions of general chemistry courses' stakeholders. Using multiple measures assisted the researcher to obtain significant information about chemistry teaching and learning effectiveness. The study investigated perceptions of faculty, students, and administrators, with a focus on the impact of chemistry education on student learning.

Utilizing the most well-known engagement measures of effective education in colleges and universities provides insight into the factors that influence student involvement. Institutional culture was inclusively assessed where cognitive expectations of chemistry teaching and learning for high performance were communicated. A mixed method was utilized to analyze different perceptions concerning key factors that demonstrate the level of commitment and engagement in general chemistry education.

First, the extent in which chemistry faculty members are utilizing the "Seven Principles for Good Practice in Undergraduate Education" in their instruction was explored. Second, student perceptions, attitudes and approaches toward chemistry learning were surveyed. The focus was on investigating students' understanding of the process of learning chemistry from their own experiences, beliefs, skills, and thoughts on what was expected of them. The seven categories used to measure students' prior knowledge on chemistry learning and their perceived expectations of educators were: effort, concepts, math link, reality link, outcome, laboratory, and visualization. The analysis represents the views of 16 faculty and 140 students and 6 administrators.

CHAPTER 4. DATA ANALYSIS AND RESULTS

Introduction

This chapter illustrated the detailed results of quantitative and qualitative data sources. The main research question guided this study: How can a proposed plan be developed to improve student engagement based on assessing perceptions of administrators, faculty, and students, with focus on impact of chemical education in general chemistry courses? The three issues questions that were posted in chapter 1 provided guidance and support to this main question. The first issue research question (1) queried to what extent the chemistry faculty members were using Chickering and Gamson's (1991) Seven Principles of Good Practice in undergraduate Education. The second issue research question (2) looked into the effects of students' approaches to learning and their expectation for learning chemistry. The third issue (3) questioned the role of administrators in the support of a long term plans.

Description of the Sample

Research Question (1)

The research question asked is: "To what extent are chemistry faculty members using Chickering and Gamson's (1991) Seven Principles of Good Practice in undergraduate Education?" For each principle, there are ten survey items that describe each principle. Survey response was reviewed and demographic analysis of participants was provided. Data analysis was presented to provide answer to the research question. The research question was answered by calculating frequencies and percentages for responses to each individual survey item. Tables 5 through 11 included each survey item, frequencies, and percentages for each rating. The Likert scale responses range from 5 (Very Often) to 1 (Never).

Survey Response

An invitation to participate in the survey was introduced to chemistry faculty members in a faculty department meeting at two institutions. The researcher who is an adjunct faculty at the three institutions allowed one-week turnaround time. Sixteen faculty members completed and returned the survey.

Demographic Analysis

Participants were asked to respond to demographic questions to characterize respondents. Demographic characteristics of faculty participants were presented in Table 5. Distribution of gender and ethnicity were approximately equal to representative trends in institutions investigated in the study. 75% of participants were part time faculty and this is equal to representative trends in institutions located in the geographic area where number of part time faculty members is more dominant than full-time faculty member.

Table 5. Demographic Characteristics of Faculty Respondents (N =16)

	N	%
Gender		
Female	10	62.5
Male	6	37.5
Employment Status		
Full-Time	4	25.0
Part-Time	12	75.0
Highest Degree Completed		
Master	9	56.3
Doctorate	7	43.7
Ethnicity		
White, Not Hispanic	8	50.0
African American	1	6.25
Asian	6	37.5
Hispanic	1	6.25

Summary of the Results

Seven Principles of Good Practice in undergraduate Education

The first principle is, "Good practice encourages student-faculty contact." Seventy five percent of faculty indicated they often and very often advise their students about career opportunities in their major field. Over 50 percent of respondents also indicated that they often and very often shared their past experiences, attitudes, and values with students and 50 percent never attend events sponsored by students groups. More than 50 percent (55.3%) of respondents made special effort to be available to students of a culture or race different from their own and (56.3%) knew their students by name by the end of the first two weeks of the term. n conclusion, faculty responded that they performed only three activities to student-faculty contact often or very often.

Less than one third of faculty (31.3%) responded that students often and very often dropped by their office just to visit and (31.3%) occasionally served as a mentor of informal advisor to students. Only 6 percent (6.3%) of participants took students to professional meetings or other events in their field (see table 6).

Table 6

Principle 1: Good Practice Encourages Student-Faculty

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. I advise my students about career opportunities in their major field.	2	12.5	10	62.5	2	12.5	2	12.5	0	0.0	16	100	0	0.0	16	100
b. Students drop by my office just to visit.	2	12.5	3	18.8	4	25.0	7	43.7	0	0.0	16	100	0	0.0	16	100
c. I share my past experience, attitudes, and values with students.	2	12.5	7	43.7	4	25.0	3	18.8	0	0.0	16	100	0	0.0	16	100
d. I attend events sponsored by students groups.	0	0.0	0	0.0	2	12.5	6	37.5	8	50.0	16	100	0	0.0	16	100
e. I work with student affairs staff on issues related to student extracurricular life and life outside of school.	0	0.0	0	0.0	2	12.5	2	12.5	12	75.0	16	100	0	0.0	16	100
f. I know my students by name by the end of the first two weeks of the term.	5	31.3	4	25.0	0	0.0	7	43.7	0	0.0	16	100	0	0.0	16	100
g. I make special efforts to be available to students of a culture or race different from my own.	3	18.8	6	37.5	0	0.0	7	43.7	0	0.0	16	100	0	0.0	16	100
h. I serve as a mentor or informal advisor to students.	6	37.5	1	6.25	1	6.25	4	25.0	4	25.0	16	100	0	0.0	16	100
i. I take students to professional meetings or other events in my field.	0	0.0	0	0.0	1	6.25	7	43.7	8	50.0	16	100	0	0.0	16	100
j. Whenever there is a conflict on campus involving students, I try to help in its resolution.	0	0.0	2	12.5	2	12.5	3	18.8	9	56.2	16	100	0	0.0	16	100

The second principle of good practice is, "Good practice encourages cooperation among students." Eighty percent of faculty stated that they often and very often encouraged students to prepare together for exams and encouraged students to do projects together. Half of respondents (50.0%) indicated that they occasionally asked students to tell each other about their interests and backgrounds. More than 15 percent (18.8%) often and very often created "learning communities" study groups, or project teams within their courses. More than half of the respondents (50.1%) asked their students to discuss key concepts with other students whose backgrounds and viewpoints are different from their own and (68.8%) distribute performance criteria to students so that each person's grade is independent of those achieved by others (see table 7).

Table 7

Principle 2: Good Practice Encourages Cooperation Among Students.

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. I ask students to tell each other about their interests and backgrounds.	0	0.0	3	18.8	8	50.0	3	18.8	2	12.5	16	100	0	0.0	16	100
b. I encourage my students to prepare together for classes or exams.	11	68.7	2	12.5	1	6.25	2	12.5	0	0.0	16	100	0	0.0	16	100
c. I encourage students to do projects together.	6	37.5	7	43.7	2	12.5	1	6.25	0	0.0	16	100	0	0.0	16	100
d. I ask my students to evaluate each other's work.	1	6.25	5	31.3	4	25.0	2	12.5	4	25.0	16	100	0	0.0	16	100
e. I ask my students to explain difficult ideas to each other.	6	37.5	8	50.0	1	6.25	1	6.25	0	0.0	16	100	0	0.0	16	100
f. I encourage my students to praise each other for their accomplishments.	0	0.0	7	43.7	1	6.25	2	12.5	6	37.5	16	100	0	0.0	16	100
g. I ask my students to discuss key concepts with other students whose backgrounds and viewpoints are different from their own.	3	18.8	5	31.3	1	6.25	2	12.5	5	31.3	16	100	0	0.0	16	100
h. I create "learning communities," study groups, or project teams within my courses.	1	6.25	2	12.5	5	31.25	2	12.5	6	37.5	16	100	0	0.0	16	100
i. I encourage students to join at least one campus organization.	0	0.0	2	12.5	0	0.0	8	50.0	6	37.5	16	100	0	0.0	16	100
j. I distribute performance criteria to students so that each person's grade is independent of those achieved by others.	7	43.7	4	25.0	2	12.5	2	12.5	1	6.25	16	100	1	0.0	16	100

The third principle is, "Good practice encourages active learning." More than eighty percent (81.3%) of chemistry faculty often used simulations, role-playing, or labs in their classes. Nearly 20 percent (18.8%) of participants often and very often asked their students to summarize similarities and differences among theories and research findings and (18.7%) often carried research projects with their students. Over forty percent (43.7%) of respondents asked their students to relate outside events or activities to the course and gave their students concrete, real life situations to analyze. Only one-fourth of participant often encouraged their students to suggest new readings, research projects, field trips (see table 8).

Table 8

Principle 3: Good Practice Encourages Active Learning

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. I ask my students to present their work.	2	13.3	4	26.7	5	33.3	4	26.7	0	0.0	15	100	1	6.3	16	100
b. I ask my student to summarize similarities and differences among research findings.	1	6.3	2	12.5	4	25.0	7	43.7	2	12.5	16	100	0	0.0	16	100
c. I ask my students to relate outside events or activities to the course.	3	18.7	4	25.0	3	18.8	4	25.0	2	12.5	16	100	0	0.0	16	100
d. I ask my students to undertake research or independent study.	0	0.0	2	13.3	2	13.3	5	33.3	6	40.0	15	100	1	6.3	16	100
e. I encourage students to challenge my ideas, the ideas of other students, or those presented in readings or other course materials.	4	25.0	3	18.7	5	31.3	4	25.0	0	0.0	16	100	0	0.0	16	100
f. I give my students concrete, real-life situations to analyze	4	25.0	3	18.8	6	37.5	3	18.7	0	0.0	16	100	0	0.0	16	100
g. I use simulations, role-playing, or labs in my classes.	13	81.3	1	6.2	2	12.5	0	0.0	0	0.0	16	100	0	0.0	16	100
h. I encourage my students to suggest new readings, research projects, field trips, or other course activities.	0	0.0	4	25.0	4	25.0	5	31.3	3	18.7	16	100	0	0.0	16	100
i. My students and I arrange field trips, volunteer activities, or internships related to the course.	0	0.0	0	0.0	0	0.0	5	31.3	11	68.7	16	100	0	0.0	16	100
J. I carry out research projects with my students.	0	0.0	3	18.7	2	12.5	3	18.7	8	50.0	16	100	0	0.0	16	100

The fourth principle is, “Good practice gives prompt feedback.” Ninety percent of faculty indicated that they often and very often returned examinations and papers within a week and all participants gave quizzes and homework assignments. One-third of respondents occasionally asked students to schedule conferences to discuss their progress. Nearly 20 percent of respondents stated that they never ask students to keep logs or records of their progress, and discuss the results of the final examination with their students at the end of the semester. Forty-four percent of faculty stated that they often and very often gave their students a pre-test at the beginning of each course. Three-quarter of respondents gave students detailed evaluations of their work early in the term. Eighty-seven of faculty indicated that they very often prepared classroom exercises and problems that give students immediate feedback on their progress (see table 9).

Table 9

Principle 4: Good Practice Gives Prompt Feedback.

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. I give quizzes and homework assignments.	14	87.5	2	12.5	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
b. I prepare classroom exercises and problems that give students immediate feedback on how well they do.	14	87.5	2	12.5	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
c. I return examinations and papers within a week.	15	93.7	1	6.3	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
d. I give students detailed evaluations of their work early in the term.	10	62.5	2	12.5	2	12.5	1	6.25	1	6.25	16	100	0	0.0	16	100
e. I ask my students to schedule conferences with me to discuss their progress.	2	13.3	2	13.3	5	33.3	5	33.3	1	6.7	15	100	1	6.3	16	100
f. I give my students written comments on their strengths and weaknesses on exams and papers.	5	31.3	4	25.0	4	25.0	2	12.5	1	6.2	16	100	0	0.0	16	100
g. I give my students a pre-test at the beginning of each course.	2	12.5	5	31.3	3	18.7	4	25.0	2	12.5	16	100	0	0.0	16	100
h. I ask students to keep logs or records of their progress.	0	0.0	1	6.7	2	13.3	9	60.0	3	20.0	15	100	1	6.3	16	100
i, I discuss the results of the final examination with my students at the end of the semester.	2	12.5	0	0.0	4	25.0	7	43.7	3	18.8	16	100	0	0.0	16	100
j. I call or write a note to students who miss classes.	0	0.0	3	18.8	7	43.7	4	25.0	2	12.5	16	100	0	0.0	16	100

The fifth principle is, “Good practice emphasizes time on task”. Almost 70 percent (68.7%) of respondents indicated that they very often expected students to complete assignments promptly. Nearly 90 percent (87.5%) of participants underscored the importance of regular work, application, and scheduling as well as explained the consequences of non-attendance. All of the respondents returned examinations and papers within a week and communicated to students the minimum amount of time they should spend preparing for class. Seventy-five percent of faculty indicated that they often made clear to students the amount of time required to understand materials. Nearly one-fourth of faculty often met with students who fall behind to discuss their study habits (see table 10).

