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Developing & Evaluating Collaborative Medical Physics Module for the First Year Medical Students at College of Medicine & Medical Sciences, Arabian Gulf University Kingdom of Bahrain

تطوير وتقييم التعلم التشاركي في تدريس حزمة تعليمية تفاعلية في الفيزياء الطبية لطلاب السنة الأولى في كلية الطب والعلوم الطبية بجامعة الخليج العربي، مملكة البحرين

Ismail, A.M.A.

العجب محمد العجب اسماعيل

Ass. Prof. of Instructional Design,

Distance Education & Physics Education

Arabian Gulf University-Kingdom of Bahrain,

P.O.Box. 26460, Manama, K. of Bahrain, Tel. + 973 17 239534

E-Mail: alagabm@agu.edu.bh

Abstract: Collaborative learning is emerging as an important learning method. It is an educational approach for teaching and learning; that involves groups of learners working together to solve a problem, complete a task, or create a product. This paper describes a comprehensive approach in collaborative inquiry of medical physics at College of Medicine & Medical Sciences (CMMS) Arabian Gulf University (AGU). The collaborative module comprises: an interactive medical physics WebCT virtual learning environment that provides students with shared workspaces for coordinating and recording their collaboration in scientific inquiry; inside and outside field visits carried out collaboratively by each subgroup and the tutor. Medical physics diagnostic and application dialogue (learning problems) and Web-based materials are designed to match and enrich the module. The individual and group assessments given to students guide their learning process, and help them to scientifically report and evaluate their collaboration inquiry experiences. The main aim of this work was to redesign the medical physics module at the AGU and contribute in shifting the learning process from a teacher-center to a learner-center activities and support learner-learner interaction, learner-content interaction, and learner-tutor interaction to a degree that facilitate deep learning and fulfill satisfaction with learning. The results indicate that collaborative learning enabled the participants to communicate easily with their teachers (resource people, tutors and professors) and their peers searching for answers for themselves. In addition, the participants were able to assess their own expertise, resulting in the enhancement of knowledge, skills, attitudes and satisfaction with learning. Concerning achievement in medical physics; data analysis results revealed no significance differences related to treatment type (collaboration, no collaboration) or the gender of the experimental group participant`s (male, female). A remarkable result was that participants who were taught through collaborative approach scored significantly more gain in achievement (M = 15.1289, SD = 16.84061) than the control group that did not use collaborative approach (M = 6.1225, SD= 21.26310), t(290) = -4.023, p < .05. i.e. collaborative approach for teaching medical physics prove its strength in empowering subjects gain development in achievement. Further research on more courses is needed to cross-validate the study findings and generalize the results. Attached an appendix titled "X-Ray and Medical Diagnostic Dialogue".

Keywords: *Collaborative Learning; Blended Learning, Learning Management System; Medical Physics; Satisfaction with learning, and Attitudes towards Medical Physics*.

