# Literature Review

# Effectiveness of Multimedia Instruction in Health Professions Education Compared to Traditional Instruction

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## Abstract

**Purpose:** It is the challenge of many health care educators to find epistemological means to create learning environments that promote critical thinking, decision making and transfer of knowledge from didactic to clinical settings in order to enhance the knowledge, skills and performance of health care students. In addition, due to a rapidly changing health care environment, health professions education has been plagued with increasing quantities of complex information with waning numbers of faculty members. Investigating pedagogical strategies that address these issues is essential. Implementing carefully designed multimedia instruction (MMI) may be part of the solution. This literature review will present research regarding the effectiveness of MMI in health care education compared to traditional pedagogies. Two specific domains emerged from the literature: types of learning with MMI and the instructional design of multimedia learning environments. Regardless of the outcomes of the study, each researcher favorably described the value of MMI in health care education, citing a need for further research before universal implementation of this technology is placed in the curriculum.


Keywords: multimedia instruction, health professions education, skill acquisition, knowledge attainment

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## Introduction

Many studies note the need for further research in effective educational strategies for health care professionals to understand, promote and incorporate various health protocols for their patients within their discipline.[1–3] 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."[4] 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 information is provided in their classroom and clinical education.[5–6] 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.[5–9] Other research has indicated that knowledge acquired in academic health care programs is more likely to be incorporated into practice than information obtained in any other setting, such as a professional continuing education course or workshop.[10] Thus, including the knowledge and practice of established, evidence–based health care protocols into the curriculum during formal training is essential.

This review of the literature will examine and present the outcomes of research in health professions education using multimedia instruction (MMI) compared to traditional teaching strategies. The medical, dental and allied health care literature in education using MMI from 1997–2009 was reviewed by utilizing MEDLINE and Pub Med databases.

## Multimedia Instruction (MMI)

Carefully designed MMI delivers information in a manner designed to help students learn new material or improve knowledge of materials previously studied.[11] MMI can be interactive or student–centered, in which the student is engaged in the program. Technological innovations implemented into the health care curriculum have modified the face of learning environments.[12] Highly structured environments are beneficial to the acquisition of clinical

skills.[13] MMI can be designed to create a structured learning environment that is student–centered, self–paced, interactive, beneficial in developing critical thinking skills and presented in a safe environment (practicing in a simulated setting before practicing on persons in a clinical setting). 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 focus on attitude of the student toward the topic.[14]

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.[15,16] Health profession educators and researchers have been capitalizing on technology as they sought to investigate educational strategies to meet the changing demands and challenges of health care as well as meeting the students' learning needs. Looking ahead, the waning number of faculty in health care education produces 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 or better to 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 time frame 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 response to these and other educational dilemmas.

## Types of Learning with MMI

Learning in health care involves the ability to transfer knowledge from didactic courses to pre–clinical, laboratory or clinical settings for optimum patient care.[17] Many studies evaluating the use of MMI in health care have concentrated on attainment of knowledge and/or skill.[17–21] The key to designing a learning activity is to cognitively engage the learner to think about the meaning and relevance of the material presented, its application and the various contexts to which it can be applied. Essential components of optimal practice include the retention of knowledge and/or skill throughout the program and into professional practice.

The design of MMI programs to educate health care students is typically created to measure and compare the effectiveness of the program as a supplement or replacement to traditional teaching strategies.[17–19,21–23] However, outcomes from such studies present inconsistent findings that need to be explored further. After reviewing the literature, it appears that MMI may be more beneficial when used as an adjunct to traditional pedagogies for promotion and attainment of knowledge and skills. Also, other forms of teaching strategies may be more effective and have greater gains in learning with the use of MMI, such as simulation–based programs. In addition, the acquisition and retention of a skill seems to have greater potential following the administration of MMI.