Table 10
Principle 5: Good Practice Emphasizes Time on Task

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. I expect my students to complete their assignment promptly	11	68.7	5	31.3	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
b. I clearly communicate to my students the amount of time they should spend preparing for classes.	14	87.5	2	12.5	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
c. I return examinations and papers within a week.	13	81.2	3	18.7	0	0.0	0	0.0	0	00	16	100	0	0.0	16	100
d. I make clear to my students the time that is required to understand complex material.	6	37.5	7	43.7	2	12.5	1	6.3	0	0.0	16	100	0	0.0	16	100
e. When oral reports or class presentations are called I encourage students to rehearse.	2	12.5	3	18.8	8	50.0	3	18.7	0	0.0	15	100	1	6.3	16	100
f. I underscore the importance of regular work, steady application, sound self-pacing, and scheduling.	11	68.7	3	18.8	2	12.5	0	0.0	0	0.0	16	100	0	0.0	16	100
g. I explain to my students the consequences of non-attendance.	12	75.0	2	12.5	2	12.5	0	0.0	0	0.0	16	100	0	0.0	16	100
h. I make it clear that full-time study is a full-time job that requires forty or more hours a week.	12	75.0	3	18.2	1	6.3	0	0.0	0	0.0	15	100	1	6.3	16	100
i. I meet with students who fall behind to discuss their study habits, schedules, and other commitments.	4	24	3	18.8	3	18.8	4	25.0	2	12.5	16	100	0	0.0	16	100

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
j. If students miss my classes, I require them to make up lost work.	0	0.0	2	12.5	6	37.5	4	25.0	4	25.0	16	100	0	0.0	16	100

The sixth principle is, "Good practice communicates high expectations." All faculty participants reported "very often" and "often" told students that they expected them to work hard and emphasized the importance of high standards. Sixty-nine percent of participants indicated that they very often made clear their expectations orally, and in writing, at the beginning of the course. Almost one-third (31.2 %) of the participants indicated that they very often helped students set challenging goals for their own learning. Half of the respondents indicated that they often explained to students what would happen if they don't complete their work on time. Sixty-three percent (62.5 %) of participants often encouraged student to write a lot and almost the same percentage suggested extra reading or writing tasks (see table 11).

Table 11

Principle 6: Good Practice Communications High Expectations

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. I tell students that I expect them to work hard in my classes.	13	81.2	3	18.8	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
b. I emphasize the importance of high standards.	14	87.5	2	12.5	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
c. I make clear my expectations orally and in writing for each course.	11	68.7	4	25.0	1	6.3	0	0.0	0	0.0	16	100	0	0.0	16	100
d. I help students set challenging goals for their own learning.	5	31.2	5	31.2	3	18.8	3	18.8	0	0.0	16	100	0	0.0	16	100
e. I explain to students what will happen if they do not complete their work on time.	2	12.5	8	50.0	4	25.0	2	12.5	0	0.0	16	100	0	0.0	16	100
f. I suggest extra reading or writing tasks.	5	31.3	5	31.2	4	25.0	2	12.5	0	0.0	16	100	0	0.0	16	100
g. I encourage students to write a lot.	2	12.5	9	52.2	3	18.8	2	12.5	0	0.0	16	100	0	0.0	16	100
h. I publicly call attention to excellent performance by my students.	4	25.0	5	31.2	4	25.0	3	18.8	0	0.0	16	100	0	0.0	16	100
i. I revise my courses.	6	37.5	9	56.2	1	6.3	0	0.0	0	0.0	16	100	0	0.0	16	100
J. I carry out research projects with my students.	10	62.5	5	31.2	1	6.3	0	0.0	0.0	0	16	100	0	0.0	16	100

The seventh principle is, "Good practice respects diverse talents and ways of learning." All faculty participants stated that they "often" and "very often" encouraged student to speak up when they did not understand. Seventy-five percent of respondents indicated that they often discouraged stride remarks, sarcasm, and other class behaviors that may embarrass students, and eighty percent "often" and "very often" used diverse teaching activities to address a broad spectrum of students. Fifty-six percent of participants (56.3%) "very often" and "often" provided extra material or exercises for students who lacked background knowledge or skills. Over eighty percent of faculty members (81.9%) rarely encouraged students to design their own majors. One-fourth of respondents never making explicit provisions for students who wish to carry out independents studies, never developing mastery learning, learning contracts, or computer assisted learning altering, and as many occasionally encouraged their students to design their own learning. Twenty-one percent of participants reported that they often integrated new knowledge about women and minorities and less than twenty percent occasionally selected reading and designed activities related to the background of the students (see table 12).

Table 12

Principle 7: Good Practice Respect Diverse Talents and Ways of Learning

	Very Often		Often		Occasionally		Rarely		Never		Total		No Response		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
a. I encourage students to speak up when they don't understand.	13	81.3	3	18.7	0	0.0	0	0.0	0	0.0	16	100	0	0.0	16	100
b. I discourage stride remarks, sarcasm, kidding, and other class behaviors that may embarrass students.	12	75.0	3	18.7	1	6.3	0	0.0	0	0.0	16	100	0	0.0	16	100
c. I use diverse teaching activities.	3	18.8	11	68.7	2	12.5	0	0.0	0	0.0	16	100	0	0.0	16	100
d. I select reading and activities related to students background	2	12.5	11	68.7	3	18.8	0	0.0	0	0.0	16	100	0	0.0	16	100
e. I provide extra material for students who lack essential skills	3	18.8	6	37.5	5	31.3	2	12.5	0	0.0	15	100	1	6.3	16	100
f. I integrate new knowledge about under-presented populations.	2	12.5	1	6.3	7	43.7	6	37.5	0	0.0	16	100	0	0.0	16	100
g. I make explicit provisions for students who wish to carry out independent studies.	0	0.0	3	18.7	4	25.0	5	31.3	4	25.0	16	100	0	0.0	16	100
h. I developed mastery learning, learning contacts, or computers assisted learning.	0	0.0	4	25.0	3	18.7	5	31.3	4	25.0	15	100	1	6.3	16	100
i. I encourage my students to design their own learning.	0	0.0	4	25.0	4	25.0	3	81.3	5	31.3	16	100	0	0.0	16	100
J. I try to find out about my students' learning styles, interests, or backgrounds	0	0.0	7	43.7	3	18.8	6	37.5	0	0.0	16	100	0	0.0	16	100

To determine differences in principle utilization by type of principle, each set of ten survey items per principle was summed for each individual. So, the total score is with a range of 10 to 50 for each principle. For example, a score of 50 means that a faculty member very often performed all ten items to a particular principle. A score of 10 means a faculty member never performed those ten items to a particular principle. Mean of the total scores for each principle was found. Some principles are more often used than others (see table 12). For example, faculty most used (mean total score 42.37 and 41.37, respectively) principal five and six (emphasizing time on task and communicating high expectation) than other principles. Faculty rated principle one (student-faculty contact) with lower mean total score (mean total score 26.43) than other six principles.

Table 13. Mean of the Total Scores for Each Principle

Principle	Mean
Principle 1	26.43
Encouraging Student-Faculty Contact	
Principle 2	31.87
Encouraging Student-Student Contact	
Principle 3	28.25
Encouraging Active Learning	
Principle 4	36.32
Giving Prompt Feedback	
Principle 5	42.37
Emphasizing Time on Task	
Principle 6	41.68
Communicating High Expectation	
Principle 7	34.37
Respecting Diverse Ways of Learning	

Detailed Analysis

Research Question (2)

The research question asked is, “what are the effects of students’ approaches to learning and their expectations about learning chemistry on the ways they engage the learning process?”

Survey Response

An invitation to participate in a survey and questionnaire was introduced to 140 students enrolled in general chemistry course at three institutions. These students agreed to participate and signed an informed consent form from approved by the Institutional Review Board.

Demographic Analysis

Participants were asked to respond to demographic questions to characterize respondents. Demographic characteristics of student participants are presented in Table 14. Distribution of gender and ethnicity are approximately equal to representative trend in institutions investigated in the study. 74% of participants are full time students and this is equal to representative trends in institutions located in the geographic area where number of full time students is more than part-time students.

Table 14. Demographic Characteristics of Student Respondents (N =140)

	N	%
Gender		
Female	73	52.1
Male	62	44.3
No response	5	3.6
Enrollment Status		
Full-Time	103	73.6
Part-Time	28	20.0
No response	9	6.4
Age		
18-25 years	124	88.6
26-50 years	16	11.4
More than 50 years	0	0.0
Ethnicity		
White, Not Hispanic	46	32.9
African American	10	7.1
Asian	18	12.9
Hispanic	66	47.1

Assessing students' perceptions toward chemical education using mixed methods was carried out to answer question (2). Data were analyzed for the quantitative research approach collected through two paper instruments to assess students' learning approaches for 140 students. Data for the qualitative research approach collected through field notes for 20 students out of the participants were analyzed based on students' answers to surveys and their performance. This assessed the correlation between students' approaches and beliefs to learning chemistry and their grades.

Summary of the Results

CHEMX

The first quantitative instrument was CHEMX Survey. CHEMX assesses students' cognitive expectations for learning chemistry and was administered to 140 students using 5-points Likert scales. There are 47 statements divided into seven clusters (effort, concepts, math link, reality link, outcome, laboratory, and visualization) include 5-points scales. The Likert scale responses range from 5 (strongly agree) to 1 (strongly disagree). Two opposing dimensions describe each cluster. The chemistry faculty expectation about learning chemistry is designated as "favorable" while the opposite view is designated as "unfavorable". The items that associate with each cluster are listed in Table 1. Of the 47 items, 25 are worded negatively (presented by bold face numbers in Table 1). Favorable view of these items are indicated by answering strongly disagree and disagree.

The research question was answered by calculating frequencies and percentages to each individual item for each cluster. Tables 15 through 21 include each survey item, frequencies and percentages for each rating. The Likert scale responses range from 5 (strongly agree) to 1 (strongly disagree).

The first Cluster is effort. Students responded that they weakly performed three activities. Only fifty-three percent (53.7%) of students reported favorable answer that they read the text in detail and worked through many of the examples given there. In doing chemistry problem, if the calculation gave a result that differed significantly from what they expected, 57 percent of students indicated that they'd have to trust the calculation. Almost half of students (52.1%) stated that the result of an exam didn't give them any useful guidance to improve their understanding of the course material. They believed that all the learning associated with an exam was in the studying that they did before it took place. Around 80 percent of respondents would go over the class notes carefully to prepare for tests in the course and use the mistakes they made on homework and on exam problems as clues to what needed to do to understand the material better (see table 15).

Table 15
Cluster 1: Effort
CHEMX Items: 2, 6, 8, 19, 22, 31,34, 38, 41

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
2. I go over my class notes carefully to prepare for tests in this course.	89	63.6	27	19.3	18	12.9	2	1.4	4	2.8	82.9	12.9	4.2	140	100
6. There is very little I can do to test whether an answer I calculate is right.	10	7.1	20	14.3	24	17.1	45	32.2	41	29.3	61.5	17.1	21.4	140	100
8. I read the text in detail and work through many of the examples given there.	26	18.5	49	35.0	35	25.0	18	12.9	12	8.6	53.5	25.0	21.5	140	100
19. In doing a chemistry problem, if my calculation gives a result that differs significantly from what I expect, I'd have to trust the calculation.	0	0.0	23	16.4	37	26.4	68	48.6	12	8.6	57.2	26.4	16.4	140	100
22. After I numerically solve a chemistry problem, I check my answer to see if the answer makes sense.	27	19.3	78	55.7	13	9.3	16	11.4	6	4.3	75.0	9.3	15.7	140	100
31. Chemical demonstrations do not provide me with useful information although they can be fun and exciting.	3	2.2	15	10.7	30	21.4	71	50.7	21	15.0	65.7	21.4	12.9	140	100
34. The results of an exam don't give me any useful guidance to improve my understanding of the course material. All the learning associated with an exam is in the studying that I do before it takes place.	19	13.6	23	16.4	25	17.9	44	31.4	29	20.7	52.1	17.9	30.0	140	100
38. Spending a lot of time (half hour or more) working on a problem is a waste of time. If I don't make progress quickly, I'd be better off asking someone who knows more than I do.	7	5.0	28	20.0	21	15.0	49	35.0	35	25.0	60.0	15.0	25.0	140	100

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
41. I use the mistakes I make on homework and on exam problems as clues to what need to do to understand the material better.	49	35.0	62	44.3	18	12.9	6	4.2	5	3.6	79.3	12.9	7.8	140	100

The second cluster is concepts. Seventy-seven percent of students (77.7%) favorably answered that they needed to know more than what each term in the equation represented to be able to use an equation in a problem. Only 27 percent of participants (27.9%) showed favorable answer when stated that problem solving in chemistry would mean matching problems with facts or equations and then substituting values to get a number. When solving most exam or homework problems, sixty percent of respondents (60.0%) indicated that they explicitly thought about the concepts that underlie the problem. Only 15 percent of students replied favorably about the most crucial thing in solving a chemistry problem would be finding the right equation to use (see table 16).