المستخلص: يعتبر التعلم التشاركي من التربويات المهمة والشائعة الاستخدام بالجامعات ودور التعليم العالي. وهو تلك العملية التعليمية التي تتم في وجود مجموعة صغيرة من المتعلمين يعملون معا من أجل حل مشكلة ما، أو إكمال مهمة، أو إعداد منتج يتعلق بمجال تعلمهم. توضح هذه الورقة نهجاً شاملاً لتقييم تجربة التعلم التشاركي في تدريس حزمة تعليمية تفاعلية في الفيزياء الطبية بجامعة الخليج العربي. تمثلت مكونات الحزمة التشاركية من: بيئة الفيزياء الطبية التفاعلية المصممة إلكترونياً على بيئة التعلم WebCT التي توفر للطلاب إمكانية مشاركة المصادر التعليمية وتداولها فيما بينهم، وتمكنهم أدواتها من تنسيق وتسجيل مشاركاتهم المتعلقة بأداء المهام التعليمية وفق الطريقة العلمية؛ الزيارات الميدانية واللقاءات التي تتم داخل وخارج الجامعة بصورة جماعية والحوارات بين كل مجموعة صغيرة مع مدرسيهم والمختصين؛ وحدة الفيزياء الطبية التشخيصية والتطبيقات (مشكلات التعلم) والمواد المستندة إلى الإنترنت والمصممة لمساندة وإثراء الوحدة التعليمية؛ والتقييمات الفردية والجماعية التي تعطى للطلاب لمساعدتهم وتوجيه تعلمهم؛ بحيث يقدم الطالب تقريراً علمياً وتقييماً لخبراته التي أكتسبها بطريقة تعاونية. إن الهدف الرئيس من هذا العمل هو تحويل عملية التعلم وإعادة تصميم دروس الفيزياء الطبية بجامعة الخليج العربي وجعلها متركزة حول المتعلم وملبية لمتطلبات التفاعلات التعليمية المتمثلة في: التفاعل بين المتعلم والمتعلم، والتفاعل بين المتعلم والمحتوى، والتفاعل بين المتعلم والمعلم، والتي تسهم بدورها في تحقيق التعلم العميق. أكدت نتائج الدراسة أن التعلم التشاركي سهل عمليات التواصل بين المشاركين ومكنهم من تبادل الخبرات التعليمية وعزز من تواصلهم مع معلميهم (مختصي المصادر، والمدرسين ومعاونيهم من الأساتذة)، وأقرانهم في البحث عن الإجابات بأنفسهم للمشكلات التعليمية. بالإضافة إلى ذلك، وفرت التجربة للمشاركين إمكانية تقييم خبراتهم الخاصة، مما أدى بدرجة متوسطة إلى تعزيز المعارف والمهارات والاتجاهات الإيجابية والرضا عن التعلم لديهم. لم تكشف نتائج الدراسة عن فروقات في التحصيل ترد لطريقة المعالجة (تعلم تشاركي – تعلم تقليدي) أو جنس المشارك في المجموعة التجريبية (ذكر، أنثى)، والجدير بالملاحظة توصل نتائج الدراسة إلى ان المشاركين الذين درسوا من خلال التعليم التشاركي سجلوا مستوى من الكسب في الإنجاز عال وذا دلالة إحصائة مقارنة بما سجله رصفائهم الذين درسوا بالطريقة التقليدية؛ بالنسبة للمجموعة التجريبية (15.1289M= ،SD = 16.84061)، أما بالنسبة للمجموعة الضابطة التي لم تستخدم التعلم التشاركي (M = 6.1225 ، SD = 21.26310)،ت (290) = - 4.023 ، دالة عند مستوى 0.05. أي أن استخدام التعلم التشاركي في تدريس الفيزياء الطبية أثبت جدواه في زيادة مستوى الكسب للمشاركين فيما يتعلق بالتحصيل والإنجاز. هناك حاجة إلى مزيد من البحث والتقصي وتطبيق التعلم التشاركسي على مزيد من المقررات الدراسية بغرض مزيد من الضبط للتحقق من نتائج الدراسة وتعميمها. مرفق ملحق بعنوان "X-Ray and Medical Diagnostic Dialogue" .

كلمات مدخلية: *التعلم التشاركي؛ نظام إدارة التعلم (LMS)، التعلم المدمج، الفيزياء الطبية؛ الرضاء عن التعلم، والإتجاه نحو الفيزياء الطبية.*

Introduction

Medical physics is one of several disciplines that have emerged from the growing interaction between physics and biological sciences. Other such disciplines include biophysics, biomedical engineering, and health physics. Although the boundaries between these fields are by no means distinct, as a general guide, one may broadly state that biophysics concerns the use of physics in study of basic biological mechanisms. While biomedical engineering concerns with development of new diagnostic instrument and prosthetic devices, health physics concerns with measurement of physical quantities that are related to environmental contaminants, especially ionizing radiation.

The field of medical physics may be defined broadly as «applications of physics in medicine» and as such incorporates these other fields to the extent that they involve medical applications. Martin (1990) mentioned that a simple definition of medical physics can be physics applied to medicine, which then leads to the following question, what is medicine? No doubt, any successful medical practices should include the three stages; examination, diagnosis, and treatment. Physics is needed and used in all three stages of medicine. For example the examination of the human body in health and disease is a task curried out by the physician and the physicist. That accounts for the similarity of the names, coming from the Greek *physike*, the science of nature. The American Association of Physics in Medicine (AAPM) emphasized the role of medical physicists as follows: AAPM (2009) states "*medical physicists contribute to the effectiveness of radiological imaging procedures by assuring radiation safety and helping to develop improved imaging techniques (e.g., mammography, CT, MR, ultrasound)*".They play a central role and contribute in the development of therapeutic techniques (*e.g*., prostate implants, stereotactic radiosurgery), collaborate with radiation oncologists to design treatment plans, and monitor equipment and procedures to insure that cancer patients receive the prescribed dose of radiation to the correct location.

