University of Cincinnati

Date: 5/9/2011

I, Cynthia A Stegeman, hereby submit this original work as part of the requirements for the degree of Doctor of Education in Curriculum & Instruction.

It is entitled:
The Effect of a Multimedia Learning Environment on the Knowledge, Attitude, Confidence, and Skill of Dental Hygiene Students

Student's name: Cynthia A Stegeman

This work and its defense approved by:

Committee chair: Janet Zydney, PhD
Committee member: Linda Plewyak, PhD
Committee member: Fabio Santos, EdD
Committee member: Janelle Schierling, EdD

1680
Dissertation for
The Effect of a Multimedia Learning Environment on the Knowledge, Attitude, Confidence, and Skill of Dental Hygiene Students

Cynthia A. Stegeman, RDH, MEd, RD, CDE
Program in Instructional Design and Technology
Department of Curriculum and Instruction

Dissertation Committee Chair
Janet Mannheimer Zydney, PhD

Submitted in partial fulfillment of the requirements for the degree of Doctoral of Education in the College of Education, Criminal Justice, and Human Services University of Cincinnati
Abstract

The purpose of this study was to compare the effects of a student-centered, interactive, case-based, multimedia learning environment to a traditional tutorial-based, multimedia learning environment on second-year dental hygiene students (n = 29). Surveys were administered at four points to measure attainment and retention of knowledge, attitude, and confidence. There was not a significant difference in attainment of these variables between the groups. As indicated by the outcomes of the repeated-measures two-way ANOVA tests, time had a significant effect on the mean overall variables for knowledge ($p < .01$) and attitude ($p < .001$), as well as three of the knowledge variables ($p < .05$) and three of the attitude variables ($p < .01$) for both groups. One attitude variable ($p < .01$) showed a positive significant difference between the case-based group and tutorial-based group. A practical examination skill test measured retention of skill. The analysis indicated that the case-based group (100% passed) did significantly better compared to the tutorial-based group (60% passed). Although the findings demonstrated that only one attitude variable was found to be significantly better for the case-based group, the greater increase in the retention of skill has notable implication for dental hygiene education. Future research should examine multimedia learning environments with larger samples and longitudinal data.
# Table of Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Rationale</td>
<td>3</td>
</tr>
<tr>
<td>Conceptual Framework and Learning Environment</td>
<td>8</td>
</tr>
<tr>
<td>Adult Learning Theory</td>
<td>8</td>
</tr>
<tr>
<td>Social Learning Theory and Self-Efficacy Theory</td>
<td>9</td>
</tr>
<tr>
<td>Case-Based Reasoning</td>
<td>11</td>
</tr>
<tr>
<td>Anchored Instruction</td>
<td>12</td>
</tr>
<tr>
<td>Video-Based Format</td>
<td>13</td>
</tr>
<tr>
<td>Narrative with Realistic Problems</td>
<td>13</td>
</tr>
<tr>
<td>Problem Complexity</td>
<td>13</td>
</tr>
<tr>
<td>Generative Format</td>
<td>14</td>
</tr>
<tr>
<td>Embedded Data Design</td>
<td>14</td>
</tr>
<tr>
<td>Relevant and Irrelevant Information</td>
<td>15</td>
</tr>
<tr>
<td>Links Across the Curriculum</td>
<td>15</td>
</tr>
<tr>
<td>Summary</td>
<td>16</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>16</td>
</tr>
<tr>
<td>II. Review of the Literature</td>
<td>18</td>
</tr>
<tr>
<td>History of Multimedia Instruction in Dental Education</td>
<td>18</td>
</tr>
<tr>
<td>Theoretical Frameworks</td>
<td>19</td>
</tr>
<tr>
<td>Case-Based Reasoning</td>
<td>20</td>
</tr>
<tr>
<td>Adult Learning Theory</td>
<td>22</td>
</tr>
</tbody>
</table>
Knowledge Attainment with Multimedia Instruction ........................................ 23
  Attainment of Knowledge ........................................................................ 24
  Retention of Knowledge ......................................................................... 29
Confidence and Attitude Attainment with Multimedia Instruction .......... 30
Skill Attainment and Retention with Multimedia Instruction .................. 34
Evaluation of Learning .............................................................................. 40
  Clinical Practice Scenarios .................................................................. 41
  Observations and Simulations ................................................................. 42
  Open-Ended Questions ......................................................................... 45
  Surveys .................................................................................................. 45
  Multiple-Choice Questions .................................................................. 46
  Multiple Methods of Evaluation ............................................................. 47
Critical Analysis of the Cited Studies ....................................................... 49
Purpose of the Study .................................................................................. 52
III. Methodology .......................................................................................... 55
  Hypothesis .............................................................................................. 55
  Setting of the Study ................................................................................ 55
  Sample .................................................................................................... 56
  Research Design ..................................................................................... 57
  Curriculum .............................................................................................. 57
  Case-Based Multimedia Instruction Group ............................................. 58
  Tutorial-Based Multimedia Instruction Group ........................................ 60
Instrumentation ......................................................................................... 60
Multimedia Instruction

Surveys .................................................................................. 61
Skill Observation Checklist .................................................. 64
Procedure .............................................................................. 65
Data Analysis .......................................................................... 66
Data Creation ........................................................................ 67
Data Evaluation ...................................................................... 67
IV. Results .............................................................................. 69
Treatment of Data .................................................................. 69
Post-Hoc Power Analysis ..................................................... 69
Data Cleaning ......................................................................... 71
Pre-Analysis ........................................................................... 72
Research Questions ............................................................... 72
Knowledge ............................................................................. 72
Attitude and Confidence ....................................................... 78
Skill ....................................................................................... 84
Summary of the Findings ....................................................... 85
V. Discussion .......................................................................... 87
Overview ............................................................................... 87
Effect of the Multimedia Instruction .................................... 89
Attainment of Knowledge .................................................... 89
Retention of Knowledge ....................................................... 92
Attainment of Attitude and Confidence ............................... 94
Retention of Attitude and Confidence ................................ 97
Multimedia Instruction

Retention of Skill ......................................................... 100

Summary of the Results .................................................. 103

Limitations of the Study .................................................. 104

Contributions to the Literature ......................................... 106

Future Research .......................................................... 107

Conclusion ................................................................. 108

VI. References ................................................................ 111

VII. Appendices

  Appendix A – Research Design ........................................ 122

  Appendix B – Script and Clues for the Video—Case-Based Group ...... 123

  Appendix C – Video—Case-Based Group ................................ 126

  Appendix D – PowerPoint Presentation—Tutorial-Based Group ....... 127

  Appendix E – Survey ....................................................... 128

  Appendix F – Skill Examination Checklist ................................. 133

  Appendix G – Codebook from the Field Study .......................... 134
Chapter 1

Introduction

Diabetes is a complex, multi-symptom syndrome that affects an estimated 23.6 million individuals in the United States, one-third of whom do not know they have the disease (Centers for Disease Control and Prevention, 2008). With an aging population and an increasing number of overweight children, adolescents, teenagers, and adults, the U.S. and other countries are experiencing a rapid increase in the prevalence of the disease, particularly type 2 diabetes. Approximately 5% of all patients and 25% of patients between the ages of 60-74 seen in a dental environment will have diabetes (Moore, Zgibor, & Dasanayake, 2003). Because diabetes is becoming more prevalent, diabetes education needs to be integrated in the academic programs for all health care occupations, including dental professionals.

Research about the association between diabetes and oral health is not new. Documents of the impact of systemic disease on oral health and the impact of poor oral health on progression of a systemic disease date back to the times of Hippocrates. A patient with uncontrolled diabetes (high blood glucose levels) in a dental environment presents many medical and dental concerns the dental professional needs to assess prior to any invasive treatment. An uncontrolled blood glucose level has been defined by the American Diabetes Association (2009) as three consecutive readings above 200 mg/dL. First, an individual with uncontrolled diabetes is at a higher risk of periodontal disease and other dental issues. A bidirectional connection exists in that infectious dental issues lead to high blood glucose values in individuals with diabetes. Both of these concerns are well documented in the dental literature. Second, an individual with low blood glucose
levels (hypoglycemia) often experiences physical and psychological signs and symptoms; however, this individual may also be asymptomatic. Hypoglycemia (less than 70 mg/dL) that is left untreated can lead to a medical emergency. Therefore, appropriate treatment with a glucose source is warranted prior to any dental procedure. Furthermore, an individual with high blood glucose levels (hyperglycemia) may experience the classic signs and symptoms related to high blood glucose values or may be asymptomatic. In some situations, this could create a medical emergency. Moreover, since most dental treatment is invasive, the incorporation of bacteria from the procedure can increase the risk of infection, impair the immune response, and decrease wound healing for individuals with hyperglycemia. Therefore, proper management of diabetes by the dental professional, including obtaining a blood glucose value prior to treatment, will positively impact the patient’s overall and oral health as well as minimize the potential for a medical emergency (Kunzel, Lalla, & Lamster, 2007; Mealey, 2007; Ship, 2003). A dental procedure may need to be rescheduled until the patient’s blood glucose level is in control and the patient should be referred to their health care provider. In many states, including Ohio, it is within the scope of practice for dental professionals to obtain a blood glucose value from patients with diabetes prior to treatment. In the clinical practice recommendations established by the American Diabetes Association (2009), it is not suggested that allied health care professionals provide a screening for all patients, but to refer those patients at high risk to their health care provider for testing.

Although the literature regarding treatment of patients with diabetes in a dental environment is abundant, over 80% of dental hygienists feel they would like to further enhance their knowledge base with continuing professional education (Boyd, Hartman-
Many dental hygienists are omitting procedures relevant to patients with diabetes. A survey conducted by Kunzel et al. (2007) found that only 3% of general dentists provided active management, including blood glucose monitoring for their patients with diabetes. In addition, a survey was administered by Stegeman (2005) to assess the attitude of the dental community toward obtaining blood glucose values prior to treatment. It was sent to three categories of individuals involved in dentistry: dentists in a large Midwest city, dental hygiene students in a 2 year program in the same city, and dental hygiene educators throughout the state. The findings indicated that 100% of dental hygiene educators taught the importance of blood glucose monitoring; 100% of students felt it was important, but were not sure they would monitor it in private practice; and 53% of dentists appreciated the value of obtaining blood glucose readings in their practice. Since the dental literature has noted that obtaining a blood glucose level is a significant component of treatment, then why aren’t blood glucose values being obtained? What can be done to increase the likelihood that a dental professional will include this procedure after graduation as part of their dental hygiene practice protocol?

**Rationale**

Many studies (Ford-Gilboe, Laschinger, Laforet-Fliesser, Ward-Griffin, & Foran, 1997; Laschinger, 1996; Rosen, 2000) noted the need for further research in effective educational strategies for health care professionals (both medical and dental) to understand, promote, and incorporate various health protocols for patients within their discipline. A standard established by the Commission on Dental Accreditation for Dental Hygiene Education Programs (2009, p. 21) states, “Dental hygiene sciences provide the
knowledge base for dental hygiene and prepares the student to assess, plan, implement and evaluate dental hygiene services as an integral member of the health team.”

Incorporating pedagogies that promote students’ awareness and appreciation of optimal care for patients while in school and which continue into practice as a health care professional will support this standard.

Students and educators have recognized that the primary source of dental knowledge is the dental program attended (Autio-Gold & Tomar, 2007; Warnakulasuriya, 2002). Autio-Gold and Tomar administered a questionnaire to 107 third- and fourth-year dental students to determine their knowledge and opinions about management of dental decay. The outcomes indicated that students are influenced by the information they are provided in their formal classroom and clinical training (Autio-Gold & Tomar). In addition, dental students agreed that many procedures taught in school have value, are important protocols in health care, and should be part of the dental curriculum (Autio-Gold & Tomar; Cannick, Horowitz, Reed, Drury, & Day, 2006; Victoroff, Dankulich-Huryn, & Haque, 2004; Warnakulasuriya; Yip, Hay, Ostroff, Stewart, & Cruz, 2000). Other researchers have indicated that knowledge acquired in a formal academic health care program is more likely to be incorporated into practice than information obtained in any other setting, such as a professional continuing education course or workshop (Fried, Reid, & DeVore, 2004). Thus, including the knowledge and practice of established, evidence-based health care protocols, such as obtaining blood glucose levels prior to dental treatment, into the curriculum during formal training is essential.

In spite of the fact that an academic health care program may provide the necessary information related to a required dental procedure, only a small percentage of
practitioners may perform all of the procedures in professional practice. Smoking cessation counseling is an example of a skill that has been identified in the dental and medical literature (Alomari, Barrieshi-Nusair, & Said, 2006; Cannick et al., 2006; Corelli et al., 2004, Fried et al., 2004; Gelskey, 2002; Koerber, Crawford, & O’Connell, 2003; Monson & Engeswick, 2005; Secker-Walker, Solomon, Flynn, & Dana, 1994; Victoroff et al., 2004). It is the responsibility of dental professionals to provide tobacco cessation counseling to patients who use tobacco products. This education is a component of all curriculums in accredited dental and dental hygiene schools; however, counseling patients often declines once dental professionals begin professional practice.

One potential delivery method to improve the transfer and continued practice of protocols taught during dental hygiene schools for evidence-based health care protocols is the use of carefully designed multimedia instruction (MMI). Cotton (1992) described MMI as the use of computer technology for supplementing the distribution of course content with that of traditional methods, such as lecture, discussion, or hard-copy text. MMI simply means the use of more than one type of media and integrating the use of text, graphics, sound, or video. MMI delivers information in a manner designed to help students learn new material or improve knowledge of materials previously studied (Azarmsa, 1991). MMI can be interactive or student-centered in which the student is required to be engaged in the program, such as answer questions or perform a task. Technological innovations incorporated into the health care curriculum have modified the face of learning environments. Linn (2003, p. 729) identified learning environments as “a coherent curriculum and a suite of technologies to support teachers and students in learning, instruction, and assessment.” Murdoch-Eaton and Cottrell (1999) found that
highly structured environments are beneficial to the acquisition of clinical skills. MMI can be designed to create a highly structured learning environment that is student-centered, self-paced, and interactive. It may also develop critical thinking and present a safe environment (practicing in a simulated setting before practicing on persons in a clinical setting). Shorter and Dean (1994) also stated that a benefit of MMI is the increased ability of the student to retain the material, therefore, enabling the instructor to cover the topic in greater depth and to focus on student attitudes toward the topic.

A review of the health care literature uncovered a lack of research studies investigating the retention of knowledge, attitudes, and confidence level of students toward a topic following exposure to MMI. In addition, no study measured the retention and application of knowledge once the student was working as a practicing health care provider. Regardless of the outcomes of the study, most researchers favorably described the value of MMI in health care education, citing a need for further research before universal implementation of this technology in the curriculum.

This research study addressed many of the needs and limitations indicated by the studies in the review of the literature. Understanding diabetes, creating a positive attitude toward the need to obtain a blood glucose level, and enhancing confidence and skill in handling a medical emergency associated with diabetes is ideally suited to MMI in health care education.

In many studies, the literature in health care education could be categorized into a case-based MMI learning experience or tutorial-based. For this reason, the research design of the current study was divided into these two categories. The treatment group was a case-based MMI learning experience for dental hygiene students compared to the
comparison group that was a traditional tutorial-based MMI learning experience. The case-based MMI involved a video-based, case scenario, text-based questions based on the video, and a collaborative team effort to synthesize a solution. The learning outcomes involved problem solving and decision making with the application of critical thinking and transfer of knowledge from a didactic to a clinical situation. The tutorial-based group was exposed to a video of a lecturer using a PowerPoint presentation of the identical diabetes information followed by a large group discussion. The purpose of the current study was to design and assess the effect of case-based MMI as a pedagogical strategy on dental hygiene students’ knowledge, attitude, confidence, and skill in treating individuals with diabetes and their ability to retain the knowledge, attitude, and confidence and transfer into professional practice.

To determine the effect of a case-based MMI on the knowledge, skill, attitude, and confidence of dental hygiene students, the following research questions were asked:

What was the effect of a case-based MMI using a clinical scenario compared to tutorial-based MMI based on using traditional pedagogy designed for 2nd-year dental hygiene students

a. on their attainment and retention of knowledge of diabetes?

b. on their attainment and retention of attitude and confidence of diabetes knowledge and its implementation in a dental environment?

c. on their retention of skill in managing a medical emergency related to diabetes?
Conceptual Framework and Learning Environment

The theory of constructivism is a broad philosophical paradigm that encompasses each of the learning theories and models reflected on in the current study. This epistemological approach to learning targets gains in knowledge through providing meaningful and authentic experiences. The student builds on current and past knowledge of themselves and peers to help them construct understanding and develop skills relevant to solving problems. This process may require the learner to revise past learning or find that current learning is irrelevant, triggering the learner to further explore, assess, and possibly redefine experiences. This approach to learning is designed to be student-centered, group-oriented, and interactive (Weimer, 2002). This study is influenced by constructivism since it provides a learning environment with the hope of enhancing knowledge, attitude, and skill immediately and over time.

The research design of MMI in the current study was developed based on the general ideology of constructivism. Specifically, the research design intertwined the principles established through the theory on adult learning (Knowles, 1990) with the self-efficacy theory presented by Albert Bandura (1977) and case-based reasoning (CBR) theory (Kolodner, 1993), along with the work of an interdisciplinary team of researchers forming the Cognition and Technology Group at Vanderbilt [CTGV] (1990) on anchored instruction.

Adult Learning Theory

Since the participants in the current study are in higher education, motivation of the adult learner, as described by Knowles (1990) regarding the constructivist adult learning theory, is appropriate as a theoretical framework. The adult learning theory
positions teaching and learning to stimulate and challenge students. The assumptions posited by Knowles included self-directed learning, interactive learning experiences, and incorporation of interesting topics relevant to the learners’ lives. Each of these assumptions was considered in the formation of the learning environment in order to enhance the ability of students to transfer their knowledge of how to appropriately manage patients with diabetes.

One assumption described by Knowles (1990) is the learning environment should be self-directed. In the current study, the case-based video was designed to be self-directed; therefore, it can be started and stopped at any point, and reviewed as often as needed. A second assumption was the provision of an interactive learning experience. This is implemented into the current study’s learning environment as a team of two students analyzed and formulated a solution to the information presented in the video for the case-based group. Lastly, Knowles described the value of incorporating interesting and relevant topics as a factor in successful adult learning. The presentation of a common medical emergency seen in the practice of dentistry was purposefully chosen for the current study to enhance the learning of the adult student.

Social Learning Theory and Self-efficacy Theory

The constructivist social learning theory and supplemental self-efficacy theory (Bandura, 1977) provided a conceptual framework for the changing attitude and confidence of the health care student in addition to the impact on knowledge and skill attainment. Bandura hypothesized that behavior and learning is a result of interactions between individual and environmental variables. Based on this premise, Bandura expanded on this concept to include cognitive development. Therefore, a component of
gaining knowledge is the individual’s perceived self-efficacy toward a learning challenge. Bandura (1993) describes self-efficacy as “people who have a strong belief in their capabilities to think, feel and behave differently from those who have doubts about their capabilities.” (p. 120). These theories posit that if educators offer pedagogical experiences that enhance self-efficacy, there will be an increased likelihood that this student will have greater personal expectations and performance accomplishments. The results could be the applying the learned protocols as part of their future clinical practice behaviors.

One area described by Bandura (1977) to enhance self-efficacy was the provision of a role model. In the current study, all faculty members in a clinical situation perform a skill until the student has received the information in the classroom. In addition, a learning environment that allows for mistakes without fear of injury to a patient was also provided to the student. If a student does not incorporate the appropriate protocol to minimize the potential for a medical emergency or does not recognize the medical emergency, a clinical faculty member would take over the situation. Both strategies minimized a stressful learning environment and had been in existence prior to the intervention. The case-based video also allowed the students in the treatment group to have another opportunity to view a medical emergency and formulate a solution in a safe and calm environment.

Another area described by Bandura (1977) to enhance self-efficacy is repeated exposure to a situation. This concept was implemented into the current study’s learning environment. Both case-based and tutorial-based groups received information on the protocol, but only the case-based MMI group was able to actually view a medical
emergency and formulate a planned response for treatment management. This gave the student in the case-based group an additional real-world view of a medical emergency.

Finally, Bandura (1993) described the value of self-efficacy in complex situations. Responding to a medical emergency is an example of a complex challenge that a dental hygienist needs to be competent in prior to graduation. Bandura idealized that a strong self-efficacy within a student may result in the willingness to participate in more complex challenges, an enhanced commitment to the goal, and the length of time that such effort will continue in response to problems and adverse situations. In the current study, the real-world, case-based video looked at a complex and often stressful situation for any health care professional. Viewing the video, and synthesizing and generating a solution could increase the likelihood that the student gains in self-efficacy toward practice of proper patient management that could transmit the learned protocols into future clinical practice behaviors.

Case-based Reasoning

CBR (Kolodner, 1993) is a problem-solving paradigm that provided a portion of the theoretical framework utilized by the current study. This constructivist theory associates memory, reasoning, and learning of the student to reach the appropriate conclusion. New situations involve retrieval of past experiences by the student along with synthesizing the new information to reach the acceptable outcome and retain the revised experience. The case developed for this specific research study involves taking information on diabetes from the classroom and applying it to a clinical setting by taking appropriate action during a medical emergency in a dental environment. Several traditional pedagogical methods are in place and supported by an authentic, student-
centered video of a similar scenario. As the students synthesize and process the information from multiple experiences and apply the knowledge to the emergency situation, they are using CBR. This provides a beneficial learning environment for health care students to transfer information from the classroom to competent patient care.

_Anchored Instruction_

Anchored instruction is a pedagogy based on constructivism, requiring a student to extract essential clues from an authentic, real-world task and apply critical thinking and reasoning to solve the difficult problem. The goal of CTGV (1990, 1992) was to transform inert learning into rich, meaningful, and useful knowledge that can be transferred to other situations. Authentic situations have been defined by Brown, Collins, and Duguid (1989) as coherent, meaningful, and purposeful activities representative of the practices within the culture. The student becomes an active learner to disentangle the challenge.