### Attainment of Knowledge

The evidence is inconsistent as to whether MMI leads to gains in knowledge for didactic instruction in health care education. Much of the literature did not find significant differences. However, it demonstrated equal gains between the groups involved in MMI compared to those in traditional learning situations. With the impending dilemma of dwindling numbers of faculty members in health care, this may also be a positive outcome. Using MMI as an adjunct to the lecture, one study found significant gains in knowledge in health care students, while a second study had similar results using self–instruction.[24,25] Other researchers, on the other hand, found no difference in knowledge gained. Finally, 2 studies found the students in the traditional learning groups to have significant improvement in knowledge over those participants in MMI groups.[18,26–29]

A team of researchers examined the effectiveness of MMI to supplement a lecture for diagnosis of endodontic issues.[24] A pre–survey to measure knowledge was administered to dental students prior to the lectures. The participants were randomly assigned to 1 of the 3 groups: lecture and exposure to MMI containing case situations, lecture and participation in a seminar group containing identical cases for the same time period and lecture only. Analysis of the identical post–survey revealed the students in the computer–simulation program scored significantly higher in knowledge than the other 2 groups. There was no difference between the seminar group and the control group. A second group of researchers integrated virtual patients, designed as a web–based program, into a classroom of dental students.[30] The research concluded that there was no difference in the group using the virtual patient led by an instructor opposed to the group using the virtual patient independently. Kleinert et al integrated a virtual patient with Down syndrome into a dental course.[31] A significant difference upon completion of the program was based on a pre– and post–knowledge test.

While most studies have used MMI as a supplement to traditional pedagogies, 2 studies found a significant difference in knowledge using only self–instruction. The first study compared a group of dental students using an electronic tutorial to previous dental classes using lectures in a classroom and microscopes in a laboratory.[25] The tutorial used images of the histological slides and the existing lecture material in the form of figures and text with access to microscopes. A comparison of 2 sets of test scores found those participants using the electronic tutorial to be significantly higher than the

scores of previous students exposed to traditional instruction. DeBate et al determined that a web–based training program on various aspects of eating disorders in dental patients increased the knowledge of students and clinicians.[32] The program used text, graphics and videos to meet objectives that are both knowledge and skill based.

Studies that have found MMI to be equally as effective as traditional methods include Aly et al.[18] The MMI contained a tutorial of interactive programs in orthodontics. Each program contained graphics, text and self–assessment components and could be viewed as often as needed. The teaching objectives were identical for both groups and pre– and identical post–surveys were administered to the students to measure changes in knowledge. Williams et al also found no difference in knowledge between the MMI and conventional learning based on the results of pre– and identical post–surveys.[26] Students were assigned to a traditional lecture or worked independently with a CD–ROM. Both groups used identical time, learning objectives and case materials.

Another example of MMI found to be equally effective as lecture in attainment of knowledge was a study conducted in a science course for health care students. The treatment conditions consisted of lecture only, interactive MMI and lecture and the interactive MMI, lecture and an enhanced learning system.[27] The MMI consisted of an existing interactive videodisc including sound, text, computer graphics and videos. The enhanced learning system was the interactive videodisc with prompts that required students to make a list of unfamiliar words before moving on.

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 designed and implemented. Several researchers indicate that knowledge attainment may be better achieved by traditional teaching methods. For example, one study found 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.[28] A second study also concluded that the attainment of knowledge is best accomplished in a didactic setting without the aid of MMI.[29] There was a significant increase in knowledge in the didactic group for the post–survey over the videotape or computer–based groups.

**Attainment of Skill**

MMI may prove to be beneficial for other modes of learning, such as acquisition of a skill. 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, MMI gives a bird's eye view of a procedure, guaranteeing that each student observes the identical procedure as another student. Use of MMI in simulated experiences offers an opportunity to visualize a process or procedure before the actual first encounter. This provides the potential to increase cognitive knowledge and analyze and apply the information to a situation.