The focus of the current paper is to explore how the systematic approach of instruction-based on the ASSURE model proposed by Heinich; Molenda; and Russell (1989) was utilized for development and evaluation of collaborative medical physics module in the pre-medical year at the Arabian Gulf University (AGU). The components of the proposed collaborative module included: the interactive WebCT course material, the individual and group learning activities, medical physics diagnostics and applications dialogues and the individual plus the group assignments. The development activities were guided and based on the directions of learning driven from the cognitive-constructivism learning theory, concerned with how the individual learner makes sense of the materials presented to him. The social- constructivism learning theory emphasizes the humanistic side of learning and how learners create meaning from social interactions (Dale, 1991; Anderson, 2005; and Vygotsky, 1978); the motivational theories which suggested three steps in motivating behavior effort, improved performance and rewards (*Herzberg, Mausner & Synderman, 1959)*; and Vroom, 1964). The directions driven from these theories were considered when developing the collaborative medical physics learning material in a systematic and interactive manner that helps medical candidates to learn collaboratively and interactively. The basic assumptions about instructional design considered during the development phase proposed also by Gagne (1985).

Medical physics program (AGU, 2005) is limited to a three credit hours` course "PHY 2313-module" taught at the pre-medical phase. This course is designed to focus into two fundamental aspects of modern medicine: how physical principles and laws explain the underlying mechanisms of functions in the human body and how medical technology use principles of physics to design medical devices that are increasingly playing a central role in diagnosis of diseases.

The scientific contents of the module seeks to explain not only perception of sound, sight, touch and taste, but also their metabolic processes that convert food into energy and other human activities. The content of the module was divided into three parts: introduction to medical physics module, physics "PHY 2313" full course schedules and module learning objectives. Any candidate registered for the course is advised to get a copy of Physics in Biology and Medicine authored by Paul Davidovits (2001) which is considered as a main reference for the module.

LITERATURE REVIEW

Potential of Collaborative Learning in Medical Physics

Regardless of the subject matter, research reported that; students working in small groups tend to learn more of what is taught and retain it longer than when the same content is presented in other instructional formats. For example; Barbara (1993) mentioned that students learn best when they are actively involved in the process. Springer L, *et. al.,* (1998) did a meta-analysis of research about the effects of cooperative learning on undergraduates in science, mathematics, engineering, and technology. The results showed that various forms of small-group learning are effective in promoting greater academic achievement, creating more favorable attitudes toward learning, and increasing persistence of knowledge in sciences, mathematics, engineering, and technology courses and programs. Hake (1998) compared an interactive-engagement *vs*. traditional methods in an introductory physics course. The conceptual and problem-solving test results strongly suggested that the classroom use of the interactive engagement methods can increase mechanics-course effectiveness well beyond that obtained in the traditional one.

Conceptual thinking skills and problem solving abilities are important factors for medical school applicants as diagnosis and treatment procedures strongly depend on these skills. The work of Blakely *et. al*. (1999) examined the changes in pre-medical students' conceptual thinking and problem solving abilities. The study was conducted for eight weeks among voluntary educationally disadvantaged post baccalaureate students. The results of study revealed that the problems solving strategies gained by the students through the course were immediately transferable in other academic context, as an average change in students' scores on the test of about 0.7 was reported.

In their study of the undergraduate teaching of ideal and real fluid flows, Baldock & Chanson (2006) described the pedagogical impact of real-world experimental project undertaken as part of an advanced undergraduate fluid mechanics subject at an Australian university. The projects have been organized to complement traditional lectures and introduce students to the challenges of professional design, physical modeling, data collection and data analysis. The overall pedagogy was a blend of problem-based and project-based learning, which combined academic research and professional practices. The assessment was a mix of peer-assessed oral presentations and written reports, the aim was to maximize student's reflection and development. The students' feedback indicated a strong motivation for courses that include a well-designed project component.

Physics as a subsidiary subject has to match very different objectives and cope with a variety of students' learning conditions. As a targeted goal Theyben (2007) developed a lab-work course in physics for medical students based on research outcomes of experts' surveys and investigation on the learning processes during lab-work. Evaluation results proved the adequacy of the newly developed concept. Subsequently related to the new lab-work course; a hypermedia learning environment (HML); was developed and implemented in physics education for medical students.