The concepts derived from the use of anchored instruction in learning provide the same outcomes intended for the target audience of dental hygiene students. The learner-centered and self-directed teaching strategies described by this instructional model follow constructivist activities and can be utilized in both the classroom and clinical settings in higher education. In tandem with the thoughts associated with CBR (Kolodner, 1993), anchored instruction also has students synthesize, collect, and evaluate the situation to be studied. The outcome is clinical reasoning and problem solving, possibly allowing the student to apply information from the classroom into patient management in a clinical setting. Many of the design features described by CTGV (1992) were incorporated into the MMI for this study, such as video-based format, narrative with a realistic problem,
problem complexity, generative format, embedded data design, relevant and irrelevant information, and links across the curriculum.

*Video-based format.* A digital video was used since it has the advantage of being able to rewind and replay any segments, and the ability to obtain a still image of any frame. The student is able to freeze, review in slow motion, analyze the video footages frame-by-frame, and scan it quickly to locate important clues. These essential components allow the learner to work at their own pace to critique the actions, analyze the situation, provide feedback, and draw conclusions. The student is analyzing the scenario and making decisions in a safe and relaxed environment. Thus, if an incorrect decision is made by the student, there will be no health consequence to the patient.

*Narrative with realistic problems.* Another design feature identified with anchored instruction is the use of a narrative of a realistic problem within the video (CTGV, 1992). The video developed for this research project uses a real-world situation that dental hygienists are most likely to encounter at some point in their professional career. The dramatic situation has the initial appearance of an average appointment with usual display of armamentarium for the dental hygienist. Filmed in the same dental clinic where the students could encounter a diabetes situation in their academic practice may have enhanced the authenticity of the situation. According to the CTGV, the outcome of the MMI could increase student confidence. This increased confidence could improve patient management.

*Problem complexity.* CTGV (1992) recommends that the problem presented is complex, involving multiple steps. This recommendation stemmed from the idea that students should be exposed to authentic levels of complexity that they would experience
in real life. The video developed for this research project uses a complex problem based on a real-world situation that students would likely experience once out in the field.

*Generative format.* Anchored instruction prescribes that the story helps students generate their own solution (CTGV, 1992). In this research project, the video presented a series of typical scenes in a dental office involving a scenario that could occur with any patient with diabetes on an average day; therefore, the student could easily identify with the problem. The video ended with the medical emergency. At this point, it is left to the student to formulate an appropriate response. A series of open-ended questions accompany the video to guide the student groups to generate the appropriate outcome.

*Embedded data design.* Another design feature of anchored instruction is the use of embedded data (CTGV, 1992). CTGV suggests embedded data will provide opportunities for links across the curricula, such as transferring information from didactic coursework to a clinical environment. Each student had received information regarding the presented clues from other courses. All of the necessary data to solve the complex problem was strategically scattered throughout the video, along with extraneous information. As identified by CTGV, the incorporation of irrelevant information can encourage the student to determine which information was relevant to solve the problem. The clues came from the dialogue of the patient, receptionist and dental hygienist; close-up shots of particular props; the verbal and nonverbal signs from the patient; and the action (non-action) of the dental hygienist. The clues included the patient mentioning that she had just come from an intense exercise class. Since exercise is one of the causes of hypoglycemia, as mentioned in a didactic class, this created the risk for low blood glucose levels.
Relevant and irrelevant information. As in traditional case studies for care of patients with diabetes, the information is generally isolated, containing only relevant information, and requiring limited critical thinking. In the video, unessential information was presented to allow for increased reflection by the student. The students were required to look at the overall picture before synthesizing and solving the problem. An example of irrelevant information in the video was the dental hygienist running behind on appointment times. This provided a reason for not obtaining a blood glucose value and created additional stress for the patient and led to an increase in her blood glucose level; however, it was not a reason why the patient’s blood glucose value dropped.

Links across the curriculum. In addition, CTGV (1992) suggests the information presented in the videos support other areas in the curriculum. The accompanying questions in this study could be modified to extend the information on diabetes to other courses or other health disciplines, such as questions regarding the necessary meal pattern for this patient to avoid this medical emergency. It also served to create enough interest that students would be impelled to read related articles in professional journals.

In conclusion, the current study carefully designed and developed a stimulating, student-centered, interactive MMI learning environment to enhance the knowledge, attitude and confidence, and skill of dental hygiene students. The constructivist theories of the adult learning theory, self-efficacy theory, and CBR provided the strong theoretical framework. The features of the MMI learning environment were designed based on anchored instruction. Each of the four frameworks work cooperatively, empowering the student to build upon previous knowledge and experiences, synthesize a solution, and apply the information to appropriate patient care.
Summary

In order to accomplish the goals, the study had 2nd-year dental hygiene students working on questions as teams of two pertaining to the scenario to analyze the situation and determine a better approach to patient care. The video provided a context embedded with clues that allowed the learner to engage in cognitive processes that required thoughtful synthesis, exploration, reflection, articulation, and evaluation. According to the work of CTGV (1990, 1992), the learning that may have been inert, could develop into practical and useable knowledge since the student will be immersed in a realistic situation in an authentic environment. In addition, the MMI also implemented a learning environment of multiple and diverse pedagogies designed to enhance the attitude and confidence of dental hygiene students and increase the likelihood of continuing established protocols into professional practice.

Definition of Terms

The following terms and accompanying definitions are used throughout the research.

*Attainment*-measurement of knowledge, attitude, and confidence immediately following the intervention; short-term

*Case-based MMI*-multimedia instruction that allows the student to work independently or as a group on a clinical situation, which can be adapted to meet diverse subject and student needs without fear of harm to the patient

*Constructivism*-a philosophical view emphasizing meaningful, authentic activities that help the learner to construct understandings and develop skills relevant to solving problems; learning that is student-centered, group-oriented, and interactive
Didactic—teacher-centered instructive pedagogy used for presenting information

Learning environments— a coherent curriculum and a suite of technologies to support teachers and students in learning, instruction, and assessment (Linn, 2003)

Multimedia instruction (MMI)—the use of more than one type of media and integrating the use of text, graphics, sound, or video

Retention—measurement of knowledge, attitude, and confidence six weeks after the intervention; long-term

Tutorial-based MMI—multimedia instruction that allows the student to work independently on the course material for acquiring knowledge and/or skill. These programs often imitate the original lecture.
Chapter 2

Review of the Literature

This chapter begins with a history of multimedia instruction (MMI) in dental education followed by a review of the literature of the use of MMI in health care education, through which two theoretical frameworks emerged that guided studies in this area of research. MMI is defined as the use of computer technology for supplementing the distribution of course content with that of traditional methods (Cotton, 1992). With the literature on MMI, three specific domains were investigated: knowledge and skill attainment, attitude and confidence, and assessment of the learning. Finally, a critical analysis of the represented studies from the past 12 years is provided. This analysis included studies that compared a constructivist-oriented MMI to a traditional pedagogy or had no comparison group. The current study was designed to determine the effect of case-based MMI as compared to tutorial-based MMI in the education of dental hygiene students while integrating the methodological and theoretical gaps.

History of Multimedia Instruction in Dental Education

The early 1970s saw the first use of computers which began to change the face of teaching and learning in dental education (Fitzgerald, 1973). The greatest insurgence of research using MMI in dental education was seen in the 1990s (Stephens & Grigg, 1994). Incorporating techniques to address all learning styles in higher education, including medical, dental, and allied health students, has been and continues to be the focus of many educational research studies in order to capture the diversity of all learners’ needs (Karakaya, Ainscough, & Chopoorian, 2001; Kaufman, Sutow, & Dunn, 1997; Newble & Entwistle, 1986). Health profession educators search for teaching strategies that employ
critical and independent thinking, enhance efficiency of learning, transfer of learning, problem solving in clinical situations, retention of material, and improve manipulative and clinical skills at a faster rate (Barzak, Ball, & Ledger, 2001; Davies & Crowther, 1995). The explosion of various pedagogies using MMI were designed, developed, implemented, and assessed as the use of computers expanded.

Health profession educators and researchers capitalized on the emerging pedagogies that emphasized technology as they sought to investigate educational strategies to meet the changing demands and challenges of health care as well as meet the students’ learning needs. One such effort was to uncover pedagogies to support and promote a student’s efforts to initiate or continue health care protocols from the classroom into professional practice. In addition, the waning number of faculty in health care education produced a need to consider instructional options to reduce the number of hours a faculty member spends in the classroom. MMI may fill this void if deemed equal to or better than a traditional lecture. Another issue regarding further investigation of MMI in health care education relates to the rapid expansion of pertinent information in all disciplines in health care. The amount of information presented today is much greater than even a decade ago, yet the program length to graduate remains the same. The need to learn more information in the same period of time is a challenge. MMI may provide a positive alternative to these and other educational dilemmas.

*Theoretical Frameworks*

A limitation of many of the studies found in the medical and dental literature in MMI was the lack of a theoretical framework to support research efforts. While many studies recognized the needs of adult learners, the benefit of learner-centered and self-
directed teaching strategies, and constructivist activities and evaluations in a classroom or clinical setting, reference to a theoretical framework was absent or inadequately linked. CBR and the adult learning theory were two constructivist learning theories that appeared to be implicated by at least one study. A review study by Chadwick, Bearn, Jack, and O’Brien (2002) identified the thoughts of the constructivist theorists Bruner, Dewey, Knowles, and Vygotsky as a vital component on which MMI in health care should be based.

*Case-based reasoning.* MMI in health education as a method for teaching and learning, especially when looking at skill acquisition, can use CBR as a cognitive theory. This constructivist perspective is a theory that intertwines memory, reasoning, and learning. It posits that the student remembers previous situations similar to the current one and uses this information to help solve the novel or unexpected case (Kolodner, 1993). Kolodner defines a case as “a contextualized piece of knowledge representing an experience that teaches a lesson fundamental to achieving the goals of the reasoner” (p. 13). Ultimately, the student will synthesize, collect, and evaluate the feedback from the CBR experience. CBR suggests an increase in the likelihood the student will be able to easily access the information from memory then apply and transfer the fundamentals acquired from the CBR experience to other related circumstances.

In dental education, case-based learning was described by Oesterle and Shellhart (1998) as a valuable epistemic learning process by which students transfer basic knowledge learned in textbooks and lecture and apply it to patient care. Therefore, the benefit from utilizing the case-based method in health education is using an authentic real-world episode to immerse the learner in a practical and applicable scenario to
promote self-directed learning, clinical reasoning, and problem solving (Engle & Hendricson, 1994). This is accomplished by providing similar experiences that are repeated in both a classroom and clinical setting and by focusing the student on the complexity of appropriate patient care. Utilizing a MMI that employs CBR may create an experience that guides students to reflect, sort ideas, gather new information, and allow for mistakes without fear of injury to a patient.

Although the theory was not identified as a basis for the research design, several studies in the health care literature using MMI used concepts associated with CBR (Boynton, Green, Johnson, Nainar, and Staffon 2007; Fouad and Burleson, 1997; Howerton, Platin, Ludlow, and Tyndall, 2002; Hudson, 2004; Kleinert et al., 2007; Williams, Aubin, Harkin, and Cottrell, 2001; Zary, Johnson, and Fors, 2009). For example, Williams et al. designed MMI that motivated students to solve problems. Students assigned to a case-based MMI were compared to those in a traditional lecture with identical objectives. Included in the program were video clips of scenarios of the interaction between the doctor and a patient experiencing panic or anxiety. The goal was for the student to correctly recognize and assess the symptoms, diagnose the situation, and create a treatment plan. After viewing the case-based MMI, the student gathered the key elements, decided which information he/she lacked which required further investigation, determined how to obtain the information (such as additional questions to the patient or looking at other resources), and sought to draw an appropriate conclusion. Kolodner (1993) argues that experiencing a similar incident once before, the student will be able to more easily understand the situation again with greater logic and less difficulty than the first time. This epistemologically rich approach to enhanced knowledge and
Multimedia Instruction
capability is fundamental in training health care professionals toward developing competence.

Adult learning theory. Although not cited, the health care literature has also utilized concepts based on the work of Knowles (1990) regarding his adult learning theory (andragogy), the study of adult teaching and learning, to stimulate and challenge the student in higher education. The adult learning theory is an alternative to traditional pedagogy, having a symbiotic relationship with constructivist epistemology that is student focused and considers previous learning as a foundation to build and expand upon new knowledge. It empowers the adult to learn using self-directed, self-paced, and interactive learning experiences. It is also based on the assumptions that the students take ownership of their learning, are interested in topics that are relevant to their lives, and understand why it is important to learn (Knowles, 1984, 1990). All three assumptions are required for students to be able to successfully learn. The role of the instructor is to serve as a facilitator or guide to promote student inquiry. The outcome is that learning is more meaningful and contextual to the students.

Since health care students are adults, they come into the classroom and clinical practice with prior knowledge from their formal education and life experiences (Cust, 1995). To enhance their knowledge base, students can use their own experiences and existing information, interpret what they do not know, and construct new knowledge from other’s experiences. When applying this knowledge in a clinical situation, such as responding to a medical emergency, the students can be better prepared for the different contexts in which these incidences may occur. Therefore, the development of a skill can
Multimedia Instruction

involve the transfer of knowledge from the classroom into a practical situation that can be modified and expanded for the next similar circumstance (Peters, 2000).

Studies cited the use of MMI as a benefit to students who prefer interactivity and independence in learning experiences. Although not specifically citing the adult learning theory, Bogacki, Best, and Abbey (2004) posit that a computer-assisted program in dental anatomy is effective since the instruction can be tailored to meet the learning needs of adult dental students.

Knowledge Attainment with Multimedia Instruction

Learning in health care involves the ability to transfer knowledge from didactic courses to pre-clinical, laboratory, clinical settings, and professional practice for optimum patient care (Hudson, 2004). All of the studies evaluating the use of MMI in health care education have concentrated on attainment of knowledge and/or skill. The key to designing a quality learning activity is to cognitively engage the learner to think about the meaning and relevance of the material, its application, and the various contexts to which it can be applied.

The design and development of MMI programs to educate health care students was diverse. Many of the studies cited were created to measure and compare the effectiveness of the MMI as an adjunct to traditional teaching strategies, while other studies used the MMI as replacement. Several studies used problem-solving and/or interactive activities to enhance learning, while other studies used MMI as a demonstration only. Studies also had students working independently, while other studies had students work collaboratively. Finally, studies used tutorial-based or case-based MMI. Tutorial-based MMI often allowed the student to work independently on the course
material for acquiring knowledge and/or skill. These programs often imitated the original lecture. Case-based MMI involved the application of the information to a clinical experience. The varying outcomes from the reviewed studies need to be explored further.

*Attainment of knowledge.* The evidence is inconsistent as to whether MMI leads to gains in knowledge in health care education. For example, Fouad and Burleson (1997), Kleinert et al. (2007), and Rosenberg et al. (2006) found significant gains in knowledge in health care students following MMI. On the other hand, Aly, Elen, and Willems (2004), Bogacki, Best, and Abbey (2004), Friedl et al. (2006), Williams et al. (2001), Seeram (2001), and Zary, Johnson, and Fors (2009) found no difference in knowledge gained using MMI. Moreover, Devitt and Palmer (1999) and Summers, Rinehart, Simpson, and Redlich (1999) found the students in the traditional learning groups to have significant improvement in knowledge over those participants in MMI groups.

Two of the studies that found MMI to be effective looked at case-based MMI. For example, one study that used case-based MMI as an adjunct or addition to a lecture was completed by Fouad and Burleson (1997) who examined the effectiveness of MMI for diagnosis of endodontic issues. A presurvey (20 multiple-choice questions) to measure knowledge was administered to 90 third-year dental students followed by ten lectures. The participants were randomly assigned to one of the three groups: lecture and exposure to MMI containing case situations that involved problem-solving activities for 1 hour; lecture and participation in a seminar group containing identical cases for the same time period as the MMI; and lecture only. Analysis of the postsurvey revealed the students in the case-based MMI group scored significantly higher in knowledge than the other two groups. There was no difference between the seminar group and the control group.
Kleinert et al. (2007) also found a significant improvement in knowledge when using case-based MMI with dental students \((n = 49)\) as an adjunct to the traditional course. An interactive case-based MMI that utilized problem solving was developed to determine the knowledge of students regarding the care and treatment of a developmentally disabled patient. There was no comparison group.

While some studies found case-based MMI to be effective at improving knowledge attainment, Rosenberg et al. (2006) found a significant increase in knowledge gained using a tutorial-based MMI that replaced the traditional lecture \((n = 69)\) compared to the use of lectures in a classroom and microscopes in a laboratory from five previous classes \((n = 347)\). The tutorial-based MMI used images of the histological glass slides and the existing lecture material in the form of figures and text. In addition, students were given a hard copy of the lecture slides. The conventional use of microscopes was available in a lab, but was not mandatory, for students using the tutorial-based MMI. A comparison of two sets of test scores found those participants using the tutorial-based MMI to be significantly higher than the scores of previous students exposed to traditional non-multimedia instruction. They scored 11.2% higher than all of the previous classes combined.

Although some studies found MMI to be better than traditional pedagogies, other studies found MMI to be equivalent in its effectiveness to traditional learning methods. For example, two studies using tutorial-based MMI as a replacement to lecture found no difference in knowledge between the groups (Bogacki et al., 2004; Friedl et al., 2006). Bogacki et al. used a tutorial-based MMI to replace the lecture course and found the knowledge gained to be equivalent for both groups. The students assigned to the tutorial-
based MMI for the dental anatomy course \((n = 46)\) were compared to the students attending the traditional lecture \((n = 59)\). The tutorial-based MMI had the same objectives as the lecture component and contained text, photographs, and illustrations. Three separate examinations measured the knowledge attainment for each group. Friedl et al. also found no difference in knowledge attainment with medical students using tutorial-based MMI compared to the print version. Both groups did improve. Each student worked independently and was measured using identical pre and posttests.

Other studies also found tutorial-based MMI used as an adjunct or addition to traditional pedagogies to be equally as effective as traditional methods. For example, Aly et al. (2004) implemented MMI that contained a tutorial of 14 programs in orthodontics that were designed and created by the authors (one dental faculty and one instructional designer). The components of each program included graphics, text, and a self-assessment that required problem solving. The tutorial-based MMI could be viewed as often as the student wanted during computer lab hours. The description of the tutorial-based MMI appeared to be a videotaped version of the traditional method using lecture and demonstration, except it was taped and placed onto a courseware package. The teaching objectives were identical for both groups. Presurvey and identical postsurveys were administered to the students to evaluate the gain in knowledge. The results indicated that no statistical difference existed between the two groups at the postsurvey. A second example of tutorial-based MMI used as an adjunct that was found to be equally effective as lecture in attainment of knowledge was a study conducted in an Anatomy and Physiology course for health care students. Seeram (2001) found no difference among a group of diverse undergraduate health care students receiving different treatment
conditions for two of the lectures: lecture only; tutorial-based MMI and lecture; and the
tutorial-based MMI, lecture, and an enhanced learning system. The tutorial-based MMI
consisted of an existing interactive videodisk including sound, text, computer graphics
and videos. The enhanced learning system was the interactive videodisk with an
instructional intervention procedure that enhanced the effectiveness of the program. For
example, prompts were given by the program that required students to make a list of
unfamiliar words before moving on. Although the outcomes did not show a significant
difference between the treatment groups, the researcher concluded that a need existed to
further investigate the incorporation of other teaching and learning strategies containing
practical applications in combination with MMI for optimal effectiveness.

In addition to the tutorial-based MMI found to be equally effective to traditional
methods, there were a couple of case-based studies that were also adjuncts to the
traditional approach, having similar results (Williams et al., 2001; Zary et al., 2009). For
example, Williams et al. also found no difference in knowledge between the case-based
MMI and traditional learning using a video of a patient experiencing anxiety ($n = 166$). It
was unclear as to the extent that the video was used during the lecture or if there was
student involvement. Both groups used identical learning objectives and case materials,
as well as the same 55-minute session to complete the module. The students worked
independently on the interactive case-based MMI that implemented problem-solving
activities. To assess knowledge, a presurvey and identical postsurvey of 10 multiple-
choice knowledge questions that included problem solving was developed. The
knowledge of both groups significantly increased after the intervention with no
significant difference between the groups.
Zary et al. (2009) was the final study to find case-based MMI to be equivalent to traditional instruction in attainment of knowledge. The case-based MMI was a series of scenarios of various patients in a general dentistry course for the student to problem solve and diagnose the dental issue presented. The knowledge of dental students receiving the intervention was compared to the students in the previous year exposed to the traditional learning. The scenarios were the same situations presented the previous year as paper-based projects. The student could view the case-based videos as often as needed, followed by the traditional learning strategy of a demonstration and a large group discussion. The outcomes did not show a difference in knowledge from the previous year.

Introducing students to MMI may not guarantee achievement of the learning expectations of health care educators and may actually negatively impact learning if not adequately planned and implemented. Several researchers indicate that knowledge attainment may be better achieved by traditional teaching methods than with tutorial-based MMI. For example, using a tutorial-based MMI, Devitt and Palmer (1999) concluded that knowledge-based information that depended on memorization and recall of the material for medical students was best accomplished with a teacher-based lecture and a passive learner. The research of Summers et al. (1999) also concluded that the attainment of knowledge is best accomplished in a didactic setting without the aid of tutorial-based MMI. There was a significant increase in knowledge in the didactic group for the postsurvey over the videotape or computer-based groups.

To summarize, the trends identified in the review of literature on health care showed that whether the MMI was case-based or tutorial-based, there was generally equal or significant improvement in attainment of knowledge compared to traditional
pedagogies. With the impending dilemma of dwindling numbers of faculty members in health care, this may also be a positive outcome. Of particular note, no study that assessed attainment of knowledge statistically distinguished between the type of knowledge questions, those requiring critical reasoning or factual-based. Characterizing this information could provide a stronger argument for the effectiveness of one approach over the other. This presents a gap in the health care literature using MMI.