Table 16
Cluster 2: Concepts
CHEMX Items: 4, 28, 36, 37, 43

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
4. Problem solving in chemistry means matching problems with facts or equations and then substituting values to get a number	25	17.8	40	28.6	36	25.7	26	18.6	13	9.3	27.9	25.7	46.4	140	100
28. The most crucial thing in solving a chemistry problem is finding the right equation to use.	39	27.9	42	30.0	38	27.1	12	8.6	9	6.4	15.0	27.1	57.9	140	100
36. When I solve most exam or homework problems, I explicitly think about the concepts that underlie the problem.	36	25.7	49	35.0	27	19.3	23	16.4	5	3.6	60.7	19.3	20.0	140	100
37. Understanding chemistry means being able to recall something you've read or been shown.	24	17.1	47	33.6	31	22.1	23	16.5	15	10.7	27.2	22.1	50.7	140	100
43. To be able to use an equation in a problem (particularly in a problem I haven't seen before), I need to know more than what each term in the equation represents.	28	20.0	81	57.9	26	18.6	4	2.8	1	0.7	77.9	18.6	3.5	140	100

The third cluster is math link. Only one-third of students (34.3%) answered favorably that all they learned from a deviation or proof of a formula was that the formula obtained is valid and it is OK to use it in problems. Thirty-seven percent (37.9%) of respondents indicated favorable answer if they didn't remember a particular equation needed for a problem in an exam there's nothing much they could do to come up with it. Sixty-three percent of respondents spent a lot of time figuring out and understanding at least some of the derivations or proofs given either in class or in the text. Almost 64 percent provided favorable answer they expected to understand equations in an intuitive sense (see table 17).

Table 17
Cluster 3: Math Link
CHEMX Items: 5, 9, 11, 21, 29

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
5. All I learn from a deviation or proof of a formula is that the formula obtained is valid and it is OK to use it in problems.	15	10.7	38	27.1	39	27.9	33	23.6	15	10.7	34.3	27.9	37.8	140	100
9. In this course, I do not expect to understand equations in an intuitive sense; they just have to be taken as givens.	6	4.3	14	10.0	30	21.4	66	47.1	24	17.2	64.3	21.4	14.3	140	100
11. I spend a lot of time figuring out and understanding at least some of the derivations or proofs given either in class or in the text.	37	26.4	52	37.1	32	22.9	11	7.9	8	5.7	63.5	22.9	13.6	140	100
21. The derivations or proofs of equations in class or in the text have little to do with solving problems or with the skills I need to succeed in this course.	0	0.0	13	9.3	27	19.3	78	55.7	22	15.7	71.4	19.3	9.3	140	100
29. If I don't remember a particular equation needed for a problem in an exam there's nothing much I can do (legally!) to come up with it.	26	18.6	30	21.4	31	22.1	34	24.3	19	13.6	37.9	22.1	40.0	140	100

The fourth cluster is reality link. Over two-third of students (67.9%) believed that chemical theories had little relation to what they experienced in the real world. Almost half of students (47.1%) reported that to understand chemistry, they sometimes thought about their personal experiences and related them to the topic being analyzed. Fifty-five percent of respondents indicated that learning chemistry helped them understand situations in their everyday life (see table 18).

Table 18
Cluster 4: Reality link
CHEMX Items: 14, 26, 30, 35, 42

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
14. Chemical theories have little relation to what I experience in the real world.	1	0.7	17	12.1	27	19.3	62	44.3	33	23.6	67.9	19.3	12.8	140	100
26. To understand chemistry, I sometimes think about my personal experiences and relate them to the topic being analyzed.	36	25.7	30	21.4	27	19.3	32	22.9	15	10.7	47.1	19.3	33.6	140	100
30. It is unnecessary for me to have to relate chemistry to the real world.	3	2.1	11	7.9	20	14.3	77	55.0	29	20.7	75.7	14.3	10.0	140	100
35. Learning chemistry helps me understand situations in my everyday life.	56	40.0	22	15.7	42	30.0	13	9.3	7	5.0	55.7	30.0	14.3	140	100
42. The chemical behavior of atoms and molecules has implications in my life.	29	20.7	54	38.6	41	29.3	9	6.4	7	5.0	59.3	29.3	11.4	140	100

The fifth cluster is outcome. Ninety percent of participants indicated that learning chemistry made them change some of their ideas about how the physical world works and a good understanding of chemistry is necessary for them to achieve their career goals. Forty-two percent of students reported that knowledge in chemistry consists of many pieces of information, each of which applies primarily to a specific situation. Over eighty percent of participants (84.3%) believed that learning chemistry required that they substantially rethink, restructure, and reorganize the information that they are given in class and/or read in the text (see table 19).

Table 19
Cluster 5: Outcome
CHEMX Items: 7, 15, 16, 17, 25, 40, 45, 47

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
7. Learning chemistry made me change some of my ideas about how the physical world works.	89	63.6	37	26.4	9	6.4	4	2.9	1	0.7	90.0	6.4	3.6	140	100
15. A good understanding of chemistry is necessary for me to achieve my career goals. A good grade in this course is not enough.	97	69.3	33	23.6	6	4.3	4	2.8	0	0.0	92.9	4.3	2.8	140	100
16. Knowledge in chemistry consists of many pieces of information, each of which applies primarily to a specific situation.	29	20.7	31	22.2	21	15.0	36	25.7	23	16.4	42.9	15.0	42.1	140	100
17. My grade in this course is primarily determined by how familiar I am with the material. Insight or creativity has little to do with it.	18	12.9	23	16.4	28	20.0	41	29.3	30	21.4	50.7	20.0	29.3	140	100

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
25. Only a very few specially qualified people are capable of really understanding chemistry.	30	21.4	86	61.4	15	10.7	4	2.9	5	3.6	82.8	10.7	6.5	140	100
40. The main skill I get out of this course is to learn how to reason logically about the physical world.	25	17.9	79	56.4	30	21.4	4	2.9	2	1.4	74.3	21.4	4.3	140	100
45. It is possible to pass this course (get a "C" or better) without understanding chemistry very well.	21	15.0	4	2.8	8	5.7	95	67.9	12	8.6	76.5	5.7	17.8	140	100
47. Learning chemistry requires that I substantially rethink, restructure, and reorganize the information that I am given in class and/or read in the text.	56	40.0	62	44.3	18	12.9	4	2.8	0	0.0	84.3	12.9	2.8	140	100

The sixth cluster is laboratory. Participants' response of this cluster aligned with favorable views. Students reported favorable answers that it is important they learn proper laboratory techniques in this course (94.3%), expect to understand how laboratory instruments work (82.9 %), and when doing lab calculations, they attempt to work through them before looking for help from the lab manual or instructor (89.3%). Ninety percent of respondents expected to use what they learned during one lab experiment in another experiment (see table 20).

Table 20
Cluster 6: Laboratory
CHEMX Items: 1, 12, 13, 23, 32, 39, 44, 46

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
1. I can do well in the chemistry laboratory (C grade or better) without understanding the chemical principles behind the labs.	8	5.7	13	9.3	21	15.0	72	51.4	26	18.6	70.0	15.0	15.0	140	100
12. It really doesn't matter how hard I work in the laboratory; the most important thing is to get the right answer.	7	5.0	21	15.0	12	8.6	71	50.7	29	20.7	71.4	8.6	20.0	140	100
13. It is important that I learn proper laboratory techniques in this course.	97	69.3	35	25.0	5	3.6	0	0.0	3	2.1	94.3	3.6	2.1	140	100
23. I really don't expect to understand how laboratory instruments work- they are just tools that help me complete the lab.	3	2.1	12	8.6	9	6.4	84	60.0	32	22.9	82.9	6.4	10.7	140	100
32. It is important that I finish a lab as quickly as possible- I'll figure out what the data meant later.	6	4.3	13	9.3	12	8.6	66	47.1	43	30.7	77.8	8.6	13.6	140	100
39. When doing lab calculations, I attempt to work through them myself before looking for help from the lab manual or instructor.	96	68.6	29	20.7	9	6.4	6	4.3	0	0.0	89.3	6.4	4.3	140	100
44. When I do an experiment in the laboratory, it is not important that I understand what is happening. I should just follow the directions carefully.	9	6.4	6	3.3	9	6.4	76	54.3	40	28.6	82.9	6.4	9.7	140	100
46. I don't expect to use what I learn during one lab experiment in another experiment.	1	0.7	6	4.3	6	4.3	98	70.0	29	20.7	90.7	4.3	5.0	140	100

The seventh cluster is visualization. Although over sixty percent of participants tried to imagine what it might look like in 3-D when they saw a drawing of a molecule in their textbook, only fifty-seven percent of students (57.2%) they tried to picture it its structure and forty-six percent of respondents (46.4%) didn't' spend much time constructing 3-D models of the 2-D structures that they draw in their class notes or read in their textbook. More than seventy-seven percent of students (77.9%) should be able to explain what they saw in terms of the reactions of atoms and molecules, after they have watched a chemistry demonstration. Almost eighty percent of students (77.8%) stated that being able to visualize molecules in 3-D is an important skill for learning chemistry. Nearly seventy percent of respondents believed that solving a chemistry problem might require them to be able to draw molecules in more than one way (see table 21).

Table 21
Cluster 7: Visualization
CHEMX Items: 3, 10, 18, 20, 24, 27, 33

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
3. When I see a drawing of a molecule in my textbook, I try to imagine what it might look like in 3-D.	27	19.3	61	43.6	29	20.7	16	11.4	7	5.0	62.9	20.7	16.4	140	100
10. When I see a chemical formula, I try to picture its structure	27	19.3	53	37.9	27	19.3	16	11.4	17	12.1	57.2	19.3	23.5	140	100
18. I don't' spend much time constructing 3-D models of the 2-D structures that I draw in my class notes or read in my textbook.	30	21.4	27	19.3	18	12.9	41	29.3	24	17.1	46.4	12.9	40.7	140	100
20. When I do an experiment in the laboratory, I try to picture the chemistry that is happening.	28	20.0	68	48.6	25	17.9	15	10.7	4	2.8	68.6	17.9	13.5	140	100
24. Solving a chemistry problem may require me to be able to draw molecules in more than one way.	38	27.1	64	45.7	27	19.3	6	4.3	5	3.6	72.8	19.3	7.9	140	100

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
27. After I have watched a chemistry demonstration, I should be able to explain what I saw in terms of the reactions of atoms and molecules.	48	34.3	61	43.6	21	15.0	7	5.0	3	2.1	77.9	15.0	7.1	140	100
33. Being able to visualize molecules in 3-D is an important skill for learning chemistry.	31	22.1	78	55.7	21	15.0	6	4.3	4	2.9	77.8	15.0	7.2	140	100

Summary of the Result

R-SPQ-2F

Data from the second instrument "The revised two-factor study process questionnaire", (R-SPQ-2F) that describes the studying attitudes and learning styles (Biggs, 1993a) were analyzed. Data from the questionnaire illustrated to what degree students are utilizing surface or deep approach in learning and studying general chemistry. The instrument that includes 5-points Likert scales and open-ended questions has been administrated to 140 students. The responses are as 5 meaning "always", 4 meaning "frequently", 3 meaning "half the time", 2 meaning "sometime", and 1 meaning "never". The questionnaire has two main scales: Deep Approach (DA) and Surface Approach (SA). Deep Approach (DA) and Surface Approach (SA) have four sub-scales, Deep Motive (DM), Deep Strategy (DS), Surface Motive (SM), and Surface Strategy (SS).