Nielsen *et. al*. (2009) investigated students' meta-cognitive engagement in both out-of-school and classroom settings, by participating in an amusement park physics programmme. Their results provided signposts of the students' meta-cognitive engagement during group problem-solving at the park and physics learning tasks in the classroom. In both cases, evidence of individual students' deeper understandings, which was manifested through students' cognitive and social behaviors, demonstrated the invocation of meta-cognition to varying degrees. The novel physics problems tackled by the students created situations where discrepancies between their prior knowledge and the direct experiences enabled them to explicate their thinking through dispositions of behavior.

Reiner (2009), described the results of an empirical study in physics learning, aimed at exploring links between sensory input, visual representations, and corresponding conceptual learning in physics. The central finding was that through sensory interaction (touch, vision) with a physical system in the physics laboratory, learners spontaneously generate a novel reference-system of pictorial representations typical to the situation explored. Results showed that in collaborative hands-on problem-solving in physics, a pictorial referential communication system is generated. Elements of the pictorial communication system were found to be one of three: photographic, metaphoric, or symbolic communication. It is powerful because it allows access and retrieval of tacit knowledge, inaccessible by symbolic interaction.

Research Aims and Questions

This study was developed to explore the possible effects of integrating WebCT virtual learning environment, internet resources and the small group activities for developing and evaluating a collaborative medical physics module at AGU. In specific, the study is going to show how can the systematic approach for designing instruction be utilized for developing a collaborative medical physics module at the Arabian Gulf University, College of Medicine and Medical Sciences, and then assess the proposed material on the first year students at AGU who study medical physics as well as their use of the online resources and the field visits for learning collaboratively. The main question addressed by the present study is: "What are the effects of the proposed systematic collaborative medical physics module on Arabian Gulf University first year students at College of Medicine and Medical Sciences learning outcomes?"

Emerging sub-questions are the following: What are the components of the proposed collaborative medical physics module like? How can the systematic development, utilization and evaluation of the proposed collaborative module take place? What are the effects of the proposed collaborative learning approach on AGU first year students' achievement in medical physics? To what degree did the collaborative learning motivate the participants to favorable learning outcomes and enhance their attitudes toward medical physics? What is the participants overall evaluation for the collaborative learning experiences in medical physics?

Rationale for the Study

The beauty of collaborative learning is that it might be practiced in a number of ways. Collaborative exercises can be practiced as whole-class events; they might also be done in small groups, presented in traditional class settings or blended into other information technology-based environments such as WebCT or Blackboard. Some collaborative exercises work best with pairs, in particular those exercises that require close attention (such as sharing whole essays and group discussions). Other collaborative exercises work best when learner or trainers need to receive multiple points of view (for example, when the aim of the exercise is to narrow a topic or a learned problem, sharpen a thesis, and so on). Whatever you decide, it's important to remember that the learning activities and the group exercises should be carefully designed and planned so that they reflect your goals and meet your learners' needs such as in mini-problems developed by the resource persons at AGU college of medicine & medical sciences for fitting the missing learning gaps in the Problem Based Learning activities (PBL). In a collaborative learning activities, the tutor doesn't necessarily, have to design the exercises on his own, sometimes (as in collaborative assessment exercises) he may want to design the exercise with his students and trainees.

Limitations of the Study

The author chose only an introductory medical physics course at the university level to implement the collaborative learning experience. The research activities mainly focused on the systematic development of the proposed collaborative learning material by utilizing a learning management system tools (i.e. WebCT learning environment). The learning outcomes under assessment are both quantitative i.e. (achievement) and qualitative (motivation to learn, attitude toward medical physics, satisfaction with the learning experience and suggestions for farther improvement). Generalization in any similar learning context and variables under investigation may be possible.

Definitions of Terms

The present study addressed the following terms:-

i. Collaborative Learning: Collaborative learning is a situation in which two or more people learn or attempt to learn something together (Dillenbourg, 1999). In the present study collaborative learning refers to the teaching/learning method used for delivering the medical physics module contents to the participants.

ii. Learning Management Systems: Learning Management Systems (LMS) is a context that gives collaborative learning particular meaning. In this context, collaborative learning refers to a collection of tools which learners can use to assist, or be assisted by others. Such tools include Virtual Classrooms (i.e. geographically distributed classrooms linked by audio-visual network connections), chat, discussion threads, application sharing (e.g. a colleague projects spreadsheet on another colleague's screen across a network link for the purpose of collaboration), among many others.