Retention of knowledge. A second category of learning identified in the health care literature is retention of knowledge. This category identifies how well the student retains the information following an assessment or evaluation of the material, such as weeks or months later. Many studies recognized a need to measure retention of knowledge. For example, Boynton et al. (2007) mentioned the possibility of measuring retention of knowledge using a computer-based simulation for behavior management of children in a dental environment. Future research could use a similar study format, but assess the knowledge of students at another point in their education or once practicing as dentists. Howerton et al. (2002) also identified a need for a longer period of time between the intervention and measurement to study the effectiveness of MMI for retention of knowledge and skill. Further, Williams et al. (2001) discussed the need to identify the value MMI may have on retention of psychiatric knowledge and skills as a possibility for future research.

There were only two studies found in the literature on retention of knowledge. These studies indicated mixed results on knowledge retention for MMI. Hudson (2004) found that each group improved in retention of knowledge. Two weeks after the intervention, a significant difference in improvement was noted for the highly interactive
case-based MMI group compared to the students involved in the didactic tutorial-based MMI group. However, no difference was noted in the less interactive case-based MMI group compared to the didactic approach in the tutorial-based MMI group in regards to retention of information. On the other hand, a study by Summers et al. (1999) found that there was a significant increase in knowledge in the didactic non-MMI group for the posttest one month following intervention compared to the tutorial computer-based and video groups. Both studies measured knowledge using an identical pretest and posttest. These outcomes indicate that additional research is needed in the area of MMI and retention of knowledge of health care students.

Confidence and Attitude Attainment with Multimedia Instruction

Providing the knowledge and practicing the skills of health care procedures is an obvious and critical part of the curriculum. Consideration of the students’ confidence in providing the treatment, perception of the role the student plays in the procedure, and gaining student acceptance toward the practice are other concepts that educators in health care should incorporate into the instruction of health care students. As recognized by Bandura (1993), low self-efficacy of a student toward learning a topic can form a barrier and impede the learning of the student. A need exists to determine if MMI has value as a pedagogical strategy in increasing confidence of the student.

Health care professionals with a sense of confidence in their ability to reason through a problem may provide a strong foundation toward performing a needed protocol. The relevance of a topic or process may be of great importance to students; however, they may have the perception of being inadequately prepared to implement the process into practice or provide the appropriate education to patients. Bandura (1993)
theorized that a strong sense of efficacy would allow a student to approach difficult situations or known barriers with greater effort. A student’s perseverance and efforts will be dependent on their level of perceived self-efficacy. The stronger the self-efficacy, the more active and determined the efforts become. The interest and passion for a skill promotes a strong commitment, and if failure to implement the skill in practice occurs, it is met with a determination to acquire additional knowledge to try another approach. On the other hand, the lower the self-efficacy, the less effort and the more prone the student will be to abandon their attempts.

There is limited research in the health care literature on the use of MMI and its effects on increasing student confidence in practicing a skill or the student’s perception of their ability to perform a skill or task (Gleydura, Michelman, & Wilson, 1995; Kock & Guice, 1989). Only one study using MMI in health care measured confidence and attitude (Boynton et al., 2007), while no study measured retention of attitude and confidence. This lack of research is a little surprising as it is important to consider how the learning activity will impact the attitude and confidence of the student and increase the likelihood of retention of the learning.

Boynton et al. (2007) found students to have an increase in confidence toward managing the behavior of children in a dental environment following case-based MMI. The authors used a questionnaire to assess the students’ confidence in treating children. Although only descriptive statistics were obtained, the researchers found importance in the positive responses to the statements, “I made mistakes on The Virtual Child website that I now know to avoid when treating a real child” and “I am better prepared to treat children after having visited The Virtual Child website.” Besides the significant increase
in knowledge and application of the material by the students using the website, more notable is that MMI created an environment to practice and make mistakes without repercussions. The MMI measured improved attainment of confidence and attitude immediately following the intervention and before going into a clinical situation with a real child.

In order to gain a sense of students’ attitude and confidence toward a topic, studies in health care outside of MMI were analyzed. In a study in which a questionnaire was administered to 398 practicing nurses, Pearcey (1995) found that 78 percent of the nurses had a positive attitude about their skills of using research findings to improve patient care; however, 93 percent indicated a lack of confidence in their knowledge of research skills. Pearcey also reported that only 29 percent of nurses felt that the instruction offered on research skills during their training was adequate.

In an effort to determine the self-efficacy of nursing students toward executing health promotion activities, Laschinger (1996) showed a significant increase in self-efficacy from the 1st to the 4th-year nursing students. A survey was administered to 114 1st, 2nd, and 4th-year nursing students to measure perceived self-efficacy in performing health promotion activities. The study concluded that self-efficacy in health care students would increase, over time, through participation in a number of pedagogical experiences. In addition, Laschinger looked at the effect of specific teaching and learning strategies on the development of health care students’ self-efficacy. She identified collaborative learning, in which students work with peers to accomplish learning; classroom discussion or written reflection of the experience; observation of a credible model; providing specific and encouraging feedback; and incorporation of case studies of realistic
experiences as examples of teaching strategies identified to heighten beliefs of self-efficacy of a health care student.

Smoking cessation is an example of a protocol taught in the majority of dental schools, yet the student often feels unprepared to initiate counseling with a patient (Weaver, Whittaker, & Valachovic, 2002). In a cross-sectional study by Cannick et al. (2006), a survey was administered to 162 first- through fourth-year dental students to ascertain their perceived ability to provide cessation counseling and perceived effectiveness of a smoking cessation program. The results revealed that 88 percent of the students indicated cessation programs were important and within the scope of practice for dentists to provide, yet only 38 percent felt they were adequately trained. In addition, only 14 percent of the students were confident in their ability to aid patients in abstaining from using tobacco products.

These studies suggest that educators should be aware of the students’ skill deficits and their perception of ability to successfully execute these skills by reinforcing confidence more consistently and clearly with effective pedagogies (Cannick et al., 2006; Pearcey, 1995). For example, performance of a skill in a clinical setting or in a simulated experience has been identified to further strengthen the level of confidence of a student (Cannick et al.; Laschinger, 1996). Therefore, level of confidence can be affected by teaching practices. Block, Hutton, and Johnson (2000) concluded that clinicians who feel prepared and confident in their ability are more likely to implement a tobacco cessation program than those who feel less prepared and confident.

As explained earlier, a review of health care literature retrieved just one study to measure the confidence and attitudes of students toward a skill or task following MMI.
This study and the health care literature outside of MMI supported the significance of attitude toward acquisition and retention of a skill. It is an important concept to continue to study in promotion of health care protocols and the teaching and learning strategies that will empower the student. This lack of research is a gap that needs to be addressed in the health care literature on MMI.

*Skill Attainment and Retention with Multimedia Instruction*

MMI may prove to be beneficial for other modes of learning, such as manipulation of a skill. Acquisition of a skill includes performance of a task, application of knowledge in a clinical setting, treatment planning, analysis or interpretation of a clinical situation, and diagnosis of a clinical situation or disease. The capability of students to review MMI as many times as necessary and stopping the program at any procedure for further analysis is an advantage. In addition, the procedure taught in a live demonstration leaves some students with a limited viewing capacity in which only those in the front have a good view. MMI gives a bird’s eye view of the procedure, guaranteeing that each student observes the identical procedure as another student. Skill attainment by students may be affected by MMI. Traditional approaches to education assume that learners are uniform in processing and organizing information. Use of MMI in simulated experiences, however, offers an opportunity to visualize a process or procedure before the actual first encounter. This provides the potential to increase cognitive knowledge and apply the information to a situation, possibly with less instruction time.

All of the studies in MMI found an equivalent comparison to traditional pedagogies or a significant improvement in skill attainment. Several studies (Aragon &
Zibrowski, 2008; Bauer & Huynh, 1998; Boynton et al., 2007; Friedl et al., 2006; Hudson, 2004; Williams et al., 2001) used MMI to positively enhance acquisition of a skill. On the other hand, Aly et al. (2004), Howerton et al. (2002), and Summers et al. (1999) found the teaching pedagogies to have equivalent outcomes. Researchers acknowledge the common challenge of students to apply information from the traditional dental classroom setting to a clinical procedure.

Three researchers found significant improvement in skill attainment using tutorial-based MMI (Aragon & Zibrowski, 2008; Bauer & Huynh, 1998; Friedl et al., 2006). For example, Aragon & Zibrowski designed a video to accommodate these learning needs of students. The class using the tutorial-based MMI scored significantly higher on the practical examination of the procedure compared to the class with traditional learning only. The tutorial-based MMI was a detailed procedural demonstration of a crown preparation and placement, used as an adjunct to the traditional lecture and clinical practice. The clinical practice included a demonstration followed by students practicing independently on a manikin with supervision by the instructor. Students \((n = 55)\) could view the video as many times as needed. The concluding 28-item practical examination was compared to the class of the previous year, and it was found that the tutorial-based MMI group performed better.

Also finding a significant improvement in skill using a tutorial-based MMI, Bauer & Huynh (1998) used MMI to educate the student on information related to blood pressure and acquiring the skill of obtaining a blood pressure reading on a patient. In this study, 27 nursing students were randomly assigned to one of three groups: tutorial-based MMI only, traditional instruction only, and a combination of both. The tutorial-based
MMI incorporated text, animated graphics, photographs, and video. The objectives of the instructional methods were identical. The combination group, receiving both lecture and tutorial-based MMI, scored significantly higher on four of the five categories that were assessed when performing the skill. The tutorial-based MMI group scored significantly higher on three of the evaluation categories while the lecture-only group scored significantly higher in only two categories using a rubric for scoring. Therefore, the outcomes support the argument for combining the MMI with the traditional pedagogy for skill attainment. In addition, Friedl et al. (2006) also found a significant improvement in skill for the group of medical students using tutorial-based MMI \( (n = 69) \) on aortic valve replacement surgery compared to a print version \( (n = 57) \); however, both groups improved in skill. Both groups were evaluated on 28 items to assess their performance in the operating room. The MMI contained videos, sound, and animations and was used as a replacement, as opposed to an adjunct, to the traditional method.

In addition to many of the tutorial-based studies, MMI studies using a case-based MMI that required interaction and problem solving by the student measured significant improvement in attainment of skill (Boynton et al., 2007; Hudson, 2004; Williams et al., 2001). Boynton et al. noted a significant increase in application of knowledge in a clinical setting when using an interactive case-based MMI to complement the traditional lecture. The 107 participants in the control group were junior-level dental students receiving two 50-minute lectures on child management behavior from the previous year. The experimental group consisted of 98 participants from the following year, receiving the same two lectures, as well as completing the case-based MMI. The identical examination tested knowledge and application of the material using 18 objective questions and one
open-ended question. The exam was reviewed for accuracy by four pediatric dentists. The case-based MMI used a text-based description of the situation that required the student to select the appropriate action. The program provided immediate feedback on the student’s choice.

In addition, Hudson (2004) found significant improvement in an interactive case-based MMI using problem solving compared to the tutorial-based MMI program that replicated a lecture. Hudson compared three MMI separate learning environments: one tutorial-based and two case-based, varying in the level of involvement of the student. Learning objectives for each group were identical. The first MMI environment consisted of a multimedia tutorial that was didactic in nature, using text and images in a structured way as if presented in a traditional lecture; therefore, the program required very minimal interaction of the student. The second MMI learning environment involved case-based teaching sessions that required more interaction with the program and application of learning to a clinical scenario. Integration of multiple-choice questions throughout the program forced student involvement. In order to continue with the program, the student had to answer each question correctly. These two MMI groups were found to have no difference in achievement of skill at the posttest. The third case-based multimedia format was the free-text version of clinical scenarios. This version involved a series of open-ended questions that needed a typed response and was compared to the author’s response before continuing with the program. This version required the greatest level of interaction by the student. The researcher concluded that all of the groups significantly improved in their ability to apply the information. The free-text, case-based MMI group showed
significant gains compared to the tutorial-based group, but not when compared to the other less interactive case-based MMI group.

Williams et al. (2001) also reported a significant increase in the ability of medical students using case-based MMI of counseling patients with anxiety compared to those attending lectures and viewing a video of a patient as a large group. The case-based MMI group used video clips of material supplemented with text to describe key information and was an adjunct to the traditional pedagogy. The student viewed the case-based video clips and followed directions to assess and diagnose the existing physical, social, and psychological problems. Following the interactive intervention, an existing tool (Hodkinson Abbreviated Mental Test score) was used to evaluate the students’ competency to recognize and manage mental health problems. In addition, a videotape of the student conducting a session with a similar client was viewed and assessed. The authors concluded that even a slight gain in skill is an indicator to future success since recognition of even one more clinical sign of anxiety is beneficial for patient care.

In addition, several studies on assessing skill acquisition following MMI found outcomes that were equal to traditional teaching strategies. Each of these studies focused on a tutorial-based MMI (Aly et al., 2004; Howerton et al, 2002; and Summers et al., 1999). Howerton et al. found that dental students using the interactive tutorial-based MMI along with lecture scored similarly in exposing and developing radiographs to those attending just the lecture. Summers et al. also noted no difference with any mode of instruction assessing practical skills at the posttest. The authors designed and implemented both a computer-based program and a video on basic surgical skills using identical pictures, text, and audio. The students were divided into lecture, watching the
Multimedia Instruction

video as a group, or the MMI. Although not clearly identified, the MMI appeared to be
tutorial-based. Aly et al. also found no difference between a group of dental students
receiving tutorial-based MMI as an adjunct to traditional pedagogy compared to those
receiving the traditional classroom instruction for working with orthodontic appliances.
This experience implemented problem-solving activities. Although each of these studies
found no significant difference, the results indicate that the effects of the pedagogical
strategies are equivalent. In other words, MMI was just as effective as the traditional
methods. Thus, these researchers included recommendations for future research in the use
of tutorial-based MMI for acquisition of a skill.

Summarizing the trends from the health care literature using MMI, the studies
implementing tutorial-based MMI showed equivalent achievement or increased skill
acquisition compared with traditional pedagogies. On the other hand, each of the studies
using case-based MMI found a significant improvement in skill. Therefore, according to
the literature, case-based MMI appears to be more effective than tutorial-based MMI at
improving skill attainment.

A unique aspect of health care education includes the current and continued
performance of a skill at a competent level for the student to successfully graduate. Only
one study measured retention of skill over time; therefore, more research is needed on the
retention of skills after graduation and is a gap in the health care literature. The one study
to measure a retention in skill was Summers et al. (1999). They found a significant
improvement utilizing a tutorial-based MMI for overall performance of a technical skill
following the posttest four weeks after the intervention compared to the didactic group,
but was equivalent to the group viewing the video. The group exposed to the computer-
based program showed similar scores to the video (basic surgical skills) group and each of the three groups performed the skill at a faster rate. This study concluded that the use of MMI may be more effective for enhancement of student skills long term.

**Evaluation of Learning**

The final section investigates a key element of health care programs: evaluation of learning in clinical settings which includes measuring a change in knowledge, skill, or attitude. Bourke and Ihrke (2005) defined evaluation as “a means of appraising data or placing a value on data collected.” (p. 443). The collection and subsequent interpretation of the data will determine the degree of effectiveness of a learning experience in assisting students to achieve the desired goals. Decisions to refine and improve educational pedagogies can be based on the outcomes of the evaluation. Pragmatically, evaluation and teaching are a synergistic dichotomy in which each influences the other.

Within health professions education, evaluations should be based on the rigorous competency standards required by external accrediting agencies for increased accountability. For example, a mandate from the Commission on Dental Accreditation for Dental Hygiene Education Programs (2009) states, “the dental hygiene program must employ student evaluation methods that measure all defined program competencies.” (p. 17). Competency is defined as a behavior or ability to meet the level of knowledge, skills, and professional values established by the American Dental Association to begin the practice of dental hygiene (Commission on Dental Accreditation for Dental Hygiene Education Programs, 2009). Hendricson and Kleffner (1998) best defined the goal of assessment in health professions education as, “determining the students’ capacity to integrate and implement the various domains of learning that collectively define
competent practice, over an extended period of time, with day-to-day consistency, in a work environment that approximates the actual work setting where health care providers interact with patients.” (p. 183). Therefore, evaluations should be designed to reveal the student’s ability to engage in critical thinking within the context of the situation and the supporting rationale and judgment for treatment decisions (Colucciello, 1997; Oermann, 1997).

There are many evaluation strategies that can be used in health professions education. The selection of evaluation methods depend on the course objectives with several choices of tools for the objective. This allows for flexibility in choosing a method (Oermann & Gaberson, 2006). The following provides a description of seven evaluation strategies that are described in the literature regarding MMI in health education to measure outcomes in knowledge, skill, and/or attitude.

Clinical practice scenarios. Presenting a patient scenario (written or virtual scenarios) allows the student to synthesize and analyze information within a given context, investigate unfamiliar information, identify possible interventions, determine salient decision points, and make a judgment on action. The scenario is often accompanied by subjective and/or objective questions in a written format. These questions will evaluate the ability of the student to apply concepts and theories from the classroom to a clinical situation. Discussion groups can also be used for critique and feedback as an alternate method of assessment or in combination with the questions (Oermann, 1997). Evaluation of the underlying thought process of the student to arrive at the answer will determine if the pedagogical tool is sufficient in meeting the educational goal (Hayes, 2006; Kramer et al., 2009). Two studies (Boynton et al., 2007; Williams et
Multimedia Instruction

al., 2001) present examples using virtual, case-based scenarios with accompanying questions to assess student knowledge and ability to transfer the information to a clinical setting. Kleinert et al. (2007) also used a virtual, case-based scenario with questions to just measure knowledge. In each of these examples, students worked independently with the MMI.

Observations and simulations. Observation of the student by a supervising clinical instructor in pre-clinical laboratories and clinical settings with actual patients is the predominant and valued method utilized in health care professions to evaluate clinical skills (Albino et al., 2008; Epstein, 2007). However, observations are subjective and present a series of consequences, including an evaluation influenced by an evaluator’s attitude, professional values, or biases. For example, in assessing students obtaining a blood pressure value on a patient, evaluators in Bauer and Huynh (1998) were familiar with the procedure; however, they were not calibrated for consistency or inter-rater reliability. Having multiple evaluators conduct observations and calculating an inter-rater reliability can avoid some of these potential biases. However, this is not always practical due to limited faculty and the creation of a more stressful environment for the anxious student. Clearly articulated standards on the evaluation tool can also help to reduce these concerns (Oermann & Gaberson, 2006).

Simulation is a situation made to resemble clinical practice (Rauen, 2004). As a learning pedagogy, simulations can develop students’ psychomotor and technological skills and the students can practice those skills to maintain competence in a safe environment. Enhanced critical thinking and problem-solving abilities in clinical situations can be the outcome of simulation experiences (Candela, Dalley, & Bensel-
As an evaluation tool, simulations offer an effective alternative to assess student ability to apply knowledge in a clinical setting. The use of manikins or standardized patients would be examples of a simulation for clinical teaching and evaluating.

The use of simulations as an assessment generates similar considerations as observations. Inter-rater reliability, patient and evaluator training, using patients and evaluators not involved in the research, and using multiple evaluators are recommended protocols for robust research. Aragon and Zibrowski (2008) used both manikins and live patients for simulation in the instruction and evaluation of dental students comparing outcomes to those of the previous class. The assessment instrument was designed by the course instructors; however, it was not clear if the tool was evaluated for effectively measuring skill or if the tool was identical to the control group. Using a manikin to assess basic surgical skills, one of two evaluators reviewed every student for each of the three evaluative sessions. The evaluators were provided with training and participated in the pilot study in the same role. Each evaluator was randomly assigned students and blinded to the instructional modality. In addition, there was a random cross-section of five students which both evaluators assessed to measure consistency between evaluators. It was unclear if the evaluators were members of the research team.

Rating of skill in a simulation or observation in clinical practice can be accomplished by using some type of a rubric, such as a checklist. A checklist of clearly articulated, specific, and critical competencies and procedures in the proper sequence is an evaluation tool which maximizes validity and reliability. Each item on the checklist requires thoughtful review by practitioners, evaluators and students for understandability,
readability, purpose, and function. An area is available on the checklist to mark from a range of scores or whether the student met the competency. The checklist can be available to the student prior to the assessment for review and self-evaluation of their practice. This assessment method can be used to evaluate competencies related to critical thinking, knowledge, or behaviors (Kramer et al., 2009; Nitko, 2004).

The following studies investigated the effectiveness of MMI in clinical settings using observations or simulations with the use of checklists as the assessment tool. Bauer and Huynh (1998) assessed students through observation using a skill checklist; however, validity and reliability of the instrument was unknown since it was not reported. A 28-item checklist was also used by five evaluators in the study by Aragon and Zibrowski (2008). The items were divided among the evaluators so that each evaluator observed the same objectives for each of the three practical examinations. Having two evaluators for each student can provide a measure of consistency or inter-rater reliability. The researchers in a second study (Howerton et al., 2002) used a checklist of criteria to evaluate the number of errors on dental radiographs in a simulated experience using manikins. The skill criteria checklist was a tool established by the program and used for many years, but it is unclear if the checklist had ever been subjected to evaluation as an assessment instrument. Another study (Summers et al., 1999) used a checklist to evaluate the skill of students. Two of the researchers developed the checklist adapted from the validated tool, “Objective Structured Assessment of Technical Skill (OSATS)” and field tested with 30 students. Finally, Friedl et al., 2006 assessed the skill of medical students by observation of 28 tasks during an aortic valve replacement operation. Each task was
measured by a trained observer; however, it is not clear how the observers were trained, the number of observers used, or the validity and reliability of the assessment instrument.