Data from the questionnaire using frequencies and percentages for the Likert scale responses for Deep Motive (DM), Deep Strategy (DS), Surface Motive (SM), and Surface Strategy (SS) demonstrate to what degree students are employing surface or deep approach in learning general chemistry course.

Deep Approach (DA) has two sub-scales; Deep Motive (DM) and Deep Strategy (DS). Tables 22 and 23 illustrate data using frequencies and percentages for Likert scale responses for Deep approach (DA). Deep Motive (DM) demonstrated that eighty percent of students reported favorable answer that they virtually felt any topic could be highly interesting once they got into it. Only fifty percent of students reported favorable answer that they found studying academic topics could at times exciting and sixty percent of respondents worked hard at their studies because they found the material interesting. Only thirty-six percent (36.4%) of students come to most classes with questions in mind that they want answering (see table 22).

Table 22

Deep Approach (DA)
Deep Motive (DM)

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
1. I find that at times studying gives me a feeling of deep personal satisfaction.	35	25.0	53	37.9	31	22.1	21	15.0	0	0.0	62.9	22.1	15.0	140	100
5. I feel that virtually any topic can be highly interesting once I get into it.	48	34.3	64	45.7	17	12.1	9	6.4	2	1.4	80.0	12.1	1.8	140	100
9. I find that studying academic topics can at times be as exciting as a good novel or movie.	27	19.3	43	30.7	42	30.0	22	15.7	6	4.3	50.0	30.0	20.0	140	100
13. I work hard at my studies because I find the material interesting.	46	32.9	39	27.9	36	25.7	16	11.4	3	2.1	60.8	25.7	13.5	140	100
17. I come to most classes with questions in mind that I want answering.	19	13.6	32	22.8	46	32.9	34	24.3	9	6.4	36.4	32.9	30.7	140	100

Data using frequencies and percentages for Likert scale responses for Deep Strategy (DS) demonstrated forty- seven percent (47.8%) of students reported favorable answer that they found most topics interesting and often spent extra time trying to obtain more information about them. Only fifty percent (51.4 %) of students reported favorable answer that they made a point of looking at most of the suggested readings that go with the lectures. Nearly 78 percent (77.9%) of students favorably answered that they found that they had to do enough work on a topic so that they could form their own conclusions before they are satisfied. Nearly sixty-eight percent (68.6%) of students tested themselves on important topics until they understood them completely (see table 23).

Table 23

Deep Approach (DA)
Deep Strategy (DS)

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.	26	18.6	83	59.3	24	17.1	5	3.6	2	1.4	77.9	17.1	5.0	140	100
6. I find most new topics interesting and often spend extra time trying to obtain more information about them.	23	16.4	44	31.4	54	38.6	14	10.0	5	3.6	47.8	38.6	13.6	140	100
10. I test myself on important topics until I understand them completely.	22	15.7	74	52.9	23	16.4	15	10.7	6	4.3	68.6	16.4	15.0	140	100
14. I spend a lot of my free time finding out more about interesting topics, which have been discussed, in different classes.	18	12.9	26	18.6	45	32.1	39	27.8	12	8.6	31.5	32.1	36.4	140	100
18. I make a point of looking at most of the suggested readings that go with the lectures.	34	24.3	38	27.1	42	30.0	20	14.3	6	4.3	51.4	30.0	18.6	140	100

Surface Approach (SA) has two sub-scales; Surface Motive (SM) and Surface Strategy (SS). Tables 24 and 25 illustrate data using frequencies and percentages for Likert scale responses for Surface Approach (SA). Data using frequencies and percentages for Likert scale responses for Surface Motive (SM) demonstrated fifty percent of students reported that they found they got by in most assessments by memorizing key sections rather than trying to understand them. Fifty-seven percent of students reported favorable answer to that they "never" or "sometime" saw no point in learning material that is not to be in the test. More than two-third of participants their aim is "never" or "sometime" to pass the course while doing as little work as possible (see table 24).

Table 24

Surface Approach (SA)
Surface Motive (SM)

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
3. My aim is to pass the course while doing as little work as possible.	8	5.7	13	9.3	23	16.4	21	15.0	75	53.6	68.6	16.4	15.0	140	100
7. I do not find my course very interesting so I keep my work to the minimum.	12	8.6	11	7.9	9	6.4	56	40.0	52	37.1	77.1	6.4	16.5	140	100
11. I find I can get by in most assessments by memorizing key sections rather than trying to understand them.	10	7.1	16	11.4	43	30.7	39	27.9	32	22.9	50.8	30.7	18.5	140	100
15. I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics.	6	4.3	9	6.4	19	13.6	71	50.7	35	25.0	75.7	13.6	10.7	140	100
19. I see no point in learning material, which is not likely to be in the examination.	12	8.6	13	9.3	35	25.0	58	41.4	22	15.7	57.1	25.0	17.9	140	100

Data using frequencies and percentages for Likert scale responses for Surface Strategy (SS) demonstrated that nearly half the students generally restricted their study to what is specifically set as they thought it is necessary to do anything extra, and believed that lectures shouldn't expect students to spend significant amounts of time studying material everyone knows wouldn't be examined. Only thirty-eight percent (38.6%) of respondents said they "never" or "sometime" learned some things by rote, going over and over until they knew them by heart without understanding. Almost two-third of students they "never" or "sometime" found the best way to pass examinations is to try to remember answers to likely questions. Forty-three percent (43.6%) of respondents they "never" or "sometime" only studied seriously what's given out in class (see table 25).

Table 25
Surface Approach (SA)
Surface Strategy (SS)

	Strongly Agree		Agree		Neutr al		Dis agree		Strongly Disagree		Favorable	Neutral	Non Favorable	Total	
	5		4		3		2		1						
	N	%	N	%	N	%	N	%	N	%	%	%	%	N	%
4. I only study seriously what's given out in class or in the course outlines.	15	10.7	42	30.0	22	15.7	34	24.3	27	19.3	43.6	15.7	40.7	140	100
8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.	19	13.6	31	22.1	36	25.7	32	22.9	22	15.7	38.6	25.7	35.7	140	100
12. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.	7	5.0	30	21.4	28	20.0	42	30.0	33	23.6	53.6	20.0	26.4	140	100
16. I believe that lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.	13	9.3	21	15.0	30	21.4	46	32.9	30	21.4	54.3	21.4	24.3	140	100
20. I find the best way to pass examinations is to try to remember answers to likely questions.	7	5.0	18	12.9	22	15.7	48	34.3	45	32.1	66.4	15.7	17.9	140	100

Qualitative Approach

The perceptions of students were evaluated using mixed methods to answer research question b; what are the effects of student' approaches to learning and their expectations for learning chemistry on the ways they engage the learning process?

Field notes from R-SPQ-2F questionnaire and CHEMX survey related to students' views and expectations about learning chemistry for a sample of 20 students were collected. For each student the results of both the R-SPQ-2Fquestionnaire and CHEMX survey were discussed with the researcher and correlated with the grade. Field notes introduced multiple examples of fact and experience of participants in its real life context.

Possible scores for CHEMEX from 47 to 235 and calculated of the 47 statements. The higher the score, the higher student's expectation associated with the favorable views determined during CHEMX survey. Deep Approach Score and Surface Approach Score for R-SPQ-2F were summed for each student.

Deep Approach Score: Σ All Deep Motive scores + all Deep Strategy scores
Surface Approach Score: Σ All Surface Motive scores + all Surface Strategy scores

Analysis of field notes was practical qualitative approach to develop new ideas for in-depth explorations of perceptions of students to prepare a proposed plan for improving general chemistry courses. Data from 20 students' performance in the class were collected and correlated with students' approaches to learning and their expectations for learning chemistry.

Evaluating Reasoning of Field Notes

Analysis of field notes was practical qualitative approach to develop new ideas for in-depth explorations of perceptions of students to prepare a proposed plan for improving general

chemistry courses. Data from 20 students' performance in the class were collected and correlated with students' approaches to learning and their expectations for learning chemistry.

The purpose of the evaluation process of field notes is to develop an understanding of the concepts and tool of data collection and analysis. The advantages of doing qualitative research such as field notes provide flexibility to follow unexpected ideas during research and explore processes effectively. Lincoln and Guba (2000) state that "qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them" (p. 3). Taking field notes can be practical qualitative research method to develop new ideas for in-depth explorations for researcher interest. There was an opportunity to be engaged in simple qualitative data gathering and analysis at the research site. This included inviting 20 students to conversation about the real impact of the effect of student beliefs and expectations for learning chemistry on the ways they engage the learning process.

Procedure

1. Meeting with each student to discuss weaknesses, strengths, opportunities, and challenges to improve their attitude toward learning and studying general chemistry course based on their CHEMX and Deep Approach scores.
2. Administrating CHEMX survey and R-SPQ-2F questionnaire to random sample of five chemistry instructors. They were asked to answer, as they would prefer their students to respond not as they might believe would respond. The response held by chemistry instructors is designated as "favorable" response and the opposite response is designated as 'unfavorable"

3. Reading the data transcript and underlining any sentences is relevant to the research question.

4. Crossing out all data is not related to the research question

5. Taking each underlying sentences that center on one idea and naming it

6. Gathering the set of meaning ideas that are related and developing patterns

7. Naming each pattern versus set of ideas as shown in Table 26

Table 26. Qualitative Approach, Pattern versus set of ideas

Pattern: Students' understanding of "Favorable" and "non-favorable" response
Pattern: Student's Deep Approach Score Σ All Deep Motive scores + all Deep Strategy scores
Pattern: Student's Surface Approach Score: Σ All Surface Motive scores + all Surface Strategy scores
Pattern: Student's CHEMX Score Σ All 47 items scores
Pattern: Student's Grade in the first tests

Engaging a sample of 20 students in a discussion about student' approaches to learning and their expectations for learning chemistry have provided rich data to suggest solutions to the research question. Cognitive expectations have an impact on students' performance because these expectations form students' beliefs about learning chemistry. It is expected that there is a gap between faculty and students expectations for learning chemistry. Therefore, for each student, Student's Deep Approach Score, Student's Surface Approach Score, and CHEMX Score were summed and correlated to their performance.

Table 27. Results of R-SPQ-2F Questionnaire and CHEMX Survey Versus Student Performance

Student	Deep Approach Score	Surface Approach Score	CHEMX Score	Grade
1501	42	16	182	C
1502	33	27	187	C
1503	35	32	187	B
1504	30	34	179	B
1505	34	16	161	C
1506	29	24	171	A
1507	31	26	174	B
1508	27	23	161	B
1509	39	27	187	A
15010	37	29	221	A
15011	35	35	187	A
15012	33	19	165	A
15013	30	27	158	C
15014	29	23	141	A
15015	26	39	180	D
15016	39	15	173	B
15017	28	30	169	C
15018	40	18	183	B
15019	24	17	165	B
15020	45	25	187	B

Means for total scores of Deep Approach Score (DA) and CHEMC Score for grade, A, B, C were determined (see table 28).

Table 28. Mean of Deep Approach (DA) and CHEMX Results Versus Grades

Grade	DA Score	CHEMX Score
A	33.7	183.0
B	33.9	173.5
C	33.4	171.4

The following illustration shows the distribution of Deep Approach (DA) Score and CHEMX Score versus Grade Scale A, B, C (Figure. 6).

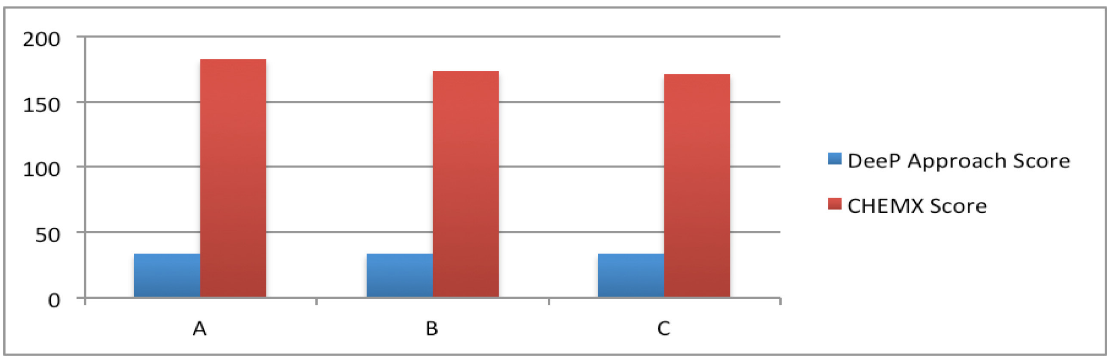

Figure 6. Deep approach score and CHEMX Score and student performance

Research Question (3)

A qualitative approach was utilized to answer question 3: " In the light of the perceptions of faculty and students, what is the role of the administrators to support a long term plans related to the proposed plan?"