Several studies used MMI as an adjunct to traditional pedagogy to enhance acquisition of a skill.[19,20,33] When combining the MMI with the lecture, these researchers found the experimental groups to have a higher level of skill than the didactic groups. Several studies found using a multimedia approach that required involvement and interaction by the student and employed the use of problem solving to yield greater learning.[17,26,33] Conversely, the outcomes attained from other researchers indicated equal attainment of skill between MMI compared to conventional pedagogical methods.[18,21,29]

Educators acknowledge the common challenge of students to apply information from the traditional dental classroom setting to a clinical dental procedure. One study designed a video to address the issues.[19] Those using the video scored significantly higher on the practical examination compared to the class with traditional learning in the classroom and lab. The video was a detailed instruction of a crown preparation and placement, followed by a group demonstration and independent practice on a mannequin. Students could view the video as many times as needed. The outcome was compared to the class of the previous year and found the video group to have better performance.

Finding a significant improvement in skill, a group of researchers used MMI as a tutorial to educate the student on information related to blood pressure and obtaining a reading.[20] In this study, nursing students were assigned to 1 of 3 groups: CD–ROM only, instruction only and a combination of both. The CD–ROM incorporated text, animated graphics, photographs and video. The objectives of the instructional methods were identical.

A significant increase in application of knowledge in a clinical setting was noted by Boynton et al when using MMI to complement the traditional lecture.[33] The dental students in the control group received lectures on child management behavior. The experimental group received the same lectures, as well as completing the web–based instructional tool. The identical exam tested knowledge and application of the material. The MMI used a text–based description of the situation that required the student to select the appropriate action, providing immediate feedback.

Another researcher reported a significant difference in interactive MMI using problem solving compared to the program that replicated a lecture.[17] One treatment group consisted of a multimedia tutorial that was didactic in nature, using text and images in a structured way. The second multimedia tutorial involved case–based teaching sessions that required more interaction with the program and application of learning to a clinical scenario. Integration of

questions throughout the case forced student involvement. In order to continue with the program, the student must answer each question correctly. The third multimedia format, requiring the greatest involvement, was the free–text version involving a series of open–ended questions in which the answers were compared to those of the author. A correct response allowed the student to continue. Learning objectives for each group were identical. Hudson concluded that all groups significantly improved in their ability to apply the information, with the "free–text" version reporting the greatest gains and the control group showing the least.[17] The free–text group showed significant improvement compared to the control group, but not when compared to the other treatment group.

Williams et al also reported a significant difference in the ability of medical students using video–clips of counseling patients with anxiety compared to those using a traditional format.[26] The MMI group used video clips of case–based material supplemented with text to describe key information. The student viewed the video clips to assess and diagnose the existing problems. Following the intervention, an existing tool was used to evaluate the students' ability 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 of success since recognition of even one more clinical sign of anxiety is beneficial for patient care.

However, one study found that dental students using MMI along with lecture scored similarly in exposing and developing radiographs to those attending the lecture.[21] Summers et al found no difference with any mode of instruction assessing practical skills at the post–test.[29] These authors implemented a computer–based program and video on basic surgical skills using identical pictures, text and audio. The students were divided into lecture, video or computer–based training. A third study also found no difference between a group of dental students receiving MMI compared to those receiving the traditional classroom instruction for working with orthodontic appliances.[18] Although each of these studies found no significant difference, the results indicate that the effects of the pedagogical strategies were equivalent. In other words, MMI was just as effective as the traditional methods. In each of these studies, recommendations for future research in the use of MMI for acquisition of a skill were made.

**Retention of Knowledge**

A third category of learning identified in the health care literature is retention of knowledge. Many studies recognize a need to measure retention of knowledge. For example, Boynton et al mentioned the possibility of measuring retention of knowledge using a computer–based simulation for behavior management of children in a dental environment.[33] 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. A second study 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.[21] Further, a third study discussed the need to identify the value MMI may have on retention of psychiatric knowledge and skills as a possibility for future research.[26]

One study reported no difference in the interactive MMI compared to a didactic approach to retain information 2 weeks after the intervention.[17] However, a study by Summers et al was not as promising, and found that there was a significant increase in knowledge in the didactic group 1 month following intervention compared to the computer–based and video groups.[29] Both studies measured knowledge using an identical pre– and delayed post–test. These outcomes indicate that additional research is needed in the area of MMI and retention of knowledge of health care students.