iii. Medical Physics: Medical physics refers to the application of physics to medicine. It generally concerns physics as applied to medical imaging and radiotherapy, although a medical physicist may also work in many other areas of healthcare. A medical physics department may be based in either a hospital (like SMC) or a university (like AGU) and its work is likely to include research, development, and clinical healthcare. Medical Physics uses physical tools, including optical and ionizing radiation, ultrasound, lasers, thermal and magnetic technologies, in the diagnosis and treatment of disease. The high technology equipment used in diagnostic and therapeutic applications is often designed and maintained by medical physicists (AL-Kairm, 2011).

iv. Satisfaction with learning: Satisfaction is ''the pleasure or contentment that one person feels when she/he does something or gets something that she/he wanted or needed to do or get'' (Collins Co build English Dictionary, 1999). Satisfaction with learning refers to the measure used of degree of subject.

v. Blended Learning: Refers to any combination of traditional teaching methods and others e-learning delivery formats (Osguthrope and Graham, 2003). Blended learning can also be defined as: the use of an electronic learning tool e.g. Virtual learning environment -VLE to supplement the face-to-face learning.

In the present study blended learning refers to the situation in which internet resources, course material, field visits and face-to-face classes are blended together for teaching the medical physics course to AGU first year medicine and medical sciences students so as to help them in learning the physics behind the clinical diagnostic & applications related to their scientific fields.

Methods & Procedures

This research aims to explore the development and evaluation of a proposed collaborative medical physics module at the Arabian Gulf University College of Medicine and Medical Sciences and test the effects of the module on first year students' performance, attitudes toward medical physics and their opinions on collaborative approach for teaching & learning medical physics. To achieve the study goal/goals, the author systematically designed the needed collaborative learning material and planned the most suitable procedures and learning activities. The procedures adopted for the study demonstrated in this section will cover the following topics: the research method, the study's population and sample, the study variables, instruments, the WebCT (online component) of the collaborative medical physics module and the statistical techniques for analyzing the collected data.

THE RESEARCH METHODOLOGY

To achieve the purpose of the study, the author adopted the developmental research method for developing the collaborative medical physics module, utilizing the material for teaching medical physics and testing the effects of the independent variable "collaboration approach" on the subjects learning outcomes (dependent variables) Developmental research, as opposed to simple instructional development, has been defined as the systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness (Richey Rita,1994). There are three types of developmental research; the most common types of developmental research involve situations in which the product-development process is analyzed and described, and the final product is evaluated. A second type of developmental research focuses more on the impact of the product on the learner or the organization. A third type of study is oriented toward a general analysis of design development or evaluation processes as a whole or as components. In this study the second type of developmental research was utilized so as to systematically develop the proposed collaborative module in medical physics and test its impacts on AGU first year's students learning outcomes.

To fulfill the goals and answer the study questions two groups of medical physics at AGU was assigned to participate as experimental and control groups in the present study. The first year students who registered for the medical physics course at AGU college of medicine and medical sciences during the academic year 2005/2006 who were taught the course material traditionally was assigned as a control group, while the experimental group was composed of the students who were taught the medical physics course by using the proposed collaborative approach during the academic year 2006/2007. Control and experimental group grades in medical physics final exams were adopted for testing the effects of the proposed collaborate approach on subjects` performance, on the other hand an attitude scale towards medical physics and open ended satisfaction with learning questionnaire were adapted and administrated at the end of the course on random representative sample of the experimental group (around 30 participants) for testing the participants satisfaction with the collaborative learning experience on medical physics.

Population and Sample

The study was conducted in the College of Medicine and Medical Sciences' at the Arabian Gulf University- Kingdom of Bahrain. The first year students who registered for the Medical Physics (PHY231) course during the academic years, 2005/2006 were 147 candidates and so for 2006/2007150 candidates. Any of the first year candidates at the Arabian Gulf University, College of Medicine and Medical Sciences would have the following characteristics as they are required for the admission and to continue studying in the college:

- Must be a citizen of one of the GCC States which are The United Arab Emirates, the Kingdom of Bahrain, the State of Kuwait, the Kingdom of Saudi Arabia, the State of Oman, and the State of Qatar. Only a limited number of students who are from other Arab nations who are residing in the GCC can be accepted for a certain fee.
- Should have a secondary school certificate (scientific section) or the equivalent from the current year or the previous year at most and have a score of at least %95 or 3.75 on the four-point scale.
- The age of the applicant must not exceed 20 years.
- The applicant must fill out the application form for admission and provide all the required information and documents.
- The application for admission is to be gotten from the Ministry of Education or Ministry of Higher Education in the GCC countries and returned to the Ministry after being filled out and providing the mentioned documents and as for applicants from other Arab countries, they are to send their applications directly to the University.