The advantages of doing qualitative research on leadership provide flexibility to follow unexpected ideas during research and explore processes effectively. Interview was a practical qualitative research method to develop new ideas for in-depth explorations of leadership phenomena for researcher interest. There was an opportunity to be engaged in qualitative data gathering and analysis at two institutions. This included carrying out six interviews with potential leaders and inviting them to conversation about the real impact of the proposed plan to develop general chemistry course.

Interview questions as illustrated in chapter 3 were obtained through an internet search of various sites related to the impact of developing a plan to improve general chemistry course. Interviewing and recording the conversation, after taking interviewees permission, assists understanding of their perception to the current situation. Following appropriate procedures and explaining the purpose of the interview can assure the participants confidentiality.

Interview Questions

1. What are the fundamental principles of a learning college?
2. How does a learning college contribute to create a learning culture focused on student achievement?
3. How do our individual and collective actions contribute to student learning?
4. Explain the college commitment to an expansive "learning outcomes" agenda?
5. How does the current leadership within our institution resolve conflicts between the mission of the organization and the needs of the students?
6. What is needed to achieve sustainable continuous quality improvement level for evaluating institutional effectiveness?
7. What types of changes would you implement within the department of chemistry to improve creating of a culture of learning?
8. How does the department recognize the role of its faculty in assuring quality of instruction?
9. How does the department seek to meet the educational needs of its students?

10. How can you assist instructors using teaching methodologies that reflects the diverse needs of the students?
11. Has the curriculum process been streamlined over the past three years?
12. Do you encourage faculty to get involved through committees such as outcomes-based assessment committee?

Evaluating Reasoning of Qualitative Interviews

The purpose of the evaluation process of interviews is to develop an understanding of data collection and analysis. Conducting qualitative analysis using data analysis in generic qualitative analysis was used. The tool for conducting the analysis of data when using the generic qualitative inquiry method for developing a dissertation at Capella is that of applying a thematic analysis. Thematic analysis was used to conduct an analysis of qualitative data in interviewing six administrators.

Appendix D presents the transcription of the data collected from the six interviews that have been conducted.

Procedure

1. Conducting a thematic analysis of data around the following research question: "In the light of the perceptions of faculty and students, what is the role of the administrators to support a long term plans related to the proposed plan?"

2. Reading the data transcript and underlining any sentences is relevant to the research question.

3. Crossing out all data is not related to the research question.

4. Taking each underlying sentences that center on one idea and naming it.

5. Gathering the set of meaning ideas that are related and developing pattern.

6. Naming each pattern versus set of ideas as shown in Table 29 below

Table 29: Qualitative Approach: Naming each pattern versus ideas

Pattern	Description
Foster a college culture that puts learning first.	The interviewees suggest that The learning college is focused on student learning by placing learning and needs of students first. "The learning college provides educational experiences for learners any way, any place, any time". Learning is our business. "We aren't here just to teach. We are here to see that our students learn." The mission of the college is "focused on engaging students as responsible partners in the lifelong learning processes". The college will judge itself on quality of student learning.
Achieve student success by placing the needs of the learners first.	The learning college provides a systematic strategy focused on student success. It provides an "overall framework for creating and examining student success". "Achieving student success can be maintained by placing their needs first". "Nurturing an assessment culture will be implemented through the empowerment of the College Outcomes and Assessment Committee (OAC)". Implementation of outcomes-based assessment requires support all facet of the college with resources. The purpose of assessment and outcomes is to "use the results to inform meaningful dialogue about ways instructional and non-instructional programs can be modified". This can be helpful to engage students in the learning process and to sustain institutional effectiveness. "The College Outcomes and Assessment Committee are responsible to implement a plan in providing a comprehensive approach to the integration of outcomes-based assessment at the site". The objective of the plan is to "ensure that the outcomes-based assessment takes place at institution, program, degree, certificate, and course levels"
Evidence of culture of learning	A focus on student learning by keeping our vision "learning to all" simplifies our vision in understandable form. "We will judge ourselves on the quality of student learning. We encourage sustained institutional commitment to funding policies for success. We reject the 'deficit" model regarding unprepared students". An example to assist the college administrators, faculty, and staff with the question of outcomes assessment alignment, the outcomes and assessment committee has developed an outcomes aligned structure. "The structure provides individuals with a visual image of how outcomes linked at several levels, as well as helping to differentiate between some commonly confused terms used in outcomes and assessment"

Student learning outcomes	Defining learning outcomes for each course and integrate it into teaching. "We teach for learning outcomes to build an assessment culture that support student achievement. This also needs to be documented". Student learning outcomes are clear statement of what student should learn and be able to "demonstrate upon completing a course or program". It described the "assessable and measurable knowledge skills, and abilities that students should attain by the end of a learning process". Results of assessment are being used "for improvement and further alignment of institutional practices". Faculty and staff in our college are fully engaged in student learning outcomes development.
Current leadership within the college	The current leadership within the institution resolves the issue of how the students are being served. "Under the best time, the managers have to direct their staff and faculty to carry those policies they believe in". "Under restricted budget, there are two issues to be considered. First, developing policies that preserve high moral among faculty and staff is crucial for leadership in the institution. Second, managing resource of money which leads to other resources is an ethical challenge to balance the interest of the students they have different needs". Examples of student needs: older students require basic skills versus transfer students require upper division classes. Another example that students at different campuses may need equal program offering in their neighborhood. There is an opportunity to creating a learning culture that can be implemented through building the knowledge for leaders and faculty to see how they make a learning college. "Leadership in our college understands that accountability system requires developing new leadership strategies that establish sustainability to promote the development of networks working within national, state, and institutional level".
Changes to improve creating of a culture of learning	Enhancing the experience with the development of learning outcomes and in the design of alternative learning opportunities, "faculty can demonstrate experience or commitment to integrating new technologies or emphases into the learning process". It is important to have a faculty profile as "a facilitator of the learning process". Engaging learners in the learning process "creates substantive change in individual learners". Assisting learners to form and participate in collaborative learning activities are also important to define the role of the learning facilitator by the need of the learners.

Chapter 4 Summary

This action research sought to propose a plan to improve student engagement in general chemistry courses. The study investigated perceptions of faculty, students, and administrators, with a focus on the impact of chemistry education on student learning. A mixed method was utilized to analyze different perceptions to demonstrate the level of commitment and engagement in general chemistry education.

Quantitative Approach

The current research considered two key components that have contributed to student learning and engagement in general chemistry course: educational practices and student behavior. Utilizing the most well-known engagement measures of quality education in colleges and universities demonstrated the factors that influence student engagement. The analysis represents the views of 16 faculty and 140 students and 6 administrators.

Faculty's Perception of the Factors that Affect Chemistry Learning.

The extent in which chemistry faculty members are utilizing the "Seven Principles for Good Practice in Undergraduate Education" in their instruction was investigated. Results have shown that each principle was used to a different degree. Comparing the principle utilization, the least-used principle was the result of principle one (encouraging student-faculty contact, mean score = 26.43). The most-used by chemistry faculty are for principle five (emphasizing time on task, mean score = 42.37) and principle 6 (communicating high expectation, mean score = 41.68).

Student's Perception of the Factors that Affect Chemistry Learning

Students' perceptions, attitudes and approaches toward chemistry learning were analyzed. The focus was on investigating students' cognitive expectations of learning chemistry from their own experiences, beliefs, skills, and thoughts on what was expected of them.

Cognitive Expectation for Chemistry Learning Using CHEMX

Seven categories used to measure students' prior knowledge on chemistry learning and their perceived expectations of educators were: effort, concepts, math link, reality link, outcome, laboratory, and visualization. The research question was answered by calculating frequencies and percentages for responses to each individual survey item. Tables 5 through 11 included each survey item, frequencies, and percentages for each rating.

Deep Learning and Surface Learning in Chemistry using R-SPQ-2F

Student perceptions and learning related attitudes were explored to examine student deep approaches to chemistry learning. The research study focused on investigating student's understanding of the process of chemistry learning from their experiences and beliefs about learning, what skills will be required, and what are expected to do to deeply engage in chemistry learning.

Qualitative Approach

The advantage of doing qualitative research is to provide flexibility to follow unexpected ideas during research and explore processes effectively. Interview was a practical qualitative research method to develop new ideas for in-depth explorations of leadership phenomena for researcher interest. There was an opportunity to be engaged in qualitative data gathering and analysis at two institutions.

Interviewing six administrators: Six interviews with potential leaders were utilized to invite them to conversation about the real impact of the proposed plan to develop general chemistry course.

Evaluating Reasoning of Field Notes from students: Field notes from (R-SPQ-2F) questionnaire and (CHEMX) survey related to students' views and expectations about learning chemistry for a sample of 20 students. Data was collected and correlated to student's performance. For each student the results of both the R-SPQ-2Fquestionnaire and CHEMX survey were discussed with the researcher and correlated with the grade. Field notes introduced multiple examples of fact and experience of participants in its real life context.

Evaluation of interviews was made of how the research study presented the process of data gathering and analysis. The purpose of evaluation process of the interview is to develop an understanding of the concepts and tool of data collection and analysis. The interview sample involved number of diverse group of administrators. Providing examples from the data to make judgment assisted the researcher to present and interpret the data.

CHAPTER 5. CONCLUSIONS AND DISCUSSION

Introduction

The purpose of the research study is to describe a process of developing a plan to improve student engagement and learning within general chemistry course. The study focused on examining and evaluating perceptions of administrators, chemistry faculty, and students to illustrate the extent to which faculty teach with institution expectations, as well as to evaluate the level of prior knowledge and cognitive expectations students have on chemistry learning. The previous chapters looked into the challenges found that impact the effectiveness of chemistry learning and teaching and affect learners' engagement in general chemistry course.

This chapter concludes and discusses the results of the research. First is a demonstration of the extent the chemistry faculty members using the principles of good practice to engage their students in general chemistry courses. Second is to determine the effects of students' approaches to learning from their beliefs and expectations for chemistry learning on the way they engage the learning process. From discussion the results with administrators arise a plan that contains the backbone for quality teaching and learning in general chemistry courses. In the line of the results of this study, quality gaps are identified between students' cognitive and affective expectations and the actual expectations provided at different stages of the process of chemistry learning. The new plan to develop general chemistry courses is the foundation to narrow the gaps and improve the student engagement and achievement. While it takes time to enhance quality and performance, Hughes, R. L. Ginnet, R.C, Curphy, G.J (2006) identify the differences between expectation and reality as expectation –performance gaps.

Lastly, there are recommendations on chemistry learning and instruction base on the purpose and the research questions of the study to look at some factors promote student engagement in general chemistry courses beyond the remedial approach of the success rate.

Summary of the Results

Faculty's Perception of the Factors that Affect Chemistry Learning

The extent in which chemistry faculty members are utilizing the "Seven Principles for Good Practice in Undergraduate Education" in their instruction was investigated. Results have shown that each principle was used to a different degree. Comparing the principle utilization, the least-used principle was the result of principle one (encouraging student-faculty contact, mean score = 26.43). The most-used by chemistry faculty are for principle five (emphasizing time on task, mean score = 42.37) and principle 6 (communicating high expectation, mean score = 41.68).

Student's Perception of the Factors that Affect Chemistry Learning

Students' perceptions, attitudes and approaches toward chemistry learning were analyzed. The focus was on investigating students' cognitive expectations of learning chemistry from their own experiences, beliefs, skills, and thoughts on what was expected of them.

Cognitive Expectation for Chemistry Learning Using CHEMX

Seven categories used to measure students' prior knowledge on chemistry learning and their perceived expectations of educators were: effort, concepts, math link, reality link, outcome, laboratory, and visualization. The research question was answered by calculating frequencies and percentages for responses to each individual survey item. Tables 5 through 11 included each survey item, frequencies, and percentages for each rating.

Deep Learning and Surface Learning in Chemistry using R-SPQ-2F

Student perceptions and learning related attitudes were explored to examine student deep approaches to chemistry learning. The research study focused on investigating student's understanding of the process of chemistry learning from their experiences and beliefs about learning, what skills will be required, and what are expected to do to deeply engage in chemistry learning.