*Open-ended questions.* Open-ended questions, both individually and as a group, can be carefully prepared to uncover the underlying rationale for the students’ decisions and critical thinking ability (Oermann & Gaberson, 2006). They require more complex cognitive processes and allow for more contextualized answers than multiple-choice questions. Clarification and higher-level questions will elicit responses that the evaluator can use to assess the learning of the student. To clarify a response, a student may be asked, “Why did you choose that approach…?” or a higher-level question may be, “What alternative treatment could have been performed?” Williams et al. (2001) used one open-ended question involving a clinical scenario to measure the skill of the student. The question was evaluated with the aid of a checklist. It was not reported how the checklist was established or whether further testing was done to ensure validity and reliability. The answers were evaluated by one of the researchers who was blind as to the instructional modality.

*Surveys.* To assess change in student knowledge, confidence, attitudes, opinions, and/or preferences, researchers in academic settings often administer surveys. Surveys are often self-reported data and may elicit descriptive information about the student. In addition, well-structured surveys generate standardized data amenable to quantification and statistical analysis. A Likert-type scaled response survey is often used to measure the answer of the participant on a horizontal continuum from one extreme to the other (Ady, 1996; Rea & Parker, 2005).
Use of a reliable and valid survey instrument is an essential component for robust research. As with checklists, surveys require careful consideration in the design. Outside of the research on MMI, three studies were analyzed in this review of literature. Laschinger (1996), Cannick et al. (2006), and Pearcey (1995) adapted questions used by established and validated surveys for their research. Laschinger administered a 4-point Likert-type scale survey to measure confidence. In their survey, Cannick et al. used a 5-point Likert-type scale survey to assess knowledge and perceived confidence of students. In addition, a factor analysis and Cronbach’s alpha was conducted on the questions to determine the reliability of the questions. To establish content validity, Pearcey (1995) pretested her survey with a convenience sample along with feedback from five faculty members.

However, two studies did not mention the design or pretesting of the survey instrument. Williams, et al. (2001) used a 7-point Likert-type scale survey to assess the students’ opinions and attitudes about their perceived ability to assess, diagnose and manage anxiety. The second study (Boynton et al., 2007) used a 5-point Likert-type scale survey to assess their perception of the MMI on pediatric behavior management. A question remains regarding the validity and reliability of these instruments and the outcomes of the studies.

Multiple-choice questions. In health education, multiple-choice questions are the most frequently used means of assessing comprehension or application of knowledge. Questions requesting factual information are effective in determining the student’s knowledge level; however, they may not provide insight into the student’s thought process but merely reflect a memorized response or a good guess (Wink, 1993). If
properly constructed, multiple-choice questions can be used to assess problem-solving and critical-thinking ability (Epstein, 2007; Kramer et al., 2009). The format of questions can follow the style of national examinations for licensure, adapted from questions that have been tested for reliability and validity, or pretested with practitioners, faculty, and/or members of the target population. In comparing MMI programs, Aly et al. (2004) used 13 multiple-choice questions to assess the knowledge and application of knowledge. Several studies also used multiple-choice questions to measure the knowledge of students (Fouad and Burleson, 1997 [20 questions]; Friedl et al., 2006 [20 questions]; Kleinert et al., 2007 [15 questions]; Summers et al., 1999 [50 questions]; Williams et al., 2001 [10 questions]). The questions in Summers et al. were designed to be similar in format to the corresponding licensure examination. In each of these studies, the tests were constructed by the researchers with no mention of how the questions were analyzed for validity and reliability. In addition, a question remains in the outcomes of these studies regarding the effectiveness of using multiple-choice questions as the only measure to evaluate the application of knowledge.

*Multiple methods of evaluations.* The use of a variety of methods to evaluate cognitive skills and higher-level thinking skills associated with application is suggested for students in health care programs allowing for broader insights into competence (Chadwick et al., 2002; Epstein, 2007; Hall & Stevens, 1991; Oermann, 1997). A combination of evaluation tools accommodates diverse academic needs, maintains interest, provides insight into distinct aspects of a student’s skill, and increases the credibility of the findings (Oermann & Gaberson, 2006).
Several studies implemented multiple methods to assess the learning of students. Hudson (2004) used a combination of subjective and objective questions. Of the 27 questions used to assess the knowledge and application of material on neuroradiology, Hudson designed 60% of the questions to be open-ended, while the remaining questions were matching or true/false. The researcher evaluated each test and was blinded to the testing format; however, the use of more than one evaluator not related to the research would have provided more robust results. The researcher did indicate this as a limitation. Another study using a combination of open-ended questions and task performance to measure skill attainment was Friedl et al. (2006). The open-ended questions were asked during the measurement of the task assessment and required a verbal response, such as, “What should you ask the anesthesiologist before sawing the sternum?” It is unclear as to the number of questions asked, who asked the questions, or how they were assessed. These questions were merged with the task assessment for statistical analysis. A final study to use a combination of assessments that included one written open-ended question based on a clinical situation was Boynton et al. (2007). A list of 13 possible solutions was composed for the rater to evaluate the open-ended question. The question and solutions were reviewed by four faculty members.

A study conducted by Summers et al. (1999) used a multiple-choice examination to measure knowledge of basic surgical skills, immediately followed by an observation of skill. Whereas, Friedl et al. (2006) used multiple-choice questions to measure knowledge and open-ended questions and a multitask skill assessment to measure skill acquisition. In another study conducted by Boynton et al. (2007), both subjective (multiple-choice, true/false, and fill-in-the-blank) and open-ended questions were constructed to measure
behavior management knowledge and were reviewed by four dental faculty. Williams et al. (2001) assessed students’ knowledge and skill attainment with multiple-choice questions, the established Hodkinson Abbreviated Mental Test, and a video of the student conducting a session with a client.

Often when multiple methods of evaluation are utilized, spacing between assessments is integrated into the process. Longitudinal assessment avoids excessive testing at one time and serves as the foundation for monitoring ongoing professional development (Epstein, 2007). The assessment strategies can focus on the thought process used by the student to make decisions in a clinical setting. A study using multiple methods of evaluation over a period of time was conducted by Williams et al. (2001). They administered a multiple-choice examination to measure knowledge along with a 7-point Likert-type scale to assess students’ perception of their ability to assess, diagnose and manage anxiety. Later, the practical skills were assessed by one of the researchers using an open-ended format to describe the process to conduct a mental state examination on a patient. Another study that used multiple methods of evaluation and separated by time was conducted by Howerton et al., (2002). Dental students exposed and processed radiographic films for evaluation followed by mounting of the films.

**Critical Analysis of the Cited Studies**

Each of the preceding articles represents research in health care education from refereed journals. Findings from a number of the studies should be interpreted with caution given some concerns with the research design. Careful consideration of research design, instructional design of the multimedia program, objectives of the course, context of the use of MMI, sample size, robust data analysis, and length of time of the studies...
were several confounding variables that affected outcomes and the explanation for unfavorable results. Failure to control for a variety of confounding variables was a common occurrence among research designs in health care literature reviewed. Use of basic statistical analysis was often presented without consideration or inadequate reporting of the limitations. Convenience samples were used in each study with no mention of a power analysis, effect size, or the increased risk of a Type II error. If the sample size and power is too small to detect differences, there is a need to recognize this as a limitation or an area for future research. The handling of outliers and missing data was also not reported. Most of these studies would have been more appropriately designed and reported as a pilot study; however, funding for such projects and time of an already overburdened faculty may be limited.

In many studies, the objectives of the control and experimental group were identical, the exception being the mode of instruction. Students received the same information, but in different formats. In addition, a comparison of a multimedia program to a traditional classroom lecture was a common approach among investigators, with varying outcomes. Another point of consideration was that each group did not receive equal treatment. For example, a lecture was given to all students and the treatment groups were also provided with the MMI (Aragon & Zibrowski, 2008; Bauer & Huynh, 1998; Howerton et al., 2002; Rosenberg et al., 2006; Seeram, 2001). A combination of pedagogical methods that integrates MMI that requires problem solving and an active learner appears to be an emerging subject of investigation in educating health care students.
The description of the instructional design of MMI in health care education was often limited. There were no reports as to the theory used, if any, for the instructional design. This made it more difficult to compare studies to determine if the theoretical framework might have been a factor in delivering the success of the MMI.

Formative evaluations of the MMI during the development phase are needed to determine if it achieves the goals of the study, including trials with similar users and reviews by experts. Although this evaluation was paramount, it is often neglected. A limitation cited by a number of researchers was the numerous lectures offered to the control groups that were provided by several instructors who are experts on the topic, but not monitored for adherence to the objectives (Bauer & Huynh, 1998; Howerton et al., 2002; Williams et al., 2001).

There was often no report if the consistency of each evaluator (intra-rater reliability) had been evaluated or investigated. For example, Williams et al. (2001) had one researcher assess the students’ skill, while Friedl et al. (2006) had one evaluator measure one task. The use of multiple evaluators not associated with the research would help support objectivity and eliminate bias.

Although the outcomes of some studies did not provide evidence of the benefit of MMI, the integration of MMI into the curriculum of health care students should continue to be investigated. The goals identified by researchers were to help students gain knowledge, attitude, confidence, and motivation; application of the material; acquisition of a skill; and retention of the information.
Purpose of the Study

Much is yet to be learned regarding MMI in health professions education. The design of this present study addressed many of the areas for further research cited in the literature. This study developed a pedagogical learning environment that was grounded in the strong theoretical frameworks of CBR, the adult learning theory, and the social learning theory, and modeled after anchored instruction. No study was found in the health care literature in which anchored instruction was utilized as a learning pedagogy. This study investigated the influence of anchored instruction by implementing an authentic, case-based, self-directed learning experience for dental hygiene students filmed in their practice setting. The addition of students working as a team to synthesize a solution to a complex problem created a learning environment that was supported by the constructivist theories.

Based on the constructivist theories, this current study presented an unexplored area in the health care MMI literature by comparing a case-based to a tutorial-based MMI on the knowledge, attitude, confidence, and skill of dental hygiene students. As an adjunct to traditional strategies, this study implemented case-based MMI showing a case scenario of a dental patient having a diabetes medical emergency in the clinic where students practice. The student acquired the appropriate information from the multimedia program, investigated further with acceptable resources, analyzed and evaluated the information, and formalized solutions that enhanced their critical thinking capabilities. The case-based MMI was designed to support the student’s problem solving and decision making, and allowed for appreciation toward the value of obtaining a blood glucose level on a patient with diabetes prior to dental treatment. Each component of the case-based
MMI involved active student participation. This learning environment was compared to tutorial-based MMI in which the student received the information in a teacher-led format followed by a large group discussion of the information.

It is important to recognize the gains obtained from a case-based compared to a tutorial-based MMI as presented by the health care literature. Studies incorporating tutorial-based MMI showed equivalent or enhanced skill attainment when compared to traditional pedagogies. In contrast, each of the studies using case-based MMI observed a significant improvement in skill. As in the present study, only one of these studies compared case-based to tutorial-based MMI, measuring skill (Hudson, 2004). Hudson found that the tutorial-based MMI group (minimal student involvement) provided equivalent improvements in skill, while the case-based MMI group (greatest involvement and problem solving) had significant improvement over the other groups. Therefore, the literature supports case-based MMI to be more effective than tutorial-based MMI for skill acquisition. In addition, no study in the health care literature compared case-based to tutorial-based MMI measuring attitude, confidence, or attainment of knowledge. Of the two studies measuring retention of knowledge, only Hudson (2004) compared case-based to tutorial-based MMI two weeks after the intervention, finding significant improvement for the case-based MMI group. This present study helped to fill the void in the health care literature by comparing case-based to tutorial-based MMI, measuring attainment and retention of knowledge, attitude, and confidence, as well as skill.

A suggestion for future research emerged from many studies citing a need to observe the effects of MMI over a longer period of time. This research study also explored the knowledge, attitude, confidence, and skill at three points during the
student’s academic program and once again after the individual had graduated and was working as a health care professional.

In addition, this research study also contributed to the research agenda described by the American Dental Hygienists’ Association (2007, p. 2) for research in professional education. Their challenge to researchers is to “evaluate the extent to which current dental hygiene curricula prepare dental hygienists to meet the increasingly complex oral health needs of the public.” With the number of patients with diabetes increasing each year, each requiring additional considerations compared to patients without diabetes, necessitates professionals to look outside of the dental hygiene routine toward effective patient management. The incorporation of case-based MMI for dental hygiene students may meet this challenge as students enter professional practice.

Based on the gaps found in the literature, the research questions for this study were:

What was the effect of a case-based MMI using a clinical scenario compared to tutorial-based MMI based on using traditional pedagogy designed for 2nd-year dental hygiene students:

a. on their attainment and retention of knowledge of diabetes?

b. on their attainment and retention of attitude and confidence of diabetes knowledge and its implementation in a dental environment?

c. on their retention of skill in managing a medical emergency related to diabetes?
Chapter 3
Methodology

This chapter provides a description of the design of the study. It is organized into the following sections: hypothesis, setting of the study, sample, research design, instrumentation, procedure, and data analysis.

Hypothesis

The focus of the study was that the pedagogical strategy incorporated into the curriculum of dental hygiene students intended to do two things:

1. expand on the foundation of didactic and clinical experiences to strengthen knowledge and skill with greater transfer of information to patients with diabetes.
2. increase appreciation for the need to obtain a blood glucose value prior to any invasive procedure on a dental patient with diabetes.

Therefore, the hypothesis was:

A case-based multimedia instruction (MMI) based on anchored instruction and CBR will increase the attainment and retention of knowledge attitude, and confidence and retention of skill of 2nd-year dental hygiene students on the need to perform an established procedure over a tutorial-based MMI that is embedded in a traditional lecture-based format.

Setting of the Study

The study took place in the 2008-2009 academic year in the dental hygiene program at a branch college of a large Midwestern university. Within the college, the
research was conducted in a number of locations: classroom, computer lab, and dental hygiene clinic.

Sample

Participants were recruited from the 2nd-year dental hygiene students in a 2 year, Associate of Applied Science (AAS) accredited dental hygiene program. Although this was a convenience sample, it was representative of dental hygiene students in 2 year programs nationwide. The population was an academically homogenous sample, as defined by the external accrediting agency (Commission on Dental Accreditation for Dental Hygiene Education Programs, 2009). The average GPA was 3.4 on a 4.0 scale. Thirty students (100% of the 2nd-year class) agreed to participate in the study and completed the presurvey. Prior to the intervention, one student withdrew from the study due to family issues. The participants consisted of all females with ages ranging from 19-43 years, with a mean age of 28. Ninety percent of the participants were Caucasian, 7% African American, and 3% Asian American while 7% represented those for which English is the second language. The socio-economic status of the students was diverse. Fourteen percent of the students had a Bachelor degree from non-health related programs. Further, 52% of the students had worked as dental assistants or in some other capacity in a dental office. No student had diabetes.

Completion of the biology and chemistry requirements and having a minimum of a 2.8 grade point average were prerequisites for the dental hygiene program that must be met before a student is placed on the dental hygiene program’s waiting list of 2-3 years. Several science and general education courses can be taken while students are waiting for admittance. Forty students are admitted each year, with an attrition rate of 20-25% by the
following year. The dental hygiene student must maintain a C- or better in all classes to continue to the next quarter.

In investigating the strength of the sample size, the review of the dental literature revealed that an established pattern of sample size exists in similar research. A meta-analysis by Rosenberg, Grad, and Matear (2003) found research in MMI in dental education to have sample sizes ranging from 20 to 105 participants. Although the sample sizes of the reviewed studies are varied, the smaller sample sizes support the current study of 29 participants. The reviewed studies also used convenience samples from their respective institutions, supporting the use of such a sample in the current study.

Research Design

The research design used for this study was a quasi-experimental design with four measuring points (presurvey, postsurvey, follow-up 1, and follow-up 2) with a nonequivalent comparison group design.

Curriculum. In the dental hygiene curriculum, the dental hygiene students were introduced to basic information on the pathophysiology of diabetes and medical emergencies in the 2nd quarter of a 7 quarter program. Students practiced dental hygiene skills on each other for the first 2 quarters. The potential for clinical application of the diabetes information occurred in the 5th quarter when students work with patients for the first time. During these initial clinical experiences with patients, students had not had instruction on the protocol for patients with diabetes; therefore, the clinical faculty coached students individually when needed. The clinical faculty were also available to help the student if a patient experienced a medical emergency during dental treatment. A patient with high blood glucose (hyperglycemia) or low blood glucose levels
(hypoglycemia) in a dental environment presents medical concerns the dental professional needs to assess prior to any invasive treatment and can be at risk for a medical emergency.

In the 5th quarter, all students received a 3 hour didactic presentation on diabetes and its application to dental patients. The information was guided by the clinical practice guidelines of the American Diabetes Association and current evidence-based research in dentistry. The presentation included a demonstration of the use of a blood glucose monitoring system, and each student was observed obtaining a blood glucose level on a peer or themselves. In a clinical situation, the student was required to obtain blood glucose levels on all patients with diabetes, either having the patient or the student obtain the value. Each student’s skill at using the blood glucose monitoring system was evaluated once during the academic year. If unsuccessful, the student was able to repeat the skill until a 100% competency level was achieved.

To assess the student’s ability to act in a medical emergency involving a patient with hypoglycemia, a skill test was administered in the 5th quarter to all students, following the diabetes lecture. For this study, an identical skill test was performed prior to graduation to measure the difference in student performance.

*Case-based multimedia instruction group.* For the treatment group (case-based MMI group), the independent variable involved the implementation of a video of a clinical case scenario in a dental situation. The video was shown in the 6th quarter. Appendix A provides the timeline of the research.

Based on the conceptual framework of Kolodner (1993) and the work of the CTGV on anchored instruction (1990, 1992) as a model, for this study a video was
developed and produced of a pending and preventable medical emergency in a dental environment. The video-based, case scenario was a complex and multifaceted dental situation that was presented to dental hygiene students to assess the situation and reach a decision on the appropriate action to prevent a medical emergency for a patient with diabetes.

The video introduced a patient with diabetes rushing into the dental reception area, only to be informed that the registered dental hygienist (RDH) was behind schedule. The next scene showed the RDH with the patient in the operatory, progressing through the appointment. At the conclusion of the appointment the patient stated that she was hungry; however, the RDH informed her that she must wait 30 minutes due to the fluoride treatment. The patient went to the reception area to establish her next appointment and collapsed from hypoglycemia.

The researcher for this project has practiced as a dental hygienist, dietitian and diabetes educator, and wrote the script for the video (Appendix B). The video was filmed in the dental hygiene clinic used by the students with actors recruited from the faculty and staff of the dental hygiene department. It contained embedded data that provided clues to identification of the problem and the solution. It was reviewed by several experts in instructional design and three dental hygiene faculty members, each of whom also practiced dental hygiene in the community at the time of the study. The video was produced through the facilities of Electronic Media Communications Department of the college. The final video was reviewed by three clinical dental hygiene faculty members, each of whom also practiced dental hygiene in the community. The video (Appendix C) was presented to the case-based MMI group with students working in teams of two to
answer the open-ended questions, as posited by CBR (Kolodner, 1993). A large group discussion summarized and clarified the feedback for each group. Appendix A provides the timeline of the research.

Tutorial-based multimedia instruction group. On the same day, the comparison group (tutorial-based MMI group) viewed a video using a traditional pedagogical approach to the topic of the appropriate diabetes protocol in a dental environment. This video and narrative was produced in the same location by this researcher. It was a head shot of this researcher, using PowerPoint slides that explained the dental management of patients with diabetes and a demonstration of the blood glucose monitoring system. Appendix D is the link to the PowerPoint presentation. Each student viewed the video independently in the computer lab, individually answered three open-ended questions, followed by group discussion. The same faculty member facilitated the large group discussion for both the case-based and tutorial-based MMI groups. This facilitator received training from the principle investigator and had no other involvement with the study.

Each learning environment required the same length of time (60 minutes) to complete. In addition, each learner was able to start, stop, rewind and review the video at any point. Access to the Internet and comprehensive dental hygiene textbooks were available learning tools for students to obtain additional information that supported their outcome.

Instrumentation

Two instruments were used to assess the dependent measures in this project; surveys and practical skill examinations. The dependent measures were the student’s
Multimedia Instruction

attainment and retention of knowledge about diabetes along with attitudes and confidence of the student toward the value of an established diabetes protocol in a dental environment. In addition, the skill of the dental hygiene student dealing with a patient with diabetes experiencing hypoglycemia was evaluated.

**Surveys.** Much of the research on the integration of MMI in health care education assessed learning using pre- and post-evaluation tools, such as tests or surveys (Aly et al., 2004; Bauer & Huynh, 1998; Howerton et al., 2002; Wannan & York, 2005; Williams et al., 2001). Based on the review of the literature, a survey research design seemed appropriate to determine if a difference existed when incorporating different types of multimedia programs into a dental experience. Many items were composed using information obtained from a review of the literature in dental and medical education. Similar studies on attitudes of health care students toward a protocol have been conducted in the area of smoking cessation programs (Alomari et al., 2006; Block et al., 2000; Cannick et al., 2006; Weaver et al., 2002). Knowledge statements related to diabetes were obtained from discipline specific textbooks. Sixty-nine percent of these statements required critical reasoning and the remaining 31% were factual-based. Therefore, to produce a consistent assessment tool, the results from the review of the literature helped establish the face validity for the survey.

Other items were created as a result of a survey conducted with area dentists and dental hygiene educators within the state that asked for their perceptions toward obtaining blood glucose values in a dental environment and perceived benefits and barriers (Stegeman, 2005). Through individual interviews, this researcher collaborated with practicing dental hygienists to gain insight into their attitude toward obtaining blood
glucose levels in dental environments and the actual protocol used, if any. The initial
draft was reviewed by a survey design expert and three dental hygiene faculty members
who also practiced dental hygiene in the community at the time of the study. Following
the review of the survey, this researcher interviewed each of these individuals for
additional feedback. Based on their recommendations, modifications were made to the
survey.