The sample of the study was an accessible population which consisted of two hundred ninety two (n=292) undergraduate students enrolled in "Medical Physics – "(PHY231)" course at the Arabian Gulf University, College of Medicine & Medical Sciences during the first semester of the academic years 2005/2006 (142 students) and 2006/2007(150 students). Ninety-eight of the participants were male (%33.60) and one hundred ninety four (194) were female (%66.4). The participants' age ranged from 17-20 years. Table (1) represents the distribution of the sample according to gender factor.

It is worth mentioning that the sample

Table 1. Sample Distribution According to Gender*

	Sample	Frequency #	Percent %	Valid Percent%	Cumulative Percent%
Valid	Male	098	%33.6	%33.6	% 33.6
	Female	194	% 66.4	% 66.4	%100
	Total	292	%100	%100	

*Source: AGU Admission & Registration Procedures for College of Medicine and Medical Sciences, (Available at: http://www.agu.edu.bh/english/units/reg_conditions_cmms.aspx).

consisted of students from the Gulf Cooperation Council (GCC) Countries. Table (2) shows the distribution of the participants according to nationality.

Table 2. The distribution of the Participants According to Nationalities*

Country	Frequency #	Percent %
K. of Saudi Arabia	130	% 44.50
K. of Bahrain	088	% 30.10
State of Kuwait	055	% 18.80
State of Oman	013	% ·4.50
State of UAE	003	% ·1.05
Arab Residents	002	% ·0.70
Republic of Lebanon	001	% ·0.35
Total	292	% 100

*Source: AGU Admission & Registration Procedures for College of Medicine and Medical Sciences, (Available at: http://www.agu.edu.bh/english/units/reg_conditions_cmms.aspx).

As shown in Table (2), around %44.5 (130) of the participants were from Saudi Arabia, %30.1 (88) of the sample from Bahrain, %18.8 (55) from Kuwait, around %4.5 (13) from Oman, %1.05 (3) from United Arab Emirates, % 0.35 (1) from Lebanon and% 0.7 (2) from residents Arab.

During their secondary education, the participants had studied general physics, mathematics, basics of computer sciences & information technology and possessed the needed skills to interact with internet (an AGU first year medical student can retrieve his internet resources, download material and print his own copies). In their first semester at AGU they studied a course in computer and information skills and obtained training sessions on how to navigate on AGU learning Management System (WebCT) as users.

The participants were highly motivated to attend classes and possessed positive attitudes toward AGU (the prestigious regional university around the Arabian Gulf). College of medicine administration used to divide each group (patch) into two sub- groups. The experimental group participants who were taught the course during the academic year 20062007/ was divided into two groups, group (A) composed of 80 participants and group (B) composed of 70 participants. To enhance collaboration and problem solving skills and help in creating homogeneous learning communities, each main group was again divided into sub groups of around 810- members.

Medical physics module represents one of the college's basic sciences required courses taught at the premedical phase. The goals of the pre-medical (basic sciences) program at AGU are to prepare students for an innovative medical program by focusing on the knowledge, skills and attitudes, as well as self-directed learning. In the pre-medical phase students take a number of courses in biology; chemistry, physics, English, psycho-social studies, biostatistics, computer skills and Islamic studies). After the student successfully completed the pre-medical phase he/she will be considered for promotion to the medical program.

THE INSTRUMENTS

To collect the study data, the following instruments were used:

1. For the study purpose, subjects' personal information data i.e. (gender, age and nationality) were collected from AGU admission & registration unit.
2. The final tests (exams) in medical physics. This instruments was used for collecting the needed data on subjects achievement (scores) in medical physics (i.e. data was used for assessing the impacts of the proposed collaborative approach on participants achievement in medical physics by comparing the final grades in medical physics for group 20052006/ who study medical physics course in the traditional teaching and group 20062007/ who study the course using the proposed collaborative module.
3. Motivation and attitudes survey scale: Needed to evaluate the effects of collaborative learning on subjects' attitudes towards medical physics and motivation to learn medical physics diagnostics and application. For collecting the attitudinal data, an attitude scale (questionnaire) was developed and administrated at the end of the module on a sample of around 28 participants drown randomly from the experimental group.
4. Personal interview conducted at the end of course. An individual interview with around 10 of the participants was conducted so as to deal with their opinions on the collaborative approach for teaching medical physics,

diagnostics and application.

DATA ANALYSIS

The participants' personal information related (gender & nationality), their medical physics exam