Discussion of the Results

The main question of the research study: How a proposed plan is developed to improve student engagement based on assessing perceptions of administrators, faculty, and students, with focus on the impact of chemical education on learning in general chemistry courses? The answer to the question is related to the factors that demonstrate the level of commitment and engagement in chemistry learning of general chemistry stakeholder. The issues questions (1) and (2) guide the main question to identify the factors that affect the level of effective engagement of chemistry education in first year college chemistry. The results of analysis of data collected represent what faculty and students do during their approaches to chemistry education and whether they benefit from the good practices and experiences or not to actively engage in general chemistry courses.

The current research considers two key components that contribute to student learning and engagement: educational practices and student behavior. Utilizing the best-known engagement measures to effective education in colleges and universities provides insight into the factors influence student engagement (Astin, 1991; Kuh et al., 2005; Pascarella & Terenzini, 2005).

First, utilization of the "seven Principle for Good Practice in Undergraduate Education" (Chickering & Gamson, 1987) to explore the extent are chemistry faculty members using these practices in their instruction. These principles include student-faculty contact, cooperation among students, active learning, prompt feedback, time on task, high expectations, and respect for diverse talents and ways of leaning (Kuh, Kinzie, Schuh, and Whitt, 2005).

Second, student perceptions and learning related attitudes are important elements to explore student approaches to learning chemistry (Biggs, 1999; Entwistle & Waterston, 1988). Institutional culture is also inclusively examined and assessed where cognitive expectations of chemistry learning for high performance are communicated. The current research study focuses on exploring student understands of the process of chemistry learning from their experiences and beliefs about learning, what skills will be required, and what are expected to do to engage deeply in chemistry learning.

First-year college chemistry students need some competencies and skills necessary to tackle challenges of learning process they face to actively engage in their learning. The seven clusters used to measure students' prior knowledge learning about chemistry learning and what they expect to do to learn are: effort, concepts, math link, reality link, outcome, laboratory, and visualization (Grove & Bretz, 2007). Addressing the mismatch between students' expectation and those of faculty expectations for learning demonstrates the level of engagement in chemistry learning and teaching.

In the light of the findings, the role of administrators appears to allocate resources and plan learning practices and strategies to encourage students to benefit from such opportunities to engage in their learning. The collaboration of chemistry faculty members, the chair of chemistry department, and the dean of science is vital approach to implement the best practices of high level of engagement and provide effective learning culture for their student.

Three shifts of multiple perspectives are discussed: why some students don't succeed in general chemistry , how chemistry faculty can change to meet the expectations of their students, and how administrators can provide the atmosphere and the reward tools that will stimulate chemistry education and research.

Faculty's Perception of the Factors that affect Chemistry Learning

The issue research question (1): To what extent are chemistry faculty members using Chickering and Gamson's (1991) "Seven Principles of Good Practice"? The question is related to the factors involved faculty perspective to actively engage students in general chemistry courses. That is demonstrated by identifying the degree chemistry faculty using the best educational practices to lead to high level of student engagement (NSSE). A detailed analysis is presented in chapter 4 to provide answer to the research question (1). The research question is answered by calculating frequencies and percentages for responses to each individual survey item. Tables 5 through 11 include each survey item, frequencies, and percentages for each rating. The Likert scale responses range from 5 (Very Often) to 1 (Never).

Results have shown that each principle was used to a different degree. The principle was compared by adding up responses for ten questions for each principle for a total score of 10 to 50 per respondent. The respondent's score were assessed to present the mean for total scores for each principle. Figure 7 demonstrates the mean for each principle.

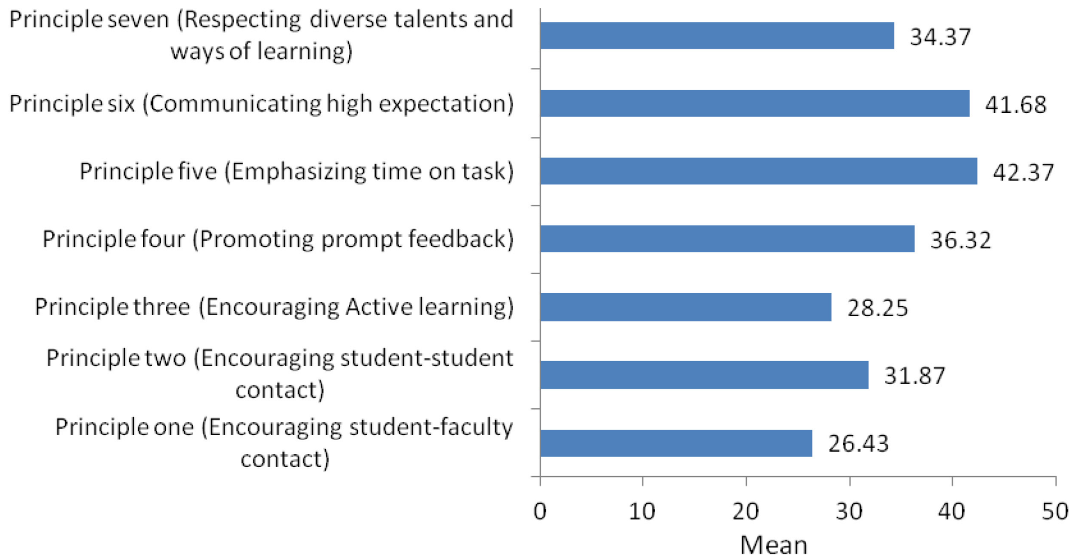

Figure 7. Principle Utilizing of Good Practices in Undergraduate education

Comparing the principle utilization, the least-used principle was the result of principle one (encouraging student-faculty contact, mean score = 26.43). This result is clearly make sense because 75% of participants are part time faculty and this is equal to representative trends in institutions located in south California where number of part time faculty members is more than full-time faculty member. Results have shown that students rarely dropped by instructor' office to visit or even engaged in professional meeting or in any conflict on campus with their instructors. Faculty also reported that they rarely worked with student affair staff on issues related to student extracurricular life and outside events.

The most-used by chemistry faculty are for principle five (emphasizing time on task, mean score = 42.37) and principle 6 (communicating high expectation, mean score = 41.68). Chemistry faculty who participated in this survey indicated they often and very often used most aspects in principle five. The high mean score for principle five could be because of challenging subject, as chemistry students need time to comprehend the difficult topics and concepts. Learning general chemistry requires substantial amount of time to perform calculations and graphing including chemical equations. However, faculty occasionally met with students who fall behind to discuss their habits, skills, and commitments or encouraged student to rehearse when class presentations are called. This is again because of the time limitations of the high percentage of part time faculty who cannot dedicate their time to a single campus to engage their students in chemistry learning. For principle six, communicating high expectation, chemistry faculty members frequently explain to students what will happen if they do not complete their work on time and always tell them to work hard in chemistry classes. However, they did not often publically call attention to excellent performance by students and help students set challenging goals for their own learning.

Cooperative learning (principle 2, mean score = 31.87) and active learning (principle 3, mean score = 28.25) are the main clusters of effective education practices used by (NSSE) to intensely engage students in their education (Kuh et al., 2005). The current study assessed and analyzed the extent chemistry faculty use the two principles. The low mean scores for utilizing cooperative learning and active learning are due to chemistry faculty perspectives that less topics might be covered by utilization those two activities in teaching and learning chemistry.

Learning and studying general chemistry require incorporating cooperative learning to encourage student-student interaction to work together on class assignments and projects. Faculty indicated that occasionally asked students to share with each other about their interests, evaluate each other's work or encourage students to praise each other for their accomplishment. This result is expected because of the time limitations of high percentage of part time faculty who hardly commit to engage their students in chemistry. With this regard, results have shown that faculty rarely created learning communities, study group, or project teams within general chemistry courses, which make sense considering almost three-quarter of participants are part time instructors.

Chemistry faculty members responded that they utilized active learning in their classes including simulation, role-playing, or labs in their classes and gave their students real life applications to analyze. However, based on the data accumulated in this research study, chemistry faculty reported that they rarely asked students to summarize similarities and differences among research findings and relate outside events to the course. Faculty also tended not to ask their students to undertake research study or encourage them to challenge ideas presented in readings or by other students. Only one-quarter of chemistry faculty arranged field trips, volunteer activities, or other extracurricular activities because of the heavily course contents they have to cover.

Chemistry faculty who participated in this research study reported promoting prompt feedback (principle 4, mean score = 36.32) as a good approach to actively engage their student in learning. Faculty also reported that they prepared classroom exercises and quizzes that give immediate feedback on how well they do. Faculty also often returned examinations and papers within a week and gave detailed evaluations on their work. However, they rarely gave students written comments on their strengths and weaknesses on exams and papers or gave their students a pre-test at the beginning of each course. Faculty indicated that they occasionally called or wrote a note to students who missed classes or asked students to keep logs or records of their progress.

Principle seven is concerned about respecting divers talents and ways of learning (mean score =36.32). Faculty who participated in the research study reported they did not often select reading and activities related to student's background, provide extra material for students who lack essential skills, and develop mastery learning or computer assisted learning. However, they often encouraged students to speak up when they don't understand. Faculty also indicated that they rarely encouraged their students to design their own learning and occasionally found out about their students' learning styles, interests, or backgrounds.

In conclusion, chemistry faculty focusing on student learning and engagement must utilize effective engaging approaches inside and outside chemistry classes through providing timely and prompt feedback intended to meet students' expectations and needs.

Student's Perception of the Factors that Affect Chemistry Learning

The second issue research question (2) examines and assesses student perceptions of the factors that affect students' approaches to learning from their beliefs and expectations for learning chemistry on the way they engage the learning process.

The current research study utilizes two engagement measures as explained in chapter 4 to yield rich information about students' preparedness for college chemistry. First is the demonstration of student's cognitive expectations for learning chemistry using CHEMX (Grove & Bretz, 2007). Second is the description of students preferred approaches to chemistry learning including prior knowledge and ability using R-SPQ-2F (Biggs, 1993),

Looking for answers to second issue question from the data accumulated in the research study leads to identify the factors that influence the level of student engagement and performance in general chemistry courses. To adjust student's preferred approach to the context of learning chemistry particularly general chemistry, the current study identifies the factors and sub-factors to what exist before student engagement. Identifying learning related factors as prior knowledge, expectations, ability, and their preferred approach to learning is vital to improve student engagement and achievement.

According to the analyzed data, the current research presumes the "Good" response of favorable response to each sub-factor question must be over 60%. A percentage for favorable response of a sub-factor less than 60% appears to be a weakness. The "weak" sub-factors are listed in the following tables in which they should be addressed to improve the process of engaging students in chemistry learning.

Cognitive Expectation for Chemistry Learning Using CHEMX

The results of analysis of the data related to factors and sub-factors of CHEMX indicate that the statements in the seven clusters (effort, concepts, math link, reality link, out link, outcome, laboratory, visualization) loaded into distinct sub-factors (Grove & Betz, 2007)(Figure 8).