The survey was field tested with four dental hygiene students in the 7th quarter of
their program (spring, 2008); therefore, these students graduated before the research
began. After taking the survey with these students, a focus group of these four students
was conducted by this researcher. The focus group isolated statements that were
confusing and provided examples of statements where there were exceptions.
Refinements were made to the instrument based on feedback and the survey was
administered to a pilot of the remaining 26 dental hygiene students (spring). As with the
focus group, these students also graduated before the research began. No further
modifications were made to the instrument once the field testing was completed. The
Flesch-Kincaid Grade Level identified the survey to be at a 10th-grade reading level.
Input from each of these sources helped ascertain the content validity, providing evidence
to the legitimacy of the survey.

Great care was given to the aesthetic appeal of the survey and efforts to minimize
participant fatigue. Because the survey was five pages long with 94 items, it was divided
into sections; each item is shaded or white; two types of item formats (“Check all that
apply” and Likert-type scale) were utilized; and the demographics were placed at the end
to improve audience acceptance of providing the information (Ady, 1996; Rea & Parker, 2005).

The goal of the final survey (Appendix E) was to determine the knowledge, attitude and confidence of a dental hygiene student toward the established protocol for patients with diabetes. The first section used “Check all that apply” for the barriers and benefits of incorporating various established protocols during dental treatment, with one open-ended question for each area of focus. The intention of the open-ended questions on the survey was to capture the thoughts of participants that had not already been identified by the items; however, there were no responses to these questions.

The benefit and barrier sections were not found to be useful and were omitted from the final analysis. The information obtained from these sections did not answer the research questions. They did not measure knowledge, attitude, or skill. Information gathered from these sections included the perception of the student regarding the knowledge and confidence of other dental team members, which was not pertinent to the goals of the study. In addition, each statement provided a binary response (true or false) and had a limited statistical value.

A 5-point Likert-type scale (strongly agree to strongly disagree) was used on the next 53 items, 12 of which measured knowledge and 10 evaluated attitude or confidence of students. This researcher reversed 15 items in the section using a Likert-type scale. The survey concluded with 9 demographic questions. The demographic subscale gathered data that included the student’s grade point average, previous experience in dentistry or other allied health fields, and familiarity with diabetes. A concluding open-ended
statement was included to solicit additional comments; however, no responses were provided.

To obscure the reason for conducting the study, items were added to distract the participant from identifying that this researcher wanted to measure diabetes knowledge and attitude. In many cases, the exact question was asked, but a different protocol was substituted. For example, the item being researched, “Patients appreciate that a dental professional obtains a blood glucose value.” had the distracter, “Patients appreciate that a dental professional obtains a blood pressure value.” as another item. The distracters were not included in the final analysis.

Once the data from the four measuring points of the survey were collected, a Cronbach’s alpha was measured. Using the standardized response relative of the survey, the Cronbach’s alpha was 0.94 and the unstandardized response was 0.93. Both measured values revealed a consistency of the survey in measuring what it intended to measure.

*Skill observation checklist.* Identical skill examinations on a standardized patient were compared to measure the ability of the student to make an appropriate decision on the treatment and management of a patient with hypoglycemia. The standardized patient is an “actor” trained to simulate the symptoms of hypoglycemia. This was the 6th year the practical examination had been used with 2nd-year dental hygiene students. In addition, several practical examinations on a variety of medical emergency situations were administered throughout the 2nd-year; therefore, the ability to “guess” the testing scenario was minimized. The first practical examination was administered in the 5th quarter. Students were given the identical practical examination in the 7th quarter, 12 weeks following the intervention. The clinical faculty had been trained to serve as
evaluators and two administrative staff members had been trained to be the patient experiencing hypoglycemia. The same evaluators administered both skill examinations using the same standardized patient with the same students.

A checklist was used as the assessment tool during the skill examination (Appendix F). The skill examination checklist was dichotomous. Students received a percentage on the examination; however, a 100% was required to pass. The skill examination and assessment tool had been reviewed by members of the dental hygiene faculty and refined each year based on feedback of faculty and students.

Procedure

This experimental research covered a 10 month period to evaluate the duration of the effect. Identical surveys were administered at four different points, extended in time. Appendix A provides the timeline of the research. The first survey (presurvey) was administered in the 5th quarter, prior to treatment. Early in the 6th quarter, each dental hygiene student was randomly assigned to either the case-based MMI group (treatment) or the tutorial-based MMI group (comparison). Both groups viewed the assigned video in the college computer lab. As the case-based MMI group finished the assignment and exited the lab, the tutorial-based MMI group immediately entered with no opportunity for discussion of the experience among groups.

In randomly assigned teams of two students, the case-based MMI group answered open-ended questions associated with the video. These open-ended questions were: “What is the medical emergency?” “What is the treatment at this point?” “Was the proper dental hygiene protocol followed?” and “What could have been done to prevent the medical emergency?” The questions led the team to assess the situation and formulate a
solution. A large group discussion followed the activity to allow the teams to provide feedback of their discussion and proposed outcome.

In the tutorial-based MMI group, the students formulated answers to three open-ended questions independently then discussed the answers as a group following the video. These open-ended questions were: “How do you respond to the following statement, ‘My A1c is 7%. That’s the important number. This means I’m fine’” “Your patient is presenting signs of hypoglycemia. What action do you take?” and “Your patient has a blood glucose level of 280 mg/dL. What action should be taken?” Each group had 60 minutes to complete the entire experience (viewing the video, answering the questions, large group discussion. An associate professor in dental hygiene not connected with the study initiated the activity, provided guidance as needed, and facilitated the large group discussion for both groups.

An identical postsurvey was completed by all participants following the MMI experience. During the 9th week of the final quarter, all students were given an identical skill examination as administered in the 5th quarter, on a similar scenario as the video. It was assessed using the skill observation checklist. During the tenth and final week of the 7th quarter, the follow-up 1 survey was administered. The follow-up 2 survey was mailed to each participant at the end of August, approximately 3 months after graduation.

Data Analysis

The data analysis section is divided into two parts. The first part is an explanation of the procedures used to create the data and the final section presents the statistical procedures. The field study guided the establishment of a data analysis protocol.
**Data creation.** The survey responses were recorded on one sheet in an Excel file. To help ensure accuracy, the data were read by one person while a second person transcribed the information. Due to the small number of participants, this researcher was able to recheck the data to correct computing errors. Each participant was represented by a single row of data across the matrix.

Recoding of reverse-scored items was required on 15 questions (i.e. 1 to 5, 2 to 4, 3 to 3, 4 to 2, 5 to 1). For example, the item “Only patients who take insulin to treat their diabetes need a blood glucose value” required a reverse score.

The survey items were divided into 11 sections as in the codebook in Appendix G. Eight variables emerged from the items; however, the variables of interest were student knowledge of diabetes and student attitude and confidence in treating persons with diabetes. The other variables were distracters.

Details of the construction of the codebook included missing data being coded as a “99”; one to five was used for the Likert-type scale; no comments in the open-ended responses was coded as a 10; and “don’t know” to GPA was coded as 11 (Appendix G). Aesthetic considerations for the codebook included dividing the information into variables and each section had alternating white and shading. The codebook was reviewed by two college professors to determine functionality.

**Data evaluation.** Analyses were conducted on the knowledge, attitude, and confidence statements. To answer the first three components of the research question, several statistical analyses were conducted. A univariate two-tailed independent-sample *t*-test was performed with the case-based and tutorial-based MMI groups for these statements to compare the means at the presurvey. The means and standard deviations
during each measuring period for overall knowledge and the associated variables of both the case-based and tutorial-based MMI groups were also conducted. The repeated-measures two-way Analysis of Variance (ANOVA) with one within factor (time) and one between factor (group) was performed to determine the effect of time and the change between groups over time. Finally, to correct the correlation problem associated with repeated-measures ANOVA, Box’s conservative epsilon and Greenhouse-Geisser epsilon were conducted.

For the analysis of the pre- and post-practical examination skill test, the Fisher’s exact test was the statistical test used to determine the $p$-value since it did not rely on using the approximate chi-square distribution and was more accurate in evaluating the significance level of the test, especially since the sample size of the current study was relatively small. Although the Pearson’s chi-square is better known, it was not determined since it uses an approximate chi-square distribution. This approximation may depart significantly from the theoretical distribution when the sample size is small, as with the current study (Agresti, 1992).
Chapter 4

Results

The purpose of this research was to investigate the influence of an authentic, self-directed MMI on the knowledge, attitude, confidence, and skill of dental hygiene students when treating patients with diabetes. This chapter will present the outcomes of the data analyses as related to the research questions. The data were analyzed by the statistical computer program, STATA. Organization of the chapter includes discussion of the treatment of the data, analyses for knowledge and affective variables overall and individually, analysis of the skill variable, followed by a summary of the outcomes.

Treatment of Data

The treatment of data section is divided into four parts. The first part is a description of the determination of the power analysis and the effect size. This is followed by a description of the data cleaning and ending with the outcomes of the presurvey analysis.

Post-hoc power analysis. A post hoc power analysis was obtained after conducting the study to determine the strength of the treatment effect. Twenty-nine students participated in the research (14 in the treatment group and 15 in the comparison group). Due to the size of the sample, a fourth measuring point was added to the study to increase the power. The additional information obtained from the follow-up 2 survey provided more data for statistical analysis.

Several tests were conducted on power, assuming three types of covariance structures with a standard deviation of 0.65 on the four repeated measurement points. The value of 0.65 was used for the standard deviation because according to the outcomes of
the field study conducted in 2008, the majority of standard deviation scores were around 0.65.

Power is a function of the structure of the covariance matrix. Since the type of covariance matrix structure in the current research is unknown, a power analysis for each type of covariance matrix was conducted. Each test for power was one-sided, with one of the covariance types (auto regressive of order 1 [AR(1)], banded, and compound symmetry) and set to detect a difference of 0.50. Table 1 shows the results of the power test when the covariance type is assumed to be auto regression of order 1. It indicates that having group sample sizes of 14 and 15 yielded 89% power with an alpha of 0.05 for the covariance structure of AR(1). Table 2 reports the results of the power test when the covariance structure is considered to be banded, with all other factors remaining the same, achieving 93% power with an alpha level of 0.05. Table 3 provides the data for compound symmetry which achieved an 83% power. Therefore, it was found, independent of the type of the data covariance matrix, that the power was high enough for the purpose of the study.

Table 1

*Numeric Results of the One-sided Power Analysis Test Using Covariance Type Auto Regression of Order 1*

<table>
<thead>
<tr>
<th>Power</th>
<th>Treatment Sample Size</th>
<th>Comparison Sample Size</th>
<th>Time Points</th>
<th>Difference to be Detected</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.89</td>
<td>14</td>
<td>15</td>
<td>4</td>
<td>0.50</td>
<td>0.65</td>
</tr>
<tr>
<td>0.95</td>
<td>14</td>
<td>15</td>
<td>4</td>
<td>0.50</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>0.05</td>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2

Numeric Results of the One-sided Power Analysis Test Using Covariance Type Banded

<table>
<thead>
<tr>
<th>Power</th>
<th>Treatment Sample Size</th>
<th>Comparison Sample Size</th>
<th>Time Points</th>
<th>Difference to be Detected</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.93</td>
<td>14</td>
<td>15</td>
<td>4</td>
<td>0.50</td>
<td>0.65</td>
</tr>
<tr>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.97</td>
<td>14</td>
<td>15</td>
<td>4</td>
<td>0.50</td>
<td>0.65</td>
</tr>
<tr>
<td>0.10</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3

Numeric Results of the One-sided Power Analysis Test Using Covariance Type Compound Symmetry

<table>
<thead>
<tr>
<th>Power</th>
<th>Treatment Sample Size</th>
<th>Comparison Sample Size</th>
<th>Time Points</th>
<th>Difference to be Detected</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.83</td>
<td>14</td>
<td>15</td>
<td>4</td>
<td>0.50</td>
<td>0.65</td>
</tr>
<tr>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.91</td>
<td>14</td>
<td>15</td>
<td>4</td>
<td>0.50</td>
<td>0.65</td>
</tr>
<tr>
<td>0.10</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each of these covariances is widely used in education research. The outcomes of each power test indicated that enough power was achieved; therefore, the study was able to detect statistically significant effects.

Data cleaning. As a general rule, 3 standard deviations from the mean is acceptable to use to determine outliers (Osborne, 2008). Assessment of the data points revealed all data fell within 3 standard deviations of the mean; therefore, no outliers existed. All participants completed the survey in a reasonable amount of time. For example, no one completed in just minutes, indicating that all students applied the
necessary effort. In addition, all of the questions were answered as designated. There was no missing data on any of the four surveys administered. Finally, there were no responses to the three open-ended questions on the survey.

Pre-analysis. The treatment and comparison groups were found to be statistically equivalent in their knowledge, attitude, and confidence at the presurvey. Univariate two-tailed independent-sample $t$-tests were performed with these two groups and found no significant difference in the group means at the presurvey for knowledge ($t(27) = -0.62, p = .54$) and for attitude and confidence ($t(27) = 0.83, p = .41$). In addition, the Fisher's exact test conducted on the pre-skill test also indicated there was no difference between the two groups ($p = .48$). Therefore, the groups were equivalent on knowledge, attitude, confidence, and skill at the start of the study.

Research Questions

Knowledge. Statements on the survey measuring student knowledge of diabetes were analyzed. Tables 4 and 5 show the means and standard deviations during each of the measuring periods for overall knowledge and all of the 12 knowledge variables from the surveys of either the treatment or comparison group. With one exception from each group (Table 4, Statement 56; Table 5, Statement 58), a general assessment of the presurvey scores for the treatment and comparison groups revealed that all variables had a mean greater than or equal to 4.00 (on a 5-point scale). Thus, starting with a high average score left very little room for improvement in knowledge. With few exceptions, the standard deviation around the mean was less than or equal to 1.00, reflecting low variability in data.
Table 4

Means and Standard Deviations for Different Time Periods on the Knowledge Variables for the Treatment Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Presurvey</th>
<th></th>
<th>Postsurvey</th>
<th></th>
<th>Follow-up 1</th>
<th></th>
<th>Follow-up 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Overall Knowledge</td>
<td></td>
<td>4.20</td>
<td>0.40</td>
<td>4.58</td>
<td>0.31</td>
<td>4.36</td>
<td>0.45</td>
<td>4.37</td>
</tr>
<tr>
<td>Statement 44</td>
<td></td>
<td>4.64</td>
<td>0.50</td>
<td>4.93</td>
<td>0.27</td>
<td>4.64</td>
<td>0.50</td>
<td>4.60</td>
</tr>
<tr>
<td>Statement 46</td>
<td></td>
<td>4.29</td>
<td>0.73</td>
<td>4.57</td>
<td>0.76</td>
<td>4.36</td>
<td>0.74</td>
<td>4.50</td>
</tr>
<tr>
<td>Statement 48</td>
<td></td>
<td>4.86</td>
<td>0.36</td>
<td>4.79</td>
<td>0.43</td>
<td>4.64</td>
<td>0.50</td>
<td>4.50</td>
</tr>
<tr>
<td>Statement 50</td>
<td></td>
<td>4.07</td>
<td>0.62</td>
<td>4.57</td>
<td>0.65</td>
<td>4.21</td>
<td>0.89</td>
<td>4.30</td>
</tr>
<tr>
<td>Statement 52</td>
<td></td>
<td>4.00</td>
<td>0.55</td>
<td>4.21</td>
<td>0.70</td>
<td>4.00</td>
<td>0.68</td>
<td>4.50</td>
</tr>
<tr>
<td>Statement 54</td>
<td></td>
<td>4.00</td>
<td>0.55</td>
<td>4.36</td>
<td>0.50</td>
<td>4.21</td>
<td>0.43</td>
<td>4.30</td>
</tr>
<tr>
<td>Statement 56</td>
<td></td>
<td>3.79</td>
<td>1.05</td>
<td>4.57</td>
<td>0.51</td>
<td>4.43</td>
<td>0.51</td>
<td>4.30</td>
</tr>
<tr>
<td>Statement 58</td>
<td></td>
<td>4.07</td>
<td>0.62</td>
<td>4.43</td>
<td>0.76</td>
<td>4.43</td>
<td>0.65</td>
<td>4.30</td>
</tr>
<tr>
<td>Statement 59</td>
<td></td>
<td>4.07</td>
<td>1.00</td>
<td>4.86</td>
<td>0.36</td>
<td>4.43</td>
<td>0.65</td>
<td>4.30</td>
</tr>
<tr>
<td>Statement 61</td>
<td></td>
<td>4.21</td>
<td>1.05</td>
<td>4.64</td>
<td>0.63</td>
<td>4.50</td>
<td>0.65</td>
<td>4.40</td>
</tr>
<tr>
<td>Statement 62</td>
<td></td>
<td>4.21</td>
<td>1.05</td>
<td>4.71</td>
<td>0.61</td>
<td>4.14</td>
<td>1.17</td>
<td>4.30</td>
</tr>
<tr>
<td>Statement 65</td>
<td></td>
<td>4.14</td>
<td>0.53</td>
<td>4.36</td>
<td>0.63</td>
<td>4.29</td>
<td>0.47</td>
<td>4.10</td>
</tr>
</tbody>
</table>
Table 5

Means and Standard Deviations for Different Time Periods on the Knowledge Variables for the Comparison Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Presurvey</th>
<th>Postsurvey</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Overall Knowledge</td>
<td>4.29</td>
<td>0.40</td>
<td>4.39</td>
<td>0.35</td>
</tr>
<tr>
<td>Statement 44</td>
<td>4.73</td>
<td>0.46</td>
<td>4.73</td>
<td>0.59</td>
</tr>
<tr>
<td>Statement 46</td>
<td>4.40</td>
<td>0.83</td>
<td>4.47</td>
<td>0.74</td>
</tr>
<tr>
<td>Statement 48</td>
<td>4.47</td>
<td>0.74</td>
<td>4.47</td>
<td>0.74</td>
</tr>
<tr>
<td>Statement 50</td>
<td>4.60</td>
<td>0.51</td>
<td>4.73</td>
<td>0.46</td>
</tr>
<tr>
<td>Statement 52</td>
<td>4.13</td>
<td>0.74</td>
<td>4.07</td>
<td>0.80</td>
</tr>
<tr>
<td>Statement 54</td>
<td>4.07</td>
<td>0.80</td>
<td>3.93</td>
<td>0.70</td>
</tr>
<tr>
<td>Statement 56</td>
<td>4.27</td>
<td>0.88</td>
<td>4.47</td>
<td>0.64</td>
</tr>
<tr>
<td>Statement 58</td>
<td>3.73</td>
<td>1.10</td>
<td>4.40</td>
<td>0.63</td>
</tr>
<tr>
<td>Statement 59</td>
<td>4.60</td>
<td>0.51</td>
<td>4.73</td>
<td>0.46</td>
</tr>
<tr>
<td>Statement 61</td>
<td>4.13</td>
<td>0.99</td>
<td>4.47</td>
<td>0.64</td>
</tr>
<tr>
<td>Statement 62</td>
<td>4.00</td>
<td>1.13</td>
<td>4.20</td>
<td>1.08</td>
</tr>
<tr>
<td>Statement 65</td>
<td>4.33</td>
<td>0.49</td>
<td>4.00</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Figure 1 shows the mean values for overall knowledge for both groups. The participants in the treatment group started at the lowest mean of the four measuring points, yet still above 4.00 (on a 5-point scale) for the presurvey. The mean jumped to the highest value for the postsurvey, decreased for the follow-up 1 survey, and finally stabilized for the follow-up 2 survey. The mean value for the comparison group started
slightly above the treatment group and advanced somewhat at the postsurvey, but made less progress than the treatment group. The comparison group decreased at the follow-up 1 survey and stabilized at the follow-up 2 survey, remaining below the treatment mean values.

Figure 1. Relationship of mean values (knowledge) for the treatment and comparison groups.

Looking at the knowledge variables for each group, table 6 presents the results of repeated-measures two-way ANOVA test performed to investigate the effects of group and time. Time was considered as the within factor and group as the between factor. According to this table, for the variable “overall knowledge,” while no significant
interaction effects were present, $F(3, 76) = 2.40, p > .05$, and no group main effects existed, $F(1, 27) = 0.96, p > .05$, time main effects were present, $F(3, 76) = 5.42, p < .01$. In addition, the effect size for the difference of knowledge variables ranged from 0.54 (postsurvey) to 0.28 (follow-up 2 survey). According to Cohen (1988), the effect sizes ranged from small to medium.