**Retention of skill**

Retention of a skill is the final area of investigation into MMI. A unique aspect of health care education includes the performance of a skill at a competent level for the student to successfully graduate. Only 1 study was found that evaluated this measure. Although there was no difference in performance of a skill at the post–test, Summers et al reported a significant difference utilizing MMI for overall performance of basic surgical skills following the delayed post–test.[29] The students assigned to the videotape and computer–based groups scored significantly higher on a technical skill compared with the didactic group 1 month following the intervention. The treatment group exposed to the computer–based program showed similar scores to the video group with each group performing the skill at a faster rate. This study concluded that the use of MMI may provide long–term enhancement of students' skills.

Health education is plagued with the problem of retention of knowledge and transferring the information to practice. However, limited and inconsistent evidence exists regarding the effectiveness of MMI toward enhancing retention of skill.

## Multimedia Instructional Design

Research in health care related to MMI can often be categorized into 2 instructional designs: tutorial–based and simulation–based or case–based. While most studies have dealt with the effectiveness of MMI in the classroom, little has been reported utilizing a clinical setting or simulated experience.

**Tutorial–based MMI**

Tutorial–based MMI allows the student to work independently on the course material for acquiring knowledge and/or skill. These programs often imitate the original

lecture. Inconsistent findings are reported from research using tutorial–based MMI that is more didactic in nature in health care courses. Three studies reported significant differences when using a tutorial–based MMI. The outcomes of a pilot study using a web–based program revealed significant improvements in knowledge on treating dental patients with eating disorders.[32] A limitation to this study, however, was that it was non–experimental and did not have a control group. Rosenberg et al found a significant difference in knowledge with implementation of a self–instructional electronic tutorial as an adjunct to the lecture for a histology course for dental students.[25] Similarly, a third study found that use of a self–instructional CD–ROM program alone showed improvement in skill over lecture alone.[19] The researchers surmised that the visual presentation offered by the CD–ROM and learning at their own pace in a safe environment contributed to these outcomes.

While some research has shown significant effects of tutorial–based MMI on gaining knowledge and/or performance of a skill, other studies have found it to be equivalent to traditional methods. For example, one group of researchers found no difference between a group of dental students receiving interactive MMI compared to a group receiving the traditional classroom instruction.[18] Students were expected to assess and diagnose the orthodontic status of given dental patients. To enhance the learning in science instruction, a second study also found no difference between 3 treatment groups in the post–test scores.[27] In both studies, there was no difference in knowledge attained or application of the information, with outcomes to support that the use of MMI is as effective as lecture.

**Simulation–based MMI**

MMI presents an opportunity for simulations of clinical situations. The research in health education reports the potential for simulations to create higher–quality learning environments, enhance students' clinical problem–solving skills and meet diverse subject and student needs.[17,21,24,26,33] Simulations can be designed to guide students toward diagnosis and management of health problems. Simulations also create a visual opportunity to view the performance of a skill by an expert, allowing the student to view the MMI as often as needed.

The following studies report that simulations using a multimedia medium permit the student to apply the information by engaging the learner. An example was reported by Boynton et al in which the learning acquired from an Internet–based instructional tool that simulated the behaviors of children during dental treatment were compared to a traditional learning experience.[33] The simulation group had a significant improvement in test scores over the control group. When compared to those in the control group who had completed a real–world experience in a clinical rotation, there was no significant difference in performance to those in the simulation group with virtual experience. Therefore, using simulations prior to a clinical experience may provide an effective clinical experience. Researchers in a second study found the MMI group of medical students had similar gains in knowledge, but scored significantly higher than the traditional group when identifying and treating anxiety.[26] Kleinert et al reported significant gains in knowledge using a virtual patient in an interactive MMI for dental students to practice care on special needs patients.[31] The module incorporated points in which the student needed to make a decision regarding treatment and care of the patient.