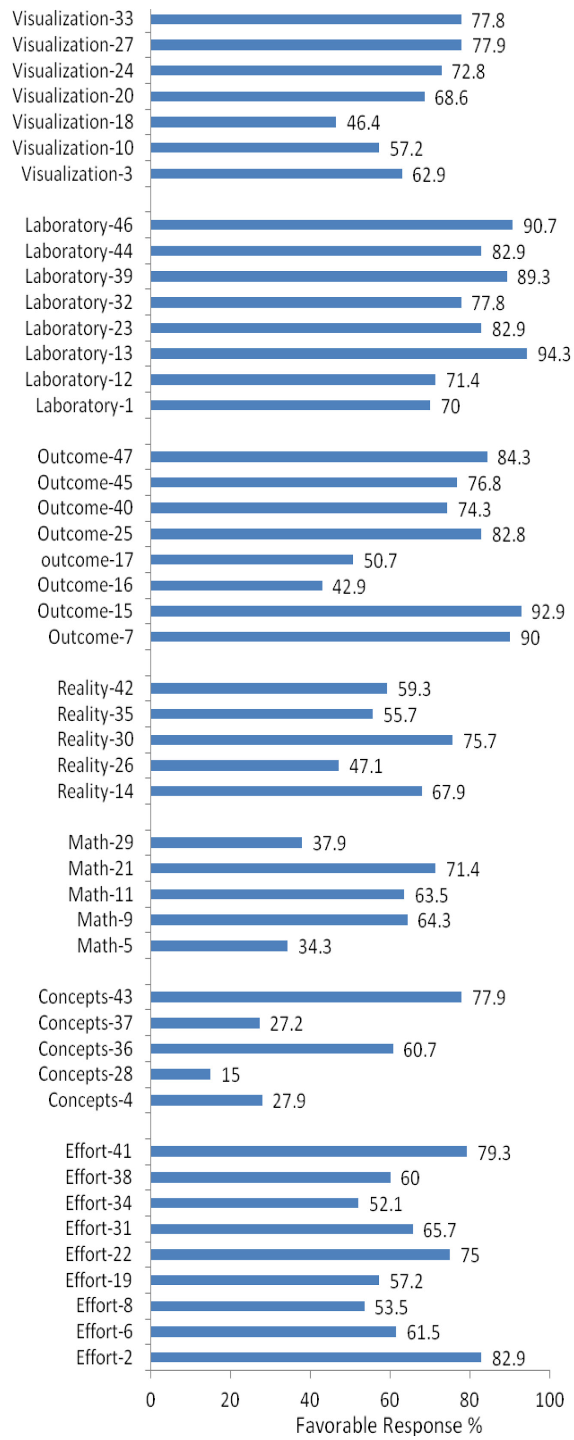

Figure 8. CHEMX Favorable Response for Factors and Sub-factors in the Seven Clusters (Effort, Concepts, Math link, Reality link, Outcome, Laboratory, Visualization)

Low percentages of favorable answers (less than 60%) for “weak” sub-factors reflect low level of expectations for learning chemistry. Those will to some degree answer why some students are not engaged and successful in general chemistry. Table 30 demonstrates the “weak” sub-factors with contribution to each cluster. For example, cluster 1: effort, low percentage favorable responses for a “weak” sub-factors 8 “ I read the text in detail and work through many of the examples given there”, “weak” sub-factor 19 “in doing chemistry problem, if my calculation gives a result that differs significantly from what I expect, I’d have to trust the calculation”, and “weak” sub-factor 34 “The most crucial thing in solving a chemistry problem is finding the right equation to use”. Because of the “weak” sub-factors related to low percentage of favorable responses of the CHEMX survey, students are not expected to engage in chemistry learning approaches. Looking into the “weak” sub-factors leads to the pathway to improve the process of chemistry learning and achievement in general chemistry courses.

Table 30: "Weak" Factors from Cognitive Expectations for Learning Chemistry CHEMX

Cluster 1: Effort

(1.8) I read the text in detail and work through many of the examples given there (53.5%).

(1.19) In doing a chemistry problem, if my calculation gives a result that differs significantly from what I expect, I'd have to trust the calculation (57.2%).

(1.34) The results of an exam don't give me any useful guidance to improve my understanding of course material. All the learning associated with an exam is in the studying that I do before it takes place (52.1%)

Cluster 2: Concepts

(2.4) Problem solving in chemistry means matching problems with facts or equations and then substituting values to get a number (27.9%).

(2.28) The most crucial thing in solving a chemistry problem is finding the right equation to use (15.0%).

(2.37) Understanding chemistry means being able to recall something you've read or been shown (27.2%).

Cluster 3: Math Link

(3.5) All I learn from a derivation or proof of formula is that the formula obtained is valid and it is OK to use it in problems (34.3).

(3.29) If I don't remember a particular equation needed for a problem in an exam there's nothing much I can do to come up with it (37.9%).

Cluster 4: Reality Link

(4.26) To understand chemistry, I sometimes think about my personal experiences and relate them to the topic being analyzed (47.1%)

(4.35) Learning chemistry helps me understand situations in my everyday life (55.7%)

(4.42) The chemical behavior of the atoms and molecules has implications in my life (59.3%)

Cluster 5: Outcome

(5.16) Knowledge in chemistry consists of many pieces of information, each of which applies primarily to a specific situation (42.9%).

(5.17) My grade in this course is primarily determined by how familiar I am with the material insight or creativity has little to do with it (50.7

Cluster 7: Visualization

(7.10) When I see a chemical formula, I try to picture its structure (57.2%).

(7.18) I don't spend much time constructing 3-D models of the 2-D structures that I draw in my class notes or read in my textbook (46.2%).

The list demonstrates 15 “weak” sub-factors, from a total of 47 items, which actually contribute to the mismatch between some students’ expectations and those of cognitive expectations for learning chemistry. Being unprepared to meet those expectations does not mean unable to meet them (Cox, 2009). Addressing those “weak” sub-factors has been the essential element for the framework of the research study to improve the process of learning in general chemistry courses.

Deep Learning and Surface Learning using R-SPQ-2F

Students’ perceptions and learning approaches became the central to teaching and learning framework known as “Student approach to learning” (SAL) theory (Biggs, 1999; Entwistle & Waterston, 1988). SAL is the building block of the total system and the heart of teaching and learning approach based on conceptual understanding.

Low percentages of favorable answers for “weak” sub-factors reflect low level of deep learning and high level of surface learning (Figure 9). Those will to some degree answer why some students are not engaged and successful in general chemistry.

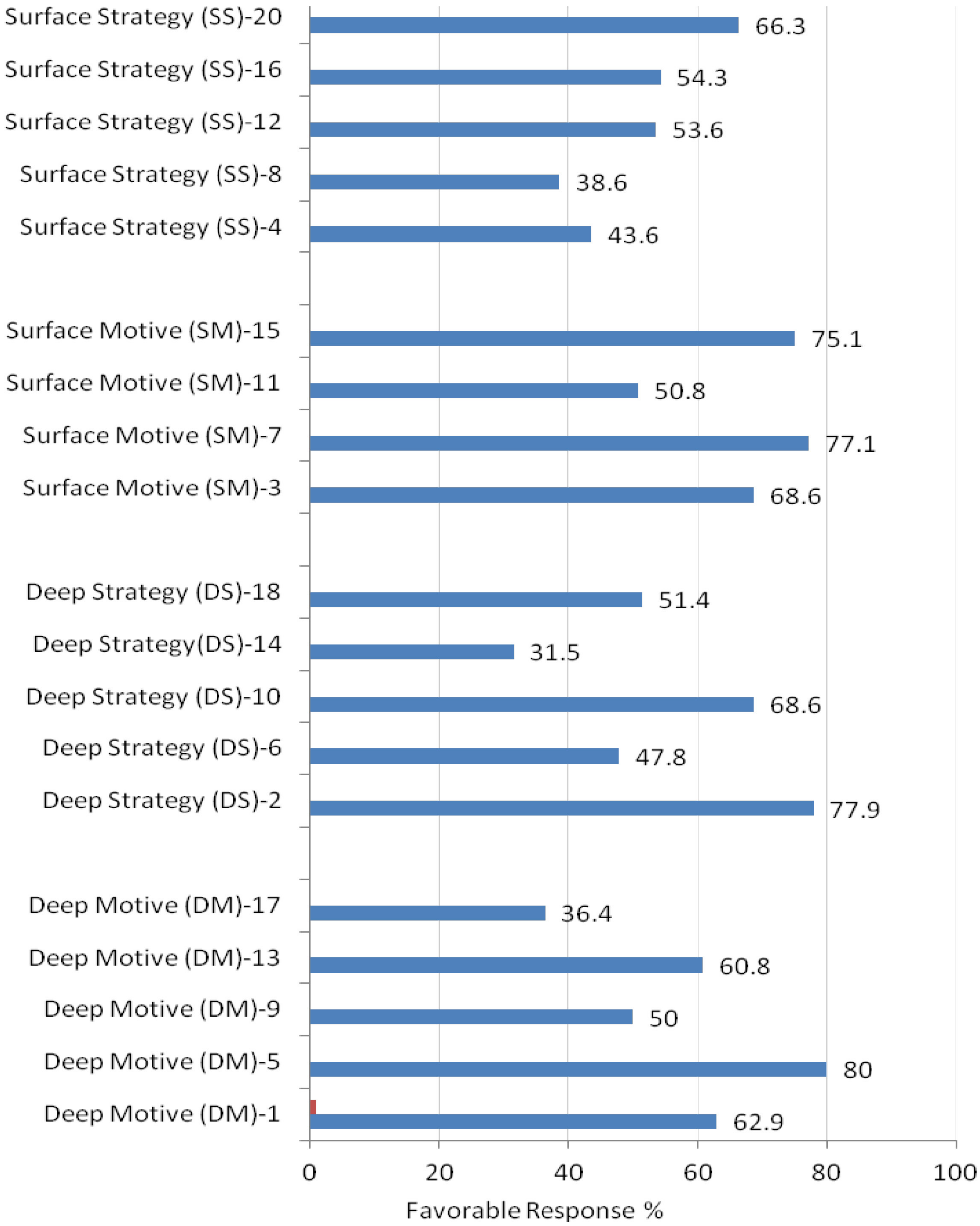

Figure 9. R-SPQ-2F Favorable Response for Factors and Sub-factors of Deep Approaches to Learning (Deep Motive (DM), Deep Strategy (DS), Surface Motive(SM), Surface Strategy (SS)

"Weak" sub-factors that result in low percentages of favorable answer of low level of deep learning and high level of surface learning are demonstrated in Table 31. For example, deep learning: deep motive, low percentage favorable responses for "weak" sub-factors 17 "I come to most classes with questions in my mind that I want answering", "weak" sub-factor 6 " I find most new topics interesting and often spend time trying".

In conclusion, according to the data accumulated in the study, "weak" sub-factors are related to students' attributes and behavior and should be addressed to improve the process of chemistry learning and engagement. Addressing "weak" sub-factors from engagement measures utilized in the current study identifies what must be improved to promote student learning and engagement in general chemistry courses.

Table 31. R-SPQ-2F “weak” sub-factor from Approach to chemistry learning

Deep Learning: Deep Motive

9. I find that studying academic topics can be as exciting as a good novel or movie (50.0%).

17. I come to most classes with questions in my mind that I want answering (36.4%).

6. I find most new topics interesting and often spend time trying (47.8%).

14. I spend a lot of my free time finding out more about interesting topics, which have been discussed, in different classes (31.5%).

Surface Learning: Surface Motive

11. I find I can get by in most assessments by memorizing key sections rather than trying to understand them (50

19. I see no point in learning material which is not likely to be in the examination (57.1%)

Surface Learning: Surface Strategy

4. I only study seriously what’s given out in class or in the course outlines (43.6%).

8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them (38.6%).

12. I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra (53.6%)

16. I believe that lectures shouldn’t expect students to spend significant amounts of time studying material everyone knows won’t be examined (54.3%).

Discussion of Results in Relation to the Literature

The results indicated that poorly engaged students who participated in the current study present a mismatch exists between students’ cognitive expectations and approaches to learning and engagement measures. Some of the current practices used in chemistry learning extending the learning gap of general chemistry. Addressing the gaps by improving student engagement in chemistry learning enables students to meet the expectations for chemistry learning. Yet, chemistry chairs and instructors can easily find the source of challenges of chemistry learning and engagement. Examples to address the educational needs for those students are: enriching faculty practices, supporting educational services, encouraging students 'interactions with peers, promoting extracurricular activities, and improve students' attributes and behavior to become successful student (Kuh, Kinzie, Schuh, & Whitt, 2010). From multiple perspectives, detailed analysis of perceptions of students, faculty, and administrators can be employed to make several recommendations for improvement.

Three shifts of multiple perspectives are discussed and interpreted: why some students don't succeed in general chemistry , how chemistry faculty can change to meet the expectations of their students, and how administrators can provide the atmosphere and the reward tools that will stimulate chemistry education and research.

Why Some Students don't Engaged in General Chemistry Courses?

Students held cognitive expectations and beliefs for chemistry learning that resist them from seeking assistance to learn new skills to engage in their chemistry learning. The "weak" sub-factors have been the essential element for the framework of the research study to improve the process of learning in general chemistry courses. Reflecting on the results of student's perceptions about their approaches to learning and expectations for chemistry learning is significant for the research study to determine the factors that influence the level of student learning and engagement in general chemistry courses.   The center of the learning system of chemistry is at the process level, where the students are either engaged or not engaged to produce the desired course outcome (Biggs, 1999).

Based on the current study, several factors appear to affect student engagement and leaning in chemistry education. The following are the factors that affect student engagement and learning in general chemistry courses:

1. Student attributes and behavior as successful student ability, expectations, prior knowledge, attitudes, skills, intrinsic interest.

2. Faculty and staff practices and rigor

3. Academic rigor: Math link, lab, reading and writing, critical thinking skills

4. Extracurricular offerings that inspire students in campus life

5. Campus activities.

The highly engaged students in the research study generally possess good attributes and behavior as a successful student. The key for their success is somehow relates to habits, skills, knowledge, commitment, and intrinsic interest. But, why highly engaged student have good qualities and attributes to become successful in learning chemistry? The answer is to some degree relates to their instructors: their support, interaction, knowledge, expectations, and commitment.

How Chemistry Faculty Can Change to Meet the Expectations of their Students?

Chemistry faculty should recognize the difficulties and challenges with chemistry learning and wonder why they got into the situation of uncomprehending students. They should believe that their enthusiasm would transfer to their students and produce college students who enjoyed chemistry subject to pursue a career in chemistry. An example such as formal power point presentation does not allow students to interact and display their misconceptions of chemistry topics. If students are presented with methods that only based on short-term memory, it is difficult to search for differences between students' knowledge and misconceptions about chemistry topics after instruction. The starting point should begin to meet the students where they are, with their interests, knowledge, abilities, and skills.

Leading students to explore new thoughts among their experiences to find the preferred way they comprehend the chemistry subject is vital so that students will learn chemistry with enjoyment. The challenge will be to incorporate teaching and learning methodology that can help instructors to be sure that students have comprehend and reexamined what is taught so students are not put off general chemistry courses early.

How Administrators can provide the Environment that will stimulate Chemistry Education?

In describing the role of administrators in the Department of Chemistry to overcome the barriers to student learning and engagement, the role of the Chair to promote system thinking in action, not only does system change, but it keeps on interacting administrators and faculty within the department to produce innovative practices that solve deep problems (Fullan 2005; Senge 1990, 2006; Higgs & Rowland 2005). The importance of exploring the perceptions of participants to discover and examine criteria of the quality of chemistry education could lead to ongoing learning process throughout general chemistry courses.

The challenge of learning process starts with all stakeholders open to learning from experience (John 2009). The learning experiences through the learning cycle provide the participants with support and training by formulating knowledge and strategies for high-quality program offerings that best serve the community. Greater number of students will be served at greater possible spectrum of range of needs to increase access to educational programs. This type of institutional learning that requires reflection on experience "leads to action, reflection, and testing the new learning with others" (p.46). Leaning from individual level to institutional level requires acceptance of the lessons learned and the change in actions becomes necessary (Argyris & Schon, 1996).

Limitations

The purpose of the evaluation process of the mixed method is to develop an understanding of the concepts and variables of data collection and analysis. The advantages of doing qualitative research such as field notes provide flexibility to follow unexpected ideas during research and explore processes effectively. Lincoln and Guba (2000) state that "qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them" (p. 3). Taking field notes was a practical qualitative research method to develop new ideas for in-depth explorations for researcher interest. There was also opportunity to be engaged in simple quantitative data gathering and analysis at the research sites. This included inviting stakeholders of general chemistry courses to be surveyed in addition to conversation about the real impact of the effect of beliefs and expectations for learning chemistry.

Implication of the Results for Practice

This research study proposes a plan to help stakeholders of general chemistry course to evaluate the quality of teaching and learning. Based on the engagement measures utilized for quality chemistry education discussed in the previous chapters, the plan should contain the foundation for quality teaching and learning in general chemistry courses. In the line of the results of this study, five different quality gaps are identified between students' cognitive and affective expectations and the actual expectations provided at different stages of the process of chemistry learning. The new plan to develop general chemistry courses will be the backbone to narrow the gaps and improve the student engagement and achievement.

1. The Gap between Students' Expectations and Faculty' Expectations

This gap is the difference between students' expectations and faculty perceptions. Students' expectations are what the students expect according to their beliefs and attitudes and are affected by cultural background, family lifestyle, personality, demographic, and experiences. Student's perceptions are based on the student's interaction with the institution. Perceptions are derived from the student's satisfaction of the quality of chemistry learning and teaching. Comparing the extent chemistry faculty members using the best practice in student engagement and students' approaches about learning chemistry, it was found to be slightly different. This mismatch between students' expectations and their instructors is the most important gap and in an ideal situation the student's expectation would be almost identical to the faculty's expectations. The best way to narrow this gap is that chemistry instructors should explore students' perceptions to understand their beliefs and attitudes and monitor the ways they engage in the process of learning.

2. The Knowledge Gap between Students' Expectations and their Institution.

The knowledge gap represents the difference between the student's expectations of the support provided and the institution. In this case, administrators are not aware or have not clearly interpreted the student's expectations in relation to the institution's need. In a student-centered learning, it is important that administrators promote good relations between students and faculty to get clear understanding of the student's needs and expectations. Narrowing the gap between the student's expectations for quality of chemistry learning and administrators' perception will require comprehensive plan and study.

3.The Gap between the Quality Learning and Administration

This gap reflects administrators' incorrect understanding of the process of chemistry learning and outcomes. Institutions that experience difficulties understanding the quality expectation into particular subject such as chemistry, can fail to sustain their provision of creating good conditions to student achievement. It was noted in this chapter the principle of encouraging student-faculty contact is that least –used principle of good practices utilized. Administrators should deal with faculty' response to change that may involve anger, fear, or confusion. Administrators always requested training where training is not the only alternative for this type of improvement. The role of administrators is to create trust and empowerment that establish the context for change so every employee will align their performance with the new direction.

4.The Gap between the Quality of Learning and Instruction

This gap demonstrates some weakness in faculty utilization of good practices in higher education such as active and collaborative learning. Lack of knowledge about students' attitudes, beliefs, and expectation can lead to difficulty satisfying student's needs. Administrators and faculty members have to address the professional development required to put the guideline for development of general chemistry course.

5.The Gap between the Quality Learning and Student's Approaches to Learning

In some situations, students are frustrated to actively engage in quality chemistry learning they desire to achieve. This is because of the expected learning result does not match the cognitive expectations of chemistry learning. By increasing and encouraging student-faculty contact, communications between faculty and students can be promoted to seek alternatives to successful achievement. Institutions always attempt to understand students' needs and expectations.

At the beginning of the general chemistry courses, faculty members are encouraged to create a student profile to clearly understand all students' needs and preferences. Recognizing students' preferred learning styles and approaches can also help to establish high expectations for academic challenge in chemistry learning. When faculty members assess students' skills and expectations, they can easily revise their courses according to assessment results. As a result, the students promote their skills and competencies to design their own learning.

Responding to diverse ways of chemistry learning students and faculty profoundly design their pedagogy to make meaning of their teaching and learning experiences. Students can track and review their chemistry learning skills for improvement to be connected to the chemistry curriculum. Faculty members empower their students to determine how they demonstrate their cognitive skills to hit learning outcomes.

Narrowing the "Performance Gap" of Chemistry-Eexpectation-Performance Gapes

It was explained earlier in chapter 2 that effective education practices in chemistry learning are a complex undertaking which include many different strategies, skills and tasks. Developing a plan for creating the best conditions to maximize students satisfaction to recognize and narrow gaps provided high quality chemistry teaching and learning. By helping students to achieve their goals and maximizing students' engagement and success, institutions celebrate good results through accountability and retention rate. This also assists administrators to identify areas of strengths, weaknesses, opportunities, and challenges to make improvements to their institutions.

Twenty first century's students have become increasingly demandable. They expect high quality institution to meet their expectation where they are to develop their experiences. By encouraging student's engagement with institution, extending pedagogies begin with a student's first day of the course.

In last decade, teaching and learning at higher education have been effective to help their students to become strategic learners. Academic efforts should include multidimensional shift of learning. This includes assessment and reflection practices that help students take control and responsibility of their learning and success. Rather than concentrate on a traditional educational practices, administrators and faculty should help students to assess their beliefs and attitudes to the contexts and subject matter in which they must learn actively and effectively.

Recommendations for Narrowing the Performance Gap

Based on the results of the research study, recommendations can be made which include a shifting of chemistry education practices toward multidimensional form of teaching and learning. Considering the perspectives of faculty, students, and administrators shifts toward multidimensional view including instructional, institutional, and affective, will benefit students to succeed in general chemistry. It is recommended that this practice be continued, and strengthened through assessing and monitoring of stakeholders' performance of general chemistry course.

Improving quality in chemistry education can bring benefits in terms of improved performance. In order to assure all stakeholders perform their work to the required quality of teaching and learning, professional development and training can be provided to improve the performance

Enhancing education for all stakeholders of the general chemistry course is the key objective of assessing the process of chemistry learning. Suggestions based on the findings of this study to describe some strategies associated with student success in general chemistry courses, are as follows:

Provide sessions to help poorly engaged students to improve their attributes and behavior.

Provide sessions to assist poorly engaged students set clear goals and take charge of their learning.

Offer extra-curricular activities and support the existing ones

Develop pathways to motivate students to engage deeply in their learning.

Provide sessions to chemistry faculty to demonstrate positive effect of multiple perspectives and how fulfill the need of chemistry learners.

Provide sessions to incorporate students with science and technology context, more students will be considering a career related to science and technology.

Provide sessions about chemistry education research such as; chemistry learning and engagement, learner-center chemistry learning, the process of chemistry learning, and chemistry representations technologies.

Recommendation for Further Research

The research study reveals knowledge and information of what students need to know to engage in general chemistry course and what factors are needed to persist in chemistry learning. Faculty and students could benefit from self-evaluation using engagement measures to learn about self-deficient aspects. However, limitations of Likert scale survey responses, which cannot be as accurate as qualitative approach such as observation or open- end responses. This is because positive respondents generally respond “very often” and negative respondents generally respond “never” without interacting well with the survey (Suskie, 1996).

Research in employing multidimensional approach to learning is needed to provide a conceptual basis to teachers’ learning. Developing a process-oriented approach in teaching presents a major challenge for teachers as well as for higher education institutions. It should be an exciting research to explore important aspects of process-oriented teaching to be applied in chemistry education.

More research is needed to study the metacognitive interventions in developing higher order critical thinking, problem solving, and visualization skills in chemistry learning. Utilizing assessment measures to determine the change in the utilization of metacognition skills is needed to provide evidence supporting higher use of metacognition instruction and learning.

Research has shown the effective role of goal orientation and self-efficacy as a predictor for achievement. More research is needed to study the interaction between extrinsic motivation, self-efficacy, deep cognitive learning, and goal orientation in student performance for first-year general chemistry courses.

Designing and addressing the development of multidimensional learning for use in undergraduate chemistry courses is useful to promote the active engagement of students in the cognitive process of learning. Research is needed to study the effect of testing learning such as working examples, tutorial, and computer simulation in guiding students through applying knowledge to real world situations to provide students with hand-on experiences and strengthen their understanding with the concepts addressed in an example or tutorial.

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APPENDIX A. STATEMENT OF ORIGINAL WORK
Academic Honesty Policy

Capella University's Academic Honesty Policy (3.01.01) holds learners accountable for the integrity of work they submit, which includes but is not limited to discussion postings, assignments, comprehensive exams, and the dissertation or capstone project.

Established in the Policy are the expectations for original work, rationale for the policy, definition of terms that pertain to academic honesty and original work, and disciplinary consequences of academic dishonesty. Also stated in the Policy is the expectation that learners will follow APA rules for citing another person's ideas or works.

The following standards for original work and definition of *plagiarism* are discussed in the Policy:

> Learners are expected to be the sole authors of their work and to acknowledge the authorship of others' work through proper citation and reference. Use of another person's ideas, including another learner's, without proper reference or citation constitutes plagiarism and academic dishonesty and is prohibited conduct. (p. 1)
>
> Plagiarism is one example of academic dishonesty. Plagiarism is presenting someone else's ideas or work as your own. Plagiarism also includes copying verbatim or rephrasing ideas without properly acknowledging the source by author, date, and publication medium. (p. 2)

Capella University's Research Misconduct Policy (3.03.06) holds learners accountable for research integrity. What constitutes research misconduct is discussed in the Policy:

> Research misconduct includes but is not limited to falsification, fabrication, plagiarism, misappropriation, or other practices that seriously deviate from those that are commonly accepted within the academic community for proposing, conducting, or reviewing research, or in reporting research results. (p. 1)

Learners failing to abide by these policies are subject to consequences, including but not limited to dismissal or revocation of the degree.

Statement of Original Work and Signature
I have read, understood, and abided by Capella University's Academic Honesty Policy (3.01.01) and Research Misconduct Policy (3.03.06), including the Policy Statements, Rationale, and Definitions.

I attest that this dissertation or capstone project is my own work. Where I have used the ideas or words of others, I have paraphrased, summarized, or used direct quotes following the guidelines set forth in the APA *Publication Manual*.

Learner name and date	Eman Shweikeh
Mentor name and school	Dr. Michael Sanders, Capella University