Although there were no significant interactions or group main effects for any of the individual knowledge variables (Table 6), three variables had a significant change in the time main effects ($p < .05$). These statements were: “All patients with type 2 diabetes are controlled by diet and exercise,” “All patients with diabetes are at risk of experiencing hypoglycemia,” and “Patients who take pills to control their diabetes should be equally as concerned about their blood glucose values as those who are on insulin.” (Statements 56, 58, & 59, respectively). Each of these statements contributed to the significant difference over time of the overall knowledge variable (Figure 1, Table 6).
Table 6

Repeated-Measures Two-Way Analysis of Variance (ANOVA) Results for the Effects of Time (Within Factor) and Group (Between Factor) on the Knowledge Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Knowledge</td>
<td>Group</td>
<td>0.43</td>
<td>1</td>
<td>0.43</td>
<td>0.96</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>1.03</td>
<td>3</td>
<td>0.34</td>
<td>5.42**</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>0.46</td>
<td>3</td>
<td>0.15</td>
<td>2.40</td>
</tr>
<tr>
<td>Statement 44</td>
<td>Group</td>
<td>0.22</td>
<td>1</td>
<td>0.22</td>
<td>0.58</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>1.43</td>
<td>3</td>
<td>0.48</td>
<td>2.25</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>0.51</td>
<td>3</td>
<td>0.17</td>
<td>0.81</td>
</tr>
<tr>
<td>Statement 46</td>
<td>Group</td>
<td>0.70</td>
<td>1</td>
<td>0.70</td>
<td>0.56</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>1.24</td>
<td>3</td>
<td>0.41</td>
<td>1.32</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>1.00</td>
<td>3</td>
<td>0.33</td>
<td>1.06</td>
</tr>
<tr>
<td>Statement 48</td>
<td>Group</td>
<td>2.52</td>
<td>1</td>
<td>2.52</td>
<td>2.69</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>1.09</td>
<td>3</td>
<td>0.37</td>
<td>2.23</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>0.09</td>
<td>3</td>
<td>0.03</td>
<td>0.18</td>
</tr>
<tr>
<td>Statement 50</td>
<td>Group</td>
<td>1.64</td>
<td>1</td>
<td>1.64</td>
<td>2.73</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>1.93</td>
<td>3</td>
<td>0.64</td>
<td>1.86</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>0.84</td>
<td>3</td>
<td>0.28</td>
<td>0.81</td>
</tr>
<tr>
<td>Statement 52</td>
<td>Group</td>
<td>0.04</td>
<td>1</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>0.78</td>
<td>3</td>
<td>0.26</td>
<td>0.98</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>1.19</td>
<td>3</td>
<td>0.40</td>
<td>1.51</td>
</tr>
<tr>
<td>Statement 54</td>
<td>Group</td>
<td>1.35</td>
<td>1</td>
<td>1.35</td>
<td>2.31</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>0.37</td>
<td>3</td>
<td>0.12</td>
<td>0.38</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>1.09</td>
<td>3</td>
<td>0.36</td>
<td>1.12</td>
</tr>
<tr>
<td>Statement 56</td>
<td>Group</td>
<td>0.48</td>
<td>1</td>
<td>0.48</td>
<td>0.31</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>4.07</td>
<td>3</td>
<td>1.36</td>
<td>3.19*</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>2.04</td>
<td>3</td>
<td>0.68</td>
<td>2.16</td>
</tr>
<tr>
<td>Statement 58</td>
<td>Group</td>
<td>2.12</td>
<td>1</td>
<td>2.12</td>
<td>2.47</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>4.23</td>
<td>3</td>
<td>1.41</td>
<td>3.36*</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>1.10</td>
<td>3</td>
<td>0.37</td>
<td>0.87</td>
</tr>
<tr>
<td>Statement 59</td>
<td>Group</td>
<td>0.07</td>
<td>1</td>
<td>0.07</td>
<td>0.11</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>4.67</td>
<td>3</td>
<td>1.56</td>
<td>4.89*</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>2.44</td>
<td>3</td>
<td>0.81</td>
<td>2.56</td>
</tr>
<tr>
<td>Statement 61</td>
<td>Group</td>
<td>1.53</td>
<td>1</td>
<td>1.53</td>
<td>1.02</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>2.11</td>
<td>3</td>
<td>0.71</td>
<td>2.03</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>0.48</td>
<td>3</td>
<td>0.16</td>
<td>0.46</td>
</tr>
<tr>
<td>Statement 62</td>
<td>Group</td>
<td>2.74</td>
<td>1</td>
<td>2.74</td>
<td>1.44</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>2.40</td>
<td>3</td>
<td>0.80</td>
<td>1.17</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>1.32</td>
<td>3</td>
<td>0.44</td>
<td>0.64</td>
</tr>
<tr>
<td>Statement 65</td>
<td>Group</td>
<td>0.02</td>
<td>1</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>0.54</td>
<td>3</td>
<td>0.18</td>
<td>0.55</td>
</tr>
<tr>
<td>(Group)(Time)</td>
<td></td>
<td>2.40</td>
<td>3</td>
<td>0.80</td>
<td>2.44</td>
</tr>
</tbody>
</table>

Note. * p < .05. ** p < .01.
The Greenhouse-Geisser and conservative Box epsilon test were conducted to adjust the repeated-measures ANOVA. Both adjustments contained a \( p \) value of \( \leq .01 \), indicating the results found are valid.

Given the focus of the research question was on group differences, no additional post-hoc analyses were conducted to follow up on the time differences for the knowledge variables for either the treatment or comparison groups. Both groups reported high values on the pretest, with little room for improvement; therefore, the differences throughout the remaining three measuring periods were not substantial.

*Attitude and confidence.* This section analyzes the statements measuring attitude and confidence toward providing care for patients with diabetes using the same statistical methods as those for knowledge. Tables 7 and 8 show the means and standard deviations during each of the measuring periods for overall attitude and the associated variables of either the treatment or comparison group. With one exception (Statement 67), all variables had a mean greater than or equal to 3.8 (on a 5-point scale) for the presurvey for both treatment and comparison groups. Therefore, there was very little room for improvement in the student’s attitude and confidence.
Table 7

*Means and Standard Deviations for Different Time Periods on the Attitude Variables for the Treatment Group*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Presurvey</th>
<th>Postsurvey</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Overall Attitude</td>
<td>4.16</td>
<td>0.44</td>
<td>4.44</td>
<td>0.33</td>
</tr>
<tr>
<td>Statement 67</td>
<td>3.64</td>
<td>0.63</td>
<td>4.07</td>
<td>0.62</td>
</tr>
<tr>
<td>Statement 71</td>
<td>4.50</td>
<td>0.65</td>
<td>4.43</td>
<td>0.65</td>
</tr>
<tr>
<td>Statement 73</td>
<td>3.93</td>
<td>0.83</td>
<td>4.57</td>
<td>0.51</td>
</tr>
<tr>
<td>Statement 77</td>
<td>3.93</td>
<td>0.83</td>
<td>4.14</td>
<td>0.66</td>
</tr>
<tr>
<td>Statement 81</td>
<td>3.93</td>
<td>0.92</td>
<td>4.36</td>
<td>0.50</td>
</tr>
<tr>
<td>Statement 85</td>
<td>4.21</td>
<td>0.89</td>
<td>4.29</td>
<td>0.61</td>
</tr>
<tr>
<td>Statement 87</td>
<td>4.29</td>
<td>1.07</td>
<td>5.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Statement 90</td>
<td>4.64</td>
<td>0.50</td>
<td>4.79</td>
<td>0.43</td>
</tr>
<tr>
<td>Statement 92</td>
<td>4.36</td>
<td>0.50</td>
<td>4.43</td>
<td>0.65</td>
</tr>
<tr>
<td>Statement 95</td>
<td>4.36</td>
<td>0.63</td>
<td>4.36</td>
<td>0.50</td>
</tr>
</tbody>
</table>
### Table 8

*Means and Standard Deviations for Different Time Periods on the Attitude Variables for the Comparison Group*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Presurvey</th>
<th>Postsurvey</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Overall Attitude</td>
<td>4.01</td>
<td>0.52</td>
<td>4.33</td>
<td>0.31</td>
</tr>
<tr>
<td>Statement 67</td>
<td>3.60</td>
<td>1.24</td>
<td>3.80</td>
<td>1.15</td>
</tr>
<tr>
<td>Statement 71</td>
<td>4.40</td>
<td>0.51</td>
<td>4.47</td>
<td>0.52</td>
</tr>
<tr>
<td>Statement 73</td>
<td>4.00</td>
<td>0.85</td>
<td>4.47</td>
<td>0.52</td>
</tr>
<tr>
<td>Statement 77</td>
<td>4.00</td>
<td>0.76</td>
<td>4.20</td>
<td>0.77</td>
</tr>
<tr>
<td>Statement 81</td>
<td>3.80</td>
<td>0.77</td>
<td>4.20</td>
<td>0.56</td>
</tr>
<tr>
<td>Statement 85</td>
<td>3.93</td>
<td>0.88</td>
<td>4.13</td>
<td>0.99</td>
</tr>
<tr>
<td>Statement 87</td>
<td>3.80</td>
<td>1.42</td>
<td>4.87</td>
<td>0.35</td>
</tr>
<tr>
<td>Statement 90</td>
<td>4.53</td>
<td>0.83</td>
<td>4.53</td>
<td>0.83</td>
</tr>
<tr>
<td>Statement 92</td>
<td>4.53</td>
<td>0.74</td>
<td>4.67</td>
<td>0.49</td>
</tr>
<tr>
<td>Statement 95</td>
<td>4.67</td>
<td>0.49</td>
<td>4.60</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Figure 2 shows the values of the mean for each of the attitude variables for both groups. The participants in the treatment group always had a mean value slightly higher than the comparison group. In both groups, the mean values reached their highest values at the postsurveys. The treatment group stabilized at the follow-up 1 and 2 surveys, while the comparison group decreased at the follow-up 1 survey and stabilized at the follow-up 2 survey.
Determination of what happened to the mean value of each group over time was accomplished by repeated-measures ANOVA. Table 9 presents the results of repeated-measures two-way ANOVA test performed to investigate the effects of group and time on the attitude variables. Time was considered as the within factor and group as the between factor. According to this table, for the variable “overall attitude,” while no significant interaction effects were present, $F(3, 76) = 0.33, p > .05$, and no group main effects existed, $F(1,27) = 1.87, p > .05$, time main effects were present, $F(3, 76) = 7.27, p < .001$. The effect size for the affective variables ranged from 0.35 (postsurvey) to 0.45 (follow-up 2 survey). According to Cohen (1988), the effect sizes ranged from small to medium.
Statement 67 had no significant group time interaction effects, \( F(3, 76) = 1.51, p > .05 \). Of importance, it had a significant difference between the treatment and comparison groups, in favor of the treatment group, \( F(1,27) = 4.46, p < .01 \). In other words, the treatment group had a significantly greater increase in an attitude statement about the future than the comparison group. Specifically, this statement (67, Table 9) stated, “If I am employed in a dental setting that does not obtain blood glucose values, I will work toward initiating a protocol for patients with diabetes.” Additionally, time effects did not exist for statement 67, \( F(3, 76) = 0.90, p > .05 \).

Further, none of the affective statements had a significant group-time interaction effects or group main effects. However, time effects existed for statements 73, 81, and 87 (Table 9). Each of these statements measured a significant change in attitude and confidence over time. One of the statements measured attitude: “I will continue to obtain blood glucose values once I am practicing as a dental hygienist,” (Table 9, Statement 73). The two statements measuring confidence included statements 81 and 87, respectively (Table 9), “I can answer basic knowledge questions from the patient on the link between diabetes and dental health” and “I can obtain a blood glucose value with confidence.” Each of these affective statements is poignant to a significant increase in overall attitude over time (Figure 2, Table 9). The remaining six attitude variables did not show significant group time interaction effects, group main effects, or time effects.
Table 9

Repeated-Measures Two-Way Analysis of Variance (ANOVA) Results for the Effects of Time (Within Factor) and Group (Between Factor) on the Attitude Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Attitude</td>
<td>Group</td>
<td>0.82</td>
<td>1</td>
<td>0.82</td>
<td>1.87</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>1.51</td>
<td>3</td>
<td>0.50</td>
<td>7.27***</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.07</td>
<td>3</td>
<td>0.02</td>
<td>0.33</td>
</tr>
<tr>
<td>Statement 67</td>
<td>Group</td>
<td>5.81</td>
<td>1</td>
<td>5.81</td>
<td>4.46**</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>1.63</td>
<td>3</td>
<td>0.54</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>2.74</td>
<td>3</td>
<td>0.91</td>
<td>1.51</td>
</tr>
<tr>
<td>Statement 71</td>
<td>Group</td>
<td>0.08</td>
<td>1</td>
<td>0.08</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>0.20</td>
<td>3</td>
<td>0.07</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.36</td>
<td>3</td>
<td>0.12</td>
<td>0.53</td>
</tr>
<tr>
<td>Statement 73</td>
<td>Group</td>
<td>0.09</td>
<td>1</td>
<td>0.09</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>4.68</td>
<td>3</td>
<td>1.56</td>
<td>4.89**</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.36</td>
<td>3</td>
<td>0.12</td>
<td>0.38</td>
</tr>
<tr>
<td>Statement 77</td>
<td>Group</td>
<td>0.68</td>
<td>1</td>
<td>0.68</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>0.65</td>
<td>3</td>
<td>0.22</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.64</td>
<td>3</td>
<td>0.21</td>
<td>0.55</td>
</tr>
<tr>
<td>Statement 81</td>
<td>Group</td>
<td>0.93</td>
<td>1</td>
<td>0.93</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>2.86</td>
<td>3</td>
<td>0.95</td>
<td>4.43**</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.12</td>
<td>3</td>
<td>0.04</td>
<td>0.18</td>
</tr>
<tr>
<td>Statement 85</td>
<td>Group</td>
<td>1.00</td>
<td>1</td>
<td>1.00</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>2.80</td>
<td>3</td>
<td>0.93</td>
<td>2.36</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.08</td>
<td>3</td>
<td>0.03</td>
<td>0.06</td>
</tr>
<tr>
<td>Statement 87</td>
<td>Group</td>
<td>2.85</td>
<td>1</td>
<td>2.85</td>
<td>4.13</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>14.86</td>
<td>3</td>
<td>4.95</td>
<td>10.84***</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.50</td>
<td>3</td>
<td>0.17</td>
<td>0.36</td>
</tr>
<tr>
<td>Statement 90</td>
<td>Group</td>
<td>1.03</td>
<td>1</td>
<td>1.03</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>0.26</td>
<td>3</td>
<td>0.09</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.09</td>
<td>3</td>
<td>0.03</td>
<td>0.32</td>
</tr>
<tr>
<td>Statement 93 (92)</td>
<td>Group</td>
<td>0.40</td>
<td>1</td>
<td>0.40</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>0.93</td>
<td>3</td>
<td>0.31</td>
<td>2.33</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>0.38</td>
<td>3</td>
<td>0.13</td>
<td>0.95</td>
</tr>
<tr>
<td>Statement 96 (95)</td>
<td>Group</td>
<td>0.28</td>
<td>1</td>
<td>0.28</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>0.51</td>
<td>3</td>
<td>0.17</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>(Group)(Time)</td>
<td>1.07</td>
<td>3</td>
<td>0.36</td>
<td>2.12</td>
</tr>
</tbody>
</table>

Note. **p < .01. ***p < .001.
Two adjustments were made to correct the problems associated with repeated-measures ANOVA: the Greenhouse-Geisser epsilon and the conservative Box epsilon. Both adjustments contain a $p$ value $\leq .01$ and .001, respectively, indicating there was still a significant difference between the groups over time and there is no threat to validity.

Given the focus of the research question were on group differences, no additional post-hoc analyses were conducted to follow up on time differences for the attitude variables for either the treatment or comparison groups. Both groups reported high values on the pretest, with little room for improvement; therefore, the differences throughout the other three measuring periods were not substantial.

**Skill.** To explore the final component of the research question, a practical examination measuring the skill of a dental hygiene student toward responding to a dental patient experiencing hypoglycemia was administered. The initial practical examination (pass or fail) was administered prior to the intervention (3rd quarter) with no student being successful in the treatment group and only two were successful in the comparison group (Table 10). The $p$-value corresponding to the Fisher’s exact test ($p = .48$) indicated that the groups and the pre-practical skill examination were not statistically related. Therefore, there was no difference between the two groups at the pretests.

The identical practical examination was administered 12 weeks after the intervention (7th quarter) reporting that all 14 students were successful in the treatment group and only 9 students were successful in the comparison group (Table 10). It is interesting to note that the 2 students from the comparison group who were successful in the initial practical examination were not successful in the post-practical skill examination. In both cases, their scores dropped from 100% to a 66% in the post practical
The statistical analysis revealed the $p$-value for the Fisher’s exact test ($p = .02$). This $p$ value indicated that the groups and post-skill test were statistically related; therefore, there was a significant difference between the two groups. The data provide sufficient evidence to conclude that there was an association between group and skill test scores and that the treatment group did significantly better than the comparison group on the skills test.

Table 10

*The Number of Participants Who Passed or Failed the Skills Test*

<table>
<thead>
<tr>
<th>Skills Test</th>
<th>Pretests</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment</td>
<td>Comparison</td>
</tr>
<tr>
<td>Fail</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Pass</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>15</td>
</tr>
</tbody>
</table>

Summary of the Findings

An analysis of all variables to determine the individual statements or overall group differences in knowledge, attitude, and confidence was conducted at each measuring point. There was no difference in the group means for knowledge, attitude, and confidence at the presurvey for both the treatment and comparison groups. There was also no difference between groups for the skills test conducted prior to the intervention.

Time had a significant effect on both the overall knowledge and attitude variables as seen by the results of the repeated-measures, two-way ANOVA tests. Three of nine
knowledge statements also revealed a significant change in the time main effects. Therefore, both the treatment and comparison groups had a significant increase in overall knowledge and three of the knowledge variables. Looking at the affective variables, along with the mean overall attitude, three of the attitude and confidence statements also revealed the existence of time effects. Therefore, both MMI experiences produced a positive change in overall knowledge and attitude, along with 6 statements over time. Further, one attitude variable showed a significant difference between the treatment and comparison groups, in favor of the treatment group, but did not show time effects. This notable statement references a positive attitude toward a dental hygiene performance in future practice. Finally, three other affective variables measured a significant change in attitude and confidence over time.

Finally, the greatest impact was found with the results of the skills test. The analysis performed on the practical skills test indicated a significant difference in group scores, with a 100% success rate for students in the treatment group.
Chapter 5
Discussion

This chapter provides an overview of the study, discussion on the attainment of knowledge, attitude, and confidence immediately following the intervention and up to 3 months post graduation, and discussion on the attainment of skill. The chapter concludes with a summary of findings, limitation of the study, contributions to the literature, and suggestions for future research.

Overview

It is the challenge of many health care educators to find epistemological means to create a learning environment that will enhance the knowledge, attitude, confidence, and skill of health care students that will carry over into professional practice. In addition, due to a rapidly changing health care environment, health professions education has been plagued with increasing quantities of complex information to present in combination with waning numbers of faculty members. This study investigated the effectiveness of a MMI over a 10-month period that addressed these issues for dental hygiene students (14 in the treatment group and 15 in the comparison group). The comparison group (tutorial-based MMI) received the same 3-hour lecture on diabetes, a demonstration of obtaining a blood glucose value, and observed dental hygiene clinical faculty mentoring the practice of monitoring diabetes in clinical situations as the treatment group. The difference was in the accompanying pedagogies. The case-based MMI presented to the treatment group consisted of a video portraying a diabetes medical emergency in a dental environment. It was followed by a team effort to formulate a solution and possible preventive measures, leading to a large group discussion of each team’s outcomes. They were compared to a
group independently viewing a video of a traditional lecture accompanied by a PowerPoint presentation, imparting the same material, using a tutorial-based MMI format. The students in this group answered open-ended questions individually and concluded with a large group discussion. Both groups were deemed academically homogeneous since no difference in the group means was noted on the presurvey.

An identical survey to measure knowledge, attitude, and confidence was administered at four points (presurvey, postsurvey, follow-up 1 and 2), extending to 3 months after graduation. The outcomes of the postsurvey measured the attainment of knowledge and affective variables, while the follow-up 1 and 2 surveys measured over time. Time had a significant effect on the overall knowledge and attitude as the repeated-measures two-way ANOVA test revealed for both MMI groups. In addition, three knowledge and three attitude statements revealed a significant change in the time main effects. Therefore, both MMI groups produced a positive change in the overall knowledge and attitude, as well as six associated statements over time. Moreover, one attitude statement showed a significant difference between the MMI groups, in favor of the treatment group.

An identical practical skill test measured the performance of dental hygiene students with a patient experiencing hypoglycemia prior to and 12 weeks after the intervention. The accompanying analysis also demonstrated a significant difference between groups.

In summary, both the case-based and tutorial-based MMI groups had a significant change in overall knowledge, attitude and confidence and several associated statements, while the case-based MMI group produced a significant increase in one attitude statement.
compared to the tutorial-based MMI group. In addition, the results of the skills test showed there was a significant difference between the treatment and comparison group for the management of patients with diabetes.

Effect of the Multimedia Instruction

In dentistry, one such example of a practice that may cease upon graduation is blood glucose monitoring for patients with diabetes (Boyd et al., 2008). This present study compared the effects of MMI on dental hygiene students toward diabetes knowledge, attitude, and confidence toward the management of patients with diabetes. In addition, the study also compared the skill of students in the case-based, multimedia learning environment associated with this protocol for patient care to students who received traditional, multimedia instruction.

Two designs were predominant in the review of literature on MMI: tutorial-based and case-based. MMI using a tutorial-based design involved the learner independently viewing some type of presentation, demonstration, or experience on a computer. On the other hand, case-based MMI provided a visual format of a clinical situation or experience that requires a transfer of knowledge from the classroom to a clinical situation. Students worked in pairs to assess the situation and formulate an outcome. The present study was designed to compare a case-based MMI (treatment group) to a tutorial-based MMI (comparison group).

Attainment of knowledge. The first component of the research question searched for development of the student’s attainment of knowledge related to diabetes and the appropriate management of patients with diabetes. The results of the postsurvey in the present study showed both MMI groups to have a positive change in the overall mean
attainment of knowledge (Figure 1, Chapter 4). The mean values for overall knowledge and the majority of knowledge statements started at 4.0 (on a 5-point scale) at the presurvey.

The results did not match the expectations for the present study. Based primarily on the adult learning theory (Knowles, 1984), the student was involved with a stimulating and interactive learning experience. In order to expand on new knowledge, the student was expected to consider previous learning and experiences to expand on new knowledge. Therefore, it was anticipated that the attainment of knowledge for the case-based MMI group would be significantly greater than the tutorial-based group.