A similar study showed a significant difference in the ability to diagnose endodontic problems using a computer–simulation program compared to groups receiving a small–group seminar and a third group receiving no additional instruction.[24] Both the computer–simulation program and the small–group seminar contained similar patient simulations. Those in the computer–simulation program were able to cover more simulations in the same 1 hour session as the small–group seminar.

Using a different approach, Hudson reported a significant difference when utilizing MMI that required a greater level of involvement by the student.[17] Three self–directed multimedia programs (repeat of a lecture and 2 versions containing case scenarios, differing only in magnitude of interaction) were implemented to measure the impact on the retention of knowledge and application of information of medical students.

One study found no difference in the quality of radiographs of dental students utilizing a simulation–based MMI integrated into a lecture when compared to the traditional teaching methods.[21] Although the MMI was deemed as effective as traditional instruction, Howerton et al questioned the time it took to design, develop and implement the multimedia program.

In summary, the studies implementing MMI to measure learning in both the tutorial–based and simulation–based or case–based components of health care education have consistently used the same learning objectives with a comparison of MMI to traditional teaching pedagogies. Several studies converted the materials used in the traditional classroom to a self–directed MMI while other research used existing software programs.[18,33,34] Further, the research on MMI in health care is often measuring independent adult learners from an academically homogeneous population without embracing the direction of theory, therefore, reaching conclusions that may be data–driven as opposed to theory–based. Future research that is based on a theoretical framework with a focus on existing studies and their limitations will be more robust.

## Future Direction for Research and Education

Much is yet to be learned regarding MMI in health professions education. A review of the health care literature suggests MMI is equivalent to or more effective than traditional learning environments for application of the material, knowledge attainment and skill acquisition.

No study measured the retention and application of knowledge following MMI once the student was working as a practicing health care provider. Retention of information may not change much in the same evaluative period, such as a 15 week semester, but may diminish over several months. A suggestion for future research emerged from many studies citing a need to study the effects of MMI over a longer period of time. It would be productive to explore the knowledge and/or skill at several points during the student's academic program and after graduation while working as a health care professional.[21]

Regardless of the outcomes of the study, each researcher favorably described the value of MMI in health care education, citing a need for further research before universal integration of this technology into the curriculum.

## Conclusion

The use of MMI in health professions education has been a popular pedagogical strategy that may be equal to or more effective than traditional instructional modalities for attainment of knowledge, skill and performance. Health care education today places much emphasis on developing and implementing pedagogical strategies that foster the development of students' critical–thinking abilities and transfer of knowledge from the classroom to clinical situations. The challenge for future research on MMI is the need to concentrate on development of learning environments that are specific to the discipline of dental hygiene.

Table I: Definitions of Education Terms

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| 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 self–directed, self–paced, and interactive |
| Critical thinking | higher–level thinking and reasoning abilities |
| Didactic | instructive |
| Epistimology | the study or a theory of the nature and grounds of knowledge; constructing knowledge |
| Learning environments | a coherent curriculum and a suite of technologies to support teachers and students in learning, instruction, and assessment15 |
| MMI | implementing a variety of digital media into instruction, the use of computer technology for supplementing the distribution of course content with that of traditional methods13 |
| Pedagogy | teaching |
| Retention of knowledge | the ability of the student to remember information following an assessment or evaluation of the material, such as weeks or months later |
| Simulation–based MMI | MMI that allows the student to work independently or as a group on a clinical situation, which can be designed to meet diverse subject and student needs without fear of harm to the patient; requires application of information |
| Tutorial–based MMI | MMI that allows the student to work independently or as a group on the course material for acquiring knowledge and/or skill |
| Traditional teaching strategies | conventional pedagogical strategies for student learning; often teacher–centered and involves passive learning; examples include lecture and use of a textbook. |

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