Further, the expectations were based on theoretical frameworks conceptualized by constructivism. Reaching the appropriate solution toward treating a dental patient with diabetes in a clinical setting requires transferring knowledge obtained from the classroom. This action commands critical reasoning. In dental hygiene education, knowledge of diabetes and appropriate reaction to a medical emergency was obtained in the classroom and followed by the student providing evidence-based treatment to a clinical dental patient with diabetes to prevent a medical emergency. This was the traditional approach to teaching students. To supplement the teaching, this researcher created and exposed students to a case-based, authentic video of a dental situation with their peers to explore solutions, developed based on the work of CTGV (1990, 1992) in anchored instruction. The CTGV group found that providing such a learning environment supported students in solving complex and applicable problems. The CTGV group also proposed that the creation of this student-centered environment would enhance the knowledge of students, going beyond inert knowledge to application of the knowledge.
Therefore, students who were administered the student-centered, case-based MMI in the current study were expected to have a significantly higher level of knowledge than the tutorial-based MMI group.

Anchored instruction tends to work best with higher-order, complex questions (CTGV, 1992). In the current study, 75% of the knowledge statements were complex, requiring critical thinking. One example was “Only patients who take insulin to treat their diabetes need a blood glucose value.” This statement required a student to synthesize the information presented in a didactic class regarding diabetes and apply it to a specific patient. There were also the open-ended questions administered following the video. These questions were developed for the team of students in the case-based MMI group to formulate a solution based on previous knowledge and experiences. An example of one of these questions was, “What could have been done to prevent the medical emergency?” These questions were not analyzed and the results were not used in this study since these outcomes would not have an impact on the final analysis.

There was a discrepancy between the expected results and the results of the study. A medical emergency lecture and observation of faculty approaching patients with diabetes in a clinical setting in the 3rd quarter, followed by a 3-hour lecture on diabetes in the 5th quarter were presented prior to the intervention. It may be that the provision of these traditional methods of imparting knowledge to students accounted for the high knowledge scores at the presurvey, leaving little room for improvement. Future studies may want to provide a survey of knowledge starting at the initiation of the academic process of the student. In this case, the presurvey could have been administered to the
Multimedia Instruction

dental hygiene students in the first quarter for a possibly greater increase in knowledge for both MMI groups.

A second speculation for not observing the expected gains in student knowledge of diabetes may be that the intervention was an adjunct to traditional pedagogical approaches. This current study reflects the outcomes of several studies using MMI to support existing pedagogies. Out of the six studies using MMI as an adjunct to traditional teaching methods, four of the studies showed no difference (Aly et al., 2004; Seeram, 2001; Williams et al., 2001; Zary et al., 2009), and two of these studies were case-based. Future research could replace the traditional pedagogy with the case-based MMI and determine the results.

This present study supported the findings of previous studies in the health care literature on MMI related to gains in knowledge. With few exceptions (Devitt & Palmer, 1999; Summers et al., 1999), the trend in the literature was that both case-based and tutorial-based MMI improved or produced similar levels of attainment of knowledge (Aly et al., 2004; Bogacki et al., 2004; Fouad & Burleson, 1997; Friedl et al., 2006; Kleinert et al., 2007; Rosenberg et al., 2006; Seeram, 2001; Williams et al., 2001; Zary et al., 2009).

Retention of knowledge. There was a significant increase in mean overall knowledge and three knowledge variables for both MMI groups over time (Chapter 4, Table 6). The three variables are: “All patients with type 2 diabetes are controlled by diet and exercise,” “All patients with diabetes are at risk of experiencing hypoglycemia,” and “Patients who take pills to control their diabetes should be equally as concerned about their blood glucose values as those who are on insulin,” (Statements 56, 58, & 59, respectively). Each of these statements contributed to the significant difference over time.
of the overall knowledge variable. There does not seem to be a reasonable explanation as to why these three variables gained significant findings over time compared to those knowledge variables that did not. Figure 1 (Chapter 4) shows the mean values for both groups to be highest at the postsurvey, dropped at the follow-up 1 survey, and stabilized at the follow-up 2 survey with a slight tendency for the treatment group to have higher knowledge.

The results did not confirm my expectations for the present study. The case-based MMI group had a similar knowledge retention compared to the tutorial-based MMI group over time. It was expected that incorporating a realistic and contextual video along with an analysis of a complex problem as a team to reach a decision would significantly enhance the knowledge of the case-based MMI group. These were design features developed for the MMI based on the theoretical frameworks of CBR and the adult learning theory in the anticipation of a greater increase of knowledge. The outcomes did not match the prediction of Kolodner (1993) and Knowles (1984) in which multiple constructivist learning experiences offered to the case-based group in both a classroom and clinical environment would guide students toward the formation of long-term knowledge.

It was speculated that the discrepancy between the expected results and the results of the study are similar to those mentioned in attainment of knowledge. The information and experiences of patients with diabetes imparted prior to the intervention many have had an impact on the outcomes. Consequently, the values on the presurvey were high, with little room for error in the follow-up surveys.
The results of this research contributed to the health care literature on retention of knowledge after MMI. Although several studies recognized the value to measure the retention of knowledge following MMI (Boynton et al., 2007; Howerton et al., 2002; Williams et al., 2001), very few obtained this information. Following the intervention and measure of the attainment of knowledge, this current research measured knowledge 5 weeks (follow-up 1) and again 10-14 weeks later (follow-up 2). Only two studies in the health care literature measured knowledge after a period of time; however, the time between intervention and measurement of knowledge was short. Two weeks after MMI, Hudson (2004) found that each of the three groups studied improved in retention of knowledge. The highly interactive case-based MMI group was the only group to have a significant increase in retention of knowledge compared to the tutorial-based MMI group. The less interactive case-based MMI was equivalent in knowledge retention as the tutorial-based group. On the other hand, Summers et al. (1999) found the non-MMI group to have greater knowledge retention one month after the tutorial-based MMI. This current study contributed to the research investigating the effectiveness of MMI on knowledge over time since it measured student knowledge for a longer delay of time than the previous studies.

**Attainment of attitude and confidence.** The second component of the research question involved improvement of attitude toward a topic and confidence in providing treatment to a patient with diabetes immediately after the intervention. The mean values for overall attitude increased for both the case-based and tutorial-based groups at the postsurvey (Figure 2, Chapter 4). The interventions occurred after the students received instruction and demonstration, practiced using the blood glucose monitoring system, and
observed dental hygiene clinical instructors correctly monitoring the blood glucose values of patients with diabetes in a clinical setting. Therefore, the affective variables had a high mean value at the presurvey for both groups, possibly due to the instructional opportunities in place prior to the presurvey.

The results did not match the expectations of this researcher for the present study. It was expected that the case-based group to significantly improve in attainment of attitude and confidence compared to the tutorial-based group. The expectation of gaining attitude and confidence was drawn from the work of CTGV (1990, 1992) in anchored instruction. CTGV was guided by the work of constructivist theorists, including situated cognition (Brown et al., 1989), to support development of confidence through problem solving of a complex dental experience. In this study, the MMI for the case-based group contained a video of a complex dental situation. The video was a meaningful and useful real-world situation that allowed learners to work as a team to solve a specific problem, basing their solution on previous knowledge and experiences, including instruction, observation, and practice. In addition, the embedded data allowed for reasoned decision making. Each of these components was in place to satisfy student-centered learning and the expectation of a greater increase in attitude and confidence.

A possible explanation for the discrepancy between expected and actual results was that the dental hygiene clinical faculty modeled the protocol established in the classroom lectures for all patients with diabetes in a clinical setting for both groups. Once the demonstration and practice of the blood glucose monitoring system by the student was completed, they performed the skill in a clinical situation on patients with diabetes in front of the faculty for evaluation. In addition, performance of the skill in a safe
environment had been implemented to enhance the self-efficacy of the students toward obtaining blood glucose values on dental patients with diabetes. A faculty member was present to assist when the students performed the skill or if a patient had a medical emergency. In summary, the performance of obtaining a blood glucose value in a clinical situation and observing faculty members following the correct protocol were experiences the students received prior to both MMI treatments.

On the other hand, there was one attitude statement that did meet the expectation of this researcher. This statement was, “If I am employed in a dental setting that does not obtain blood glucose values, I will work toward initiating a protocol for patients with diabetes” (Statement 67, Chapter 4). This statement was the only one in which the treatment group measured significantly greater than the comparison group. Many students had observed faculty following an appropriate protocol for a diabetes patient, but may not have observed a “real” medical emergency in a clinical setting involving a patient experiencing symptoms of hypoglycemia. However, the case-based video presented such a scenario in a realistic setting. Thus, it may be that the students viewing a potential medical emergency and formulation of a solution with a peer helped to develop greater self-efficacy and/or established an urgency to have a protocol for patients with diabetes. Similarly in the literature, Lashinger (1996) found an increase in self-efficacy as the number of experiences increased, as well as implementation of collaborative learning. Lashinger also noted that working with peers, observation of a credible model, and exposure to authentic case studies were examples of educational strategies that increased the likelihood of enhanced self-efficacy. Therefore, the intervention involving a student-centered, case-based MMI might be the reason for this one statement to have had a
significant increase over the tutorial-based MMI. In other words, this pedagogical approach increased the attitude and confidence of the student. This aspect of learning could be a focus of future research.

The results of this research were similar to the findings of the only study found in the literature related to the effect of MMI on attitude and confidence. From the analysis, Boynton et al. (2007) found an increase in student confidence of using a skill within the health care profession immediately following a case-based MMI; however, the comparison was to lectures, not tutorial-based MMI as in the present study.

Outside of health care, the use of MMI based on anchored instruction has also been found to have a positive change in attitude in areas such as mathematical problem solving (e.g. CTGV, 1997; Zydney, Stegeman, Bristol & Hasselbring, 2010). This present study contributed to the literature by measuring and comparing the attainment of attitude and confidence of dental hygiene students for both case-based and tutorial-based MMI.

Retention of attitude and confidence. The mean overall attitude and three attitude variables showed a significant change over time for both the case-based and tutorial-based MMI groups. Both groups found that the improvement in students’ attitude and confidence stabilized weeks after the intervention and into their first job as a dental hygienist (Figure 2, Chapter 4).

One of the most poignant findings of this study was found with the statement, “If I am employed in a dental setting that does not obtain blood glucose values, I will work toward initiating a protocol for patients with diabetes.” This statement measured a significant improvement in attitude in the case-based group compared to the tutorial-based group and was sustained after graduation and into the first employment
opportunity. This outcome supports creating a case-based MMI to strengthen a student’s attitude. In this situation, an improved attitude for a dental hygiene student can transfer current, evidence-based practice obtained in a didactic and clinical academic environment into practice in the dental community. As this statement is only one of many attitude statements highlighted in the current study, it is recommended that further research be conducted.

Although there was no difference between groups, statements 73, 81, and 87 measured a significant change in attitude and confidence over time. One of the statements measured attitude: “I will continue to obtain blood glucose values once I am practicing as a dental hygienist,” (Table 9, Statement 73, Chapter 4). The two statements measuring confidence included statements 81 and 87, respectively (Table 9, Chapter 4), “I can answer basic knowledge questions from the patient on the link between diabetes and dental health” and “I can obtain a blood glucose value with confidence.” Each of these affective statements is poignant to a significant increase in overall attitude over time (Figure 2, Table 9, Chapter 4). There does not seem to be a reasonable explanation as to why these three variables gained significant findings over time compared to those affective variables that did not.

Also of particular interest was the variable, “I am interested in reading articles in professional journals related to the effect of diabetes on dental patients” (Statement 77). Although a significant difference was not obtained, each group had a slight increase in their mean score following some type of intervention, indicating that the case-based MMI was equal to or as effective than the tutorial-based. The Commission on Dental Accreditation for Dental Hygiene Education Programs (2009) indicated a need for life-
long learning. This data supports this standard and students participating in this study may continue to be advocates for appropriate management of dental patients with diabetes.

With the exception of one statement, the results did not meet the expectation of this researcher. Using a case-based MMI followed by a team approach to solving a complex problem was thought to significantly improve the attitude and confidence of the student compared to the tutorial-based group. The expectation was based on the concepts derived from Bandura (1993), who proposed that self-efficacy may strengthen with each experience.

In addition, the expectation of this researcher was based on the theories derived from Kolodner (1993) and Knowles (1984). The case-based MMI provided the student with the increased likelihood of drawing information from memory, expanding on it, and applying it to a clinical situation as needed. Therefore, as a student experiences similar medical emergencies in the future, there is an increased likelihood that each event will afford greater confidence in performance and a stronger attitude toward providing blood glucose values for patients with diabetes.

A possible explanation for the discrepancy of outcomes for retention of attitude and confidence may again be attributed to the experiences the student was involved in prior to the implementation of the MMI. For example, the students observed clinical faculty who calmly and confidently performed the appropriate protocol in a safe environment, and this may have helped students build confidence in their own abilities.

No study in the health care literature that implemented MMI measured retention of attitude and confidence. This current study is unique since it measured retention of
attitude and confidence in health care education following MMI. In looking outside the literature in MMI, this present study was similar to only one study in the health care literature that measured attitude over time subsequent to implementation of a variety of constructivist pedagogies. Laschinger (1996) showed a significant increase in attitude toward health promotion activities after students were assigned a variety of learning opportunities, none of which involved technology, throughout their academic study. The present study is distinctive from the Laschinger study since it employed MMI based on anchored instruction as one of the constructivist pedagogies.

Retention of skill. The final component of the research question searched for improvement in managing a patient experiencing hypoglycemia in a dental environment after involvement with MMI. Student understanding of diabetes and the appropriate treatment to prevent or react to a medical emergency is vital and complex information for the general health and well-being for the patient. In the current study, the outcomes of the pre-practical skill test showed that only 2 of the 29 students passed the simulation of a diabetes medical emergency (5th quarter). This simulation was following traditional pedagogies of disseminating the material on diabetes management in the classroom and clinic in the 3rd quarter. Not being able to respond appropriately to a common medical emergency is a concern in dental health care.

The data analyses conducted on the pre- and post-practical skill test performances provided sufficient evidence that there were significant differences between the groups. The case-based group scores ranged from no one passing the pre-practical skill test to 100% of the group passing. The tutorial-based group significantly improved in skill, but
only 60% successfully passed the post-practical skill test. The post-practical skill test was administered 12 weeks following the administration of the intervention.

The results met this researcher’s expectations that the case-based group would achieve significantly greater skill compared to the tutorial-based group. The design of the MMI for the case-based group contained mechanisms associated with constructivist theories, such as solving the complex problem presented in the video in pairs. Another possible explanation why the treatment group may have done better is the post-practical skill examination was this MMI provided a similar scenario, while the tutorial-based MMI group only received a traditional lecture on the topic.

The theoretical frameworks that underlie the case-based MMI reason that a constructivist approach to learning develops the knowledge and confidence for skill acquisition. For example, CBR (Kolodner, 1993) posits that student-centered learning transfers didactic knowledge to a clinical setting. The authentic, real-world, case-based video provided another experience that can occur in a clinical setting in which the learner can draw on for successful performance of a medical emergency. In addition, the enhancement of retention of attitude and confidence for the case-based group supported Bandura’s (1977) theory of self-efficacy for the successful performance of the skill during a stressful situation.

The current study was compared to several studies in the health care literature related to skill attainment. Similar to Hudson (2004), this present study compared the skill acquisition obtained from students receiving a case-based MMI to those in a tutorial-based MMI. Both studies found the case-based MMI group using problem solving to be more effective at improving skill acquisition than the tutorial-based MMI group that
replicated a lecture. Of the seven studies measuring the effect of tutorial-based MMI on acquisition of skill, three found an increase in skill (Aragon & Zibrowski, 2008; Bauer & Huynh, 1998; Friedl et al., 2006) and four found equivalent achievement (Aly et al., 2004; Howerton et al., 2002; Hudson; and Summers et al., 1999). In comparison, each of the three studies using case-based MMI found a significant improvement in skill (Boynton et al., 2007; Hudson; Williams et al., 2001). Thus, the general trend seen in the literature is that case-based MMI is more effective at improving skill acquisition than tutorial-based MMI.

Each of the previous studies looked at skill acquisition immediately following the MMI, while only one study looked at retention of skills (Summers et al., 1999). In conjunction with looking at attainment of skill, Summers et al. also assessed performance of a technical skill at a posttest one month after the intervention for each of the three groups. The tutorial-based MMI and video groups had significant improvement in skill compared to the didactic group, but the tutorial-based MMI group was equivalent to the video group. This is similar to the current study which also measured the skill attainment weeks after the intervention, just prior to graduation. However, this study was unique since it measured skill attainment 12 weeks after the intervention.

The ability of a student to transfer knowledge to performance of a skill, especially handling a medical emergency, is critical in health care. Williams et al. (2001) stated it best when describing that even a slight increase in skill in health care is considered a success since the recognition of one more element (in the case of this study, a medical emergency) will strengthen patient care.
Summary of the Results

The effects of two multimedia learning environments were compared using a survey administered at four points and a practical examination skill test administered at two points. The postsurvey measured the attainment of knowledge and affective variables, while the follow-up 1 and 2 surveys measured retention. The final measuring point was 3 months following graduation and over half of the students were employed as dental hygienists.

There was not a significant difference in the attainment of knowledge, attitude, and confidence for both the treatment and comparison groups. The outcomes from the presurvey for both groups indicated a start with high mean values, with little room for improvement at the postsurvey.

Time, however, had a significant effect on both the mean overall knowledge and affective variables for both the treatment and comparison groups. In addition, there were three knowledge and three affective variables that reported a significant change over time for both the case-based and tutorial-based MMI groups. Most importantly, one attitude variable showed a significant change for the treatment group, but not the comparison group. This statement suggests a positive attitude toward performance in future practice as a dental hygienist.

The retention of knowledge, attitude, and confidence showed the group mean values for the case-based and tutorial-based groups to be highest at the postsurvey, drop slightly, and to eventually stabilize over time into the participant’s first employment as a practicing dental hygienist.
There was a significant increase in retention of skill for both groups; however, a greater increase was reported for those students in the case-based MMI group. The ability of a health care provider to act appropriately in the event of a medical emergency is paramount and a valuable aspect of the current study.

Taking the knowledge of diabetes and a positive attitude and confidence toward the management and care of patients with diabetes from an academic setting into professional practice was a goal of this study. In addition, the confirmatory responses to the two attitude statements related to obtaining blood glucose values once practicing as a dental hygienist were a strong support for this goal.

Limitations of the Study

There were several limitations in the present study. The first limitation was the participants were drawn from the same program and comprised of a convenience sample. Further, although the sample size had enough power as measured in power analyses, the smaller sample size would be a delimitation that affects the generalizability of the outcomes to all dental hygiene students.

Several issues related to the design of the case-based MMI could be limitations. The students received didactic and clinical instruction and experiences prior to the intervention with mean scores averaging high at the presurvey, with little room for improvement. Administering the presurvey in the first quarter of their academic program would provide a better measure. Although it was intentional to use a familiar environment and actors for the case-based video, this may also have presented a limitation since the video may not have the same effect for students unfamiliar with the actors and setting.
Although the current study looked at retention of skill, it would have been beneficial to have measured skill after graduation. The post-practical skill examination was administered one week prior to graduation, approximately 8 months after the initial examination and 12 weeks after the intervention. While the time period between the pre- and post-practical skill test and between the intervention and post-practical skill test was noteworthy, it would be impractical in the design of the current study to administer another practical skill examination for those who had graduated. If a practical skill examination was administered to graduates, it would be the prediction of this researcher that the same percentage of medical emergencies involving dental patients with hypoglycemia would be handled appropriately for the practicing health professionals that were involved with the case-based group. Though no two medical emergencies are alike, Knowles (1984) suggested that students/future health care providers will have a better and faster reaction to similar medical emergencies in the future based on the constructivist pedagogies incorporated for the case-based group. In addition, Bandura (1993) proposed that enhanced self-efficacy can be an element of future successful performances. This concept would be valuable to examine in future research.

Another limitation of design was the small sample size did not allow for two other treatment groups: paper-based, case-based MMI and paper-based, tutorial-based MMI. This would have allowed a determination of whether the pedagogy or the MMI learning environment attributed to the success.

Regarding the statements on the survey, there were Likert-style statements in which the participants could “guess” at the response. There were three open-ended questions on the survey that did not have any responses. Having all questions open-ended
would provide richer data to measure higher level thinking, required for critical reasoning.

**Contributions to the Literature**

Most studies in the health care literature were not grounded in theory, but were data driven. However, it appeared that two studies formulated their MMI based on the epistemological ideologies of constructivist theorists, although neither referenced the theorist. Bogacki et al. (2004) alluded to the work of the adult learning theory (Knowles, 1984) to tailor the MMI to the adult student to capture advanced learning. In addition, Williams et al. (2001) appeared to embrace the work of CBR (Kolodner, 1993) in producing the MMI for health care professionals. The design and development of the MMI in the present study originated with a strong foundation derived from the theories of Knowles and Kolodner, lending to robust quality of the research.

One unexplored area in the health care literature was the development and production of a video-based, case scenario that was modeled after the work of the CTGV (1990, 1992) on anchored instruction, which is grounded in constructivist theories and illustrates specific development of a case. In the present study, the video was designed and developed to also include concepts presented by CTGV, such as the use of an authentic, meaningful, and real-world situation containing embedded information that is significant and irrelevant to allow for reasoned decision making. This was the first study in health education research that utilized this pedagogical approach.

Another element this study contributed to the literature was the creation and development of a video-based, case scenario in the same dental setting the participants used for their clinical experiences to enhance the possibility of an authentic and real-
world scenario (CTGV, 1992). The actors in the video were familiar members of the dental hygiene faculty and staff. This is a unique and valuable perspective to approaching the case scenario. It appears that this may have been the first study in the health care education literature to assess a video-based, case scenario with familiar components. This was difficult to ascertain because the other studies in the health care literature presented some detail of the content, but had limited or no description of the design and development of the MMI.

All studies in health care education that measured the effects of MMI focused on attainment of knowledge and/or skill. The current study not only explored knowledge and skill, but also the attitude and confidence level of students. In addition, much of the research measured the students immediately following the intervention, with suggestions for longer periods of evaluation for future research. The contribution of this study to the literature was that it assessed the knowledge and affective variables at several points during the student’s final year of their academic program and 3 months after graduation.

In addition, this present study compared a case-based MMI to a tutorial-based MMI. Only one other study in the health care MMI literature did this (Hudson, 2004). A final contribution of this research is that the MMI was developed for and implemented with dental hygiene students. No study in the health care literature used dental hygiene students in investigating the impact of MMI.

Future Research

The current study highlighted several areas for future research. Although the present study measured students 3 months after graduation, it would be valuable to
measure the participant’s knowledge, attitude, and confidence over a longer period of
time. This would be effective to generalize concepts and increase transfer of information

Future research could include a larger sample size to allow for comparison of
multiple learning environments, such as a tutorial-based MMI, traditional classroom
experience, a case-based MMI, and a case-based, paper-based environment. This would
enable researchers to draw conclusions regarding whether it is the media or the
underlying theoretical framework driving the results.

Another recommendation is to change the research design of the current study to
replace traditional pedagogies with case-based MMI instead of using the MMI as an
adjunct to existing teaching strategies. This approach may produce greater gains in the
knowledge of the student. Along the same line, future research could administer the
presurvey in the first few weeks of entering the health care program, before any
information on the knowledge of diabetes is provided, in the hopes of observing greater
gains in knowledge.

Another avenue to investigate in future studies is to conduct a correlation to
determine if an increase in self-efficacy has a significant impact on the performance of a
skill when exposed to case-based MMI. This outcome will identify if a relationship exists
between an enhanced attitude and improved skill performance as predicted by Bandura
(1993).

Conclusion

The inclusion of MMI in health professions education has been a popular
pedagogical strategy for decades. Attention to underlying theories provides the
foundation for a strong design in connection with student learning outcomes. This study
investigated constructivist strategies that involved a multimedia instructional design for effective and efficient learning, skill attainment, and increase in attitude and confidence.

Not all designs of MMI created for health care education are equal. MMI ranges from lectures in health care that are reproduced as MMI to well designed multimedia learning environments. Variations of MMI are created to accommodate the current curriculum, making it difficult to compare for use in other programs or disciplines. The literature in health care needs to do a better job of describing and designing MMI so that better comparisons can be made and appropriate applications of MMI can be utilized.

The current study compared a case-based MMI to a tutorial-based MMI learning environment. The principal outcome was the retention of the skill by the students involved with the case-based MMI learning environment. In addition, the case-based MMI learning environment was effective at enhancing the retention of student attitude on one variable related to future practice. Both of these have a valuable impact on pedagogies chosen by educators in health care. Given these preliminary findings, educators in health care may want to give additional thought to what type of MMI they are using for a particular learning experience.

In addition, the consideration of measuring attitude toward a topic and confidence toward performing a skill may help the educator to create a learning environment to promote these affective variables. The creation of a case-based MMI to supplement traditional pedagogies and implement strategies toward student-centered learning may help to transfer the complex information required for health care professionals to know and appreciate, and to feel more confident in their ability to apply the information to a clinical setting while in school and persevere into professional practice. The integration
of MMI into the curriculum of dental hygiene and other health care students should continue to be investigated to further bridge the gap between academic and professional practice.
References


care to children with developmental disabilities using a virtual patient module.

*Journal of Dental Education, 71*(2), 279-286.


Appendix B

Script and Clues for the Video—Case-based Group

This appendix provides the script and embedded clues of the case-based scenario.

*Media Direction:*
CU is close-up
LS is long shot
MS is mid-shot.

*Characters:*
Susan—patient scheduled for a prophylaxis with the registered dental hygienist (RDH)
Jodee—receptionist at the front desk
Patsy—RDH
Narrator

<table>
<thead>
<tr>
<th>Video</th>
<th>Audio</th>
</tr>
</thead>
</table>
| Scene 1  
LS Susan is rushing into the reception area. Jodee is sitting behind the desk.  
MS Jodee and Susan  
MS Susan is sitting down  
CU Clock (11:00) | S: I made it! I have been running all morning long and just came from a spinning class. I was so worried I would be late.  
T: Well Susan, Patsy is running about 15 minutes behind this morning. That will give you a chance to catch your breath and update your medical history for us.  
S: Super! Gee, I can’t believe it is already 11:00. Time sure flies. |
| Scene 2  
LS We see Patsy, RDH helping patient into chair and placing bib on.  
MS The RDH is holding the health history on a clipboard. RDH begins reviewing the health history.  
LS The camera slowly pans the operatory.  
CU On the counter is the blood pressure cuff, BGMS with supplies, a red sharps container, a pen and the chart.  
CU The unit is set up with instruments on the tray.  
MS Receptionist interrupts.  
MS RDH puts on mask, gels hands, puts on | P: So you’re baby is two years old and you still have not smoked?  
S: Not one puff since the day I found out I was pregnant.  
P: Susan, I am so proud of you for making such a healthy decision for you and your family. I know how difficult it was and continues to be. What about your diabetes…Is it in control?  
S: Oh sure.  
J: Patsy, your next patient is here.  
P: Thanks Jodee. (To Susan) Wow! This has been some day. Thanks for waiting, I have been behind all day.  
S: Not a problem, I was running late myself.  
P: Let’s get started. |
Scene 3
CU RDH is flossing the patient’s teeth.
MS RDH is talking to the patient as she flosses her teeth.

P: Your gums bled fairly easily today and your gum tissue is more inflamed than usual. I want to encourage you to floss every day and remember to wrap the floss tightly around each tooth.
S: I quit flossing because my gums started to bleed.
P: When your gums bleed, it is an indication to floss more.
S: Alright, I’ll start again tonight. Wow! I am so hungry. Is it alright if I eat as soon as I leave? I’m starting to feel a little light-headed. I’m really hungry.
P: I’m going to do a fluoride treatment. Can you wait another 30 minutes?
S: Just slowly shakes head.
P: After the fluoride treatment, I’ll have you go out and set up your next appointment with Jodee.

Scene 4
LS The receptionist is helping another patient with an appointment.
CU Clock, it is 12:15
MS Trish is slumped in the chair.
S: Trish, go ahead and have a seat. I’ll be right with you.
S: OK Trish, let’s set up your appointment.
S: Trish, are you alright? Trish? Dr. Long, I need your assistance?

Scene 5
MS of narrator
Narrator: The clues are within the video. You can stop and start this video at any point as many times as you want. Analyze the situation, obtain supporting information, and draw a solution to the problem. You may use information from previous courses, textbooks and the Internet to establish a solution.

Embedded Clues within the video:

- The patient has been running all morning. Consideration should include she might not have eaten all morning, therefore a greater potential for low blood glucose levels.
- The patient just came from intense exercise class. Exercise lowers blood glucose levels
- RDH briefly acknowledged diabetes, but did not obtain a blood glucose level
• RDH noted bleeding of the gum tissue. This is a characteristic of uncontrolled blood glucose levels.
• Time. The patient needed a snack this morning; therefore blood glucose levels will be low.
• Patient stated she was hungry, which is a sign of hypoglycemia.
• The blood glucose monitoring system on counter was not used and viewers do not see the patient checking the level, therefore, a blood glucose level was not taken.
• The patient appears lethargic and does not respond in the conversation, which are signs of hypoglycemia.
• The patient slowly walks to the waiting room, with no conversation, and loses consciousness, all signs of hypoglycemia.
Appendix C

Video—Case-based Group

To access the video:

URL: http://blackboard.uc.edu/webapps/portal/frameset.jsp

To Login: username: v_grgasre12925 and password: 1Dental

click on Dental Hygiene Organization

click on Documents

click on Video 4-29-09
Appendix D

PowerPoint Presentation—Tutorial-based Group

To access the video:

URL: http://blackboard.uc.edu/webapps/portal/frameset.jsp

To Login: username: v_grgasre12925 and password: 1Dental

click on Dental Hygiene Organization

click on Documents

click on DH Lecture PPT
Appendix E

Survey

This appendix provides the survey that will be used for four data collection points.

### Dental Hygiene Student Survey

**Directions:** Identify the response that most closely matches your opinion regarding patient care.

**In a dental setting, which of the following do you feel are benefits to patient treatment?**

*Check all that apply.*

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtaining a blood pressure is within the scope-of-practice for a RDH in Ohio.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining a blood glucose value is within the scope-of-practice for a RDH in Ohio.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining an adequate health history (as taught in dental training) will minimize the risk of infection.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a blood glucose value prior to dental treatment will minimize the risk of infection.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining an adequate health history can determine a possible cause for xerostomia.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a blood glucose value can determine a possible cause for xerostomia.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining an adequate health history can determine an appropriate recare appointment schedule.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a blood glucose value can determine an appropriate recare appointment schedule.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining an adequate health history can determine appropriate treatment for periodontal disease.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a blood glucose value will help determine appropriate treatment for periodontal disease.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a blood pressure value will help determine appropriate treatment for periodontal disease.</td>
<td>❑</td>
</tr>
<tr>
<td>Assessing a 1-3 day diet history can determine appropriate therapy for an increased caries rate.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a BG value will help determine appropriate treatment for an increased risk of caries.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining an adequate medical history will minimize the risk of a medical emergency.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a blood pressure value will minimize the risk of a medical emergency.</td>
<td>❑</td>
</tr>
<tr>
<td>Identifying a blood glucose value will minimize the risk of a medical emergency.</td>
<td>❑</td>
</tr>
<tr>
<td>Patients appreciate a thorough intra-oral exam (as performed during dental training) for early detection of dental issues.</td>
<td>❑</td>
</tr>
<tr>
<td>Patients appreciate a thorough extra-oral exam for early detection of dental issues.</td>
<td>❑</td>
</tr>
<tr>
<td>Patients appreciate that a dental professional obtains a blood pressure value to ensure safe treatment.</td>
<td>❑</td>
</tr>
<tr>
<td>Patients appreciate that a dental professional obtains a blood glucose value to ensure safe treatment.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining a blood pressure value will support efforts to educate the patient regarding the link between heart disease and dental issues.</td>
<td>❑</td>
</tr>
<tr>
<td>Obtaining a blood glucose value will support efforts to educate the patient regarding the link between diabetes and dental issues.</td>
<td>❑</td>
</tr>
<tr>
<td>Performing a thorough intra-oral exam will support efforts to educate the patient.</td>
<td>❑</td>
</tr>
<tr>
<td>Performing a thorough extra-oral exam will support efforts to educate the patient.</td>
<td>❑</td>
</tr>
</tbody>
</table>

**Other benefits** *(Please list)*
In a dental setting, which of the following do you feel are barriers to patient treatment? Check all that apply.

- Not enough time
- No reimbursement from insurance
- High cost of supplies
- Lack of equipment
- Lack of functioning equipment
- Lack of patient acceptance
- Lack of patient knowledge
- It may not be an established protocol in my future position
- Lack of confidence to perform
- Other dental team members do not feel it is important
- Lack of interest from other dental team members
- Lack of confidence to obtain a BP value from other dental team members (DDS, other RDH, assistant)
- Lack of confidence to obtain a blood glucose value from other dental team members
- Lack of knowledge from other dental team members regarding potential medical emergencies
- Lack of knowledge from other dental team members regarding potential diabetes medical emergencies
- Lack of knowledge from other dental team members regarding potential hypotensive or hypertensive medical emergencies
- Lack of knowledge from other dental team members regarding the effects of uncontrolled diabetes on the oral cavity

Other barriers (Please list)

Directions: Please rate how strongly you agree or disagree with each of the following statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only patients who take insulin to treat their diabetes are at risk of a medical emergency, such as hypoglycemia (low blood glucose).</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Only patients who take an antihypertensive medication are at risk of a medical emergency.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Only patients who take insulin to treat their diabetes need a blood glucose value.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Only patients who take an antihypertensive medication need a blood pressure value.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Only patients who take insulin to treat their diabetes require special care in a dental setting.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Only patients who take an antihypertensive medication require special care in a dental setting.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Patients who take insulin and/or an antidiabetic medication are at risk of increased infection.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Patients who take an antihypertensive medication are at risk of increased infection.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>Patients who have been diagnosed with pre-diabetes need to worry about complications associated with diabetes.</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>
Patients who have been diagnosed with prehypertension need to worry about stroke, myocardial infarction or heart failure.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

Patients whose diabetes is treated by diet and exercise need to worry about complications associated with diabetes.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

Patients whose hypertension is treated by diet and exercise need to worry about complications.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with type 2 diabetes are controlled by just diet and exercise.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with prehypertension are controlled by just diet and exercise.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with diabetes are at risk of experiencing hypoglycemia.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

Patients who take pills to control their diabetes should be equally as concerned about their BG values as those who are on insulin.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

Patients who take pills to control their high blood pressure should be equally as concerned about their BP values as those who do not.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with diabetes know when their BG value is too high.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with diabetes know when their BG value is too low.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with hypertension know when their BP values are too high.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with hypertension know when their BP values are too low.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

Diabetes is the result from defects in insulin secretion and/or insulin action.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

Directions: Please rate how strongly you agree or disagree with each of the following statements.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

It is the responsibility of the medical profession, not the dental profession, to educate the patient with hypertension.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

It is the responsibility of the medical profession, not the dental profession, to educate the patient with diabetes.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with hypertension have the right to refuse to obtain a blood pressure value prior to dental treatment.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

All patients with diabetes have the right to refuse to obtain a blood glucose value prior to dental treatment.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

It is my responsibility to educate patients regarding their high blood pressure and the effects on their oral health.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

It is my responsibility to educate patients regarding their diabetes and the effects on their oral health.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

If I am employed in a dental setting that does not obtain BP values, I will work toward initiating a protocol for the patients.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

If I am employed in a dental setting that does not obtain blood glucose values, I will work toward initiating a protocol for patients with diabetes.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>

If I am employed in a dental setting that does not have an adequate health history, I will work toward initiating an appropriate document.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
</tbody>
</table>
If I am employed in a dental environment that does not do thorough oral exams (as taught in dental training), I will work toward creating a protocol for accepted practice.

I am interested in reading articles in professional journals related to the effect of blood pressure on dental patients.

I am interested in reading articles in professional journals related to the effect of diabetes on dental patients.

I am interested in reading articles in professional journals related to medical emergencies.

I am interested in reading articles in professional journals related to oral exams.

I will continue to obtain blood pressure values once I am practicing as a dental hygienist.

I will continue to obtain blood glucose values once I am practicing as a dental hygienist.

I will continue to perform a thorough extra-oral exam once I am practicing as a dental hygienist.

I will continue to perform a thorough intro-oral exam once I am practicing as a dental hygienist.

I know where to get the appropriate equipment to obtain a blood pressure value once practicing as a dental hygienist.

I know where to get the appropriate equipment to obtain a blood glucose value once practicing as a dental hygienist.

**Directions: Please rate how strongly you agree or disagree with each of the following statements.**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can obtain a blood pressure value with confidence.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can obtain a blood glucose value with confidence.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can obtain information on a health history with confidence.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can perform an oral exam with confidence.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is my role as a dental hygienist to be a member of the medical health care team.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is my role as a dental hygienist to be a member of the diabetes health care team.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can answer basic knowledge questions on hypertension from the patient.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can answer basic knowledge questions on diabetes from the patient.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can ask appropriate follow up questions related to ‘Yes’ responses on the medical history.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can answer basic knowledge questions from the patient on the link between heart disease and dental health.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can answer basic knowledge questions from the patient on the link between diabetes and dental health.</td>
<td>SD D N A SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# General Demographic Information

What is your age? _______ years

How would you describe your racial or ethnic background? Check all that apply.

___ White/Caucasian  ___ Asian American  ___ Hispanic or Latin American
___ African American  ___ Hawaiian/Pacific Islander  ___ Native American

Other_____________________________________

What is your Grade Point Average (GPA)? ______GPA  _______ don't know

Have you worked in a dental setting?

___ Never  ___ Less than a year  ___ One or more years

Have you ever lived with an individual with diabetes, pre-diabetes, or gestational diabetes?  ___ No  ___ Yes
Have you ever lived with an individual with hypertension?  ___ No  ___ Yes

Have you been diagnosed with diabetes, pre-diabetes or gestational diabetes?  ___ No  ___ Yes
Have you been diagnosed with hypertension?  ___ No  ___ Yes

Do you have a license in another health profession?  ___ No  ___ Yes

If yes, please identify the discipline  __________________________________________

## Comments or thoughts not expressed:

---

**By completing this survey, you give consent to participate in this study**

All information in this survey is *confidential.*

Thank you for completing this survey and for being part of enhancing the education of our future dental hygienists.
Appendix F

Skill Examination Checklist

This appendix provides the instrument used to assess the performance and decision making of the students using a simulated patient.

### CLINIC PRACTICUM III

#### SKILLS TEST

##### MEDICAL EMERGENCY SKILL

<table>
<thead>
<tr>
<th>Evaluator Form</th>
<th>Student Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Date</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypoglycemia Medical Emergency Criteria</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Student reviews the patient <strong>health history</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Student checks <strong>pulse</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Student takes <strong>BP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Student requests <strong>BG monitor</strong> and supplies to test BG level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Student identifies condition as <strong>hypoglycemia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Student states <strong>treatment</strong> is to give <strong>glucose tablets or gel</strong> (do not accept fructose source, must be a glucose source)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Student Score: Pass/Remediate/Repeat

Evaluator’s Initials: ______
Appendix G

Codebook from the Field Study

This appendix provides the codebook established from the field study. A similar format may be used for the research study.

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Variable</th>
<th>Definition</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>Name of participant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID(2)</td>
<td>Participant number</td>
<td>1-29</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>Treatment</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comparison</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Pretests</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Posttest</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Follow up 1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Follow up 2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Skill Test</td>
<td>Fail</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pass</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Q20Ben dmatt Attitude of students Yes = 0
Q38Bar toward treatment of pts with diabetes No = 1
Q42Bar

Q67A (Q67A-Q96A: avg. 1-5)
Q69A
Q71A
Q73A
Q77A
Q81A
Q85A
Q87A
Q90A
Q91A
Q93A
Q96A

Q19Ben htnatt Attitude of students Yes = 0
Q37Bar toward treatment of pts with hypertension No = 1
Q41Bar

Q66A
Q68A
Q70A
Q72A
Q76A
Q80A
Q84A
Q86A
Q92A
Q95A
| Q17Ben | medhxatt | Attitude of students toward importance of obtaining a medical history | Yes = 0  
| Q18Ben |  |  | No = 0  
| Q39Bar |  |  | Missing = 99  
| Q74A |  |  | S. Disagree = 1  
| Q78A |  |  | Disagree = 2  
| Q88A |  |  | Neutral = 3  
| Q94A |  |  | Agree = 4  
|  |  |  | S. Agree = 5  
|  |  |  | Missing = 99  
| Q26Bar- | bar_att | Barriers to patient care-student attitude | Yes = 0  
| Q36Bar |  |  | No = 1  
|  |  |  | Missing = 99  
| Q44Bar | OtherBar | Other barriers to patient care-student attitudes | No comment/Blank = 10  
| Q2 Ben | dmrknow | Knowledge of students on diabetes | Yes = 0  
| Q4 Ben |  |  | No = 1  
| Q6 Ben |  |  | Missing = 99  
| Q8 Ben |  |  |  
| Q10 Ben |  |  |  
| Q13 Ben |  |  |  
| Q16 Ben |  |  |  
| Q22 Ben |  |  |  
| Q44K (Q44K-Q65K: avg 1-5) |  |  |  
| Q46K |  |  |  
| Q48K |  |  |  
| Q50K |  |  |  
| Q52K |  |  |  
| Q54K |  |  |  
| Q56K |  |  |  
| Q58K |  |  |  
| Q59K |  |  |  
| Q61K |  |  |  
| Q62K |  |  |  
| Q65K |  |  |  
| Q1 Ben | htnknow | Knowledge of students on hypertension | Yes = 0  
| Q11 Ben |  |  | No = 1  
| Q15 Ben |  |  | Missing = 99  
| Q21 Ben |  |  |  
| Q45K |  |  |  
| Q47K |  |  |  
| Q49K |  |  |  
| Q51K |  |  |  
| Q53K |  |  |  
| Q55K |  |  |  
| Q57K |  |  |  
| Q60K |  |  |  
| Q63K |  |  |  
| Q64K |  |  |  

135
Multimedia Instruction

<table>
<thead>
<tr>
<th>Q3Ben</th>
<th>medhnkn Knowledge of students on the value of a medical history</th>
<th>Yes = 0 No = 1 Missing = 99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5Ben</td>
<td>oeknow Knowledge of students on performing an oral exam</td>
<td>Yes = 0 No = 1 Missing = 99</td>
</tr>
<tr>
<td>Q7Ben</td>
<td>Q9Ben</td>
<td>Q12Ben</td>
</tr>
<tr>
<td>Q98</td>
<td>Race Race or ethnic background White = 12 AA = 13 Asian = 14 Hawaiian = 15 Hispanic = 16 Native American = 17 Other = 18 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q99</td>
<td>GPA Grade Point Average 2.5-4.0 Don’t Know 11 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q100</td>
<td>EXPER Length of time employed in a dental office Never = 19 &lt;1 yr = 20 1+ yrs = 21 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q101</td>
<td>DM Living with someone with diabetes Yes = 0 No = 1 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q102</td>
<td>HTN Living with someone with hypertension Yes = 0 No = 1 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q103</td>
<td>PerDM Personal experience with diabetes Yes = 0 No = 1 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q104</td>
<td>PerHTN Personal experience with hypertension Yes = 0 No = 1 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q105</td>
<td>OtherLic License in another health profession Yes = 0 No = 1 Missing = 99</td>
<td></td>
</tr>
<tr>
<td>Q106</td>
<td>ID Lic If yes to Q 105, ID the discipline No = 1 Blank = 10 CNA = 22</td>
<td></td>
</tr>
<tr>
<td>Q107</td>
<td>Comments Additional comments Blank = 10</td>
<td></td>
</tr>
</tbody>
</table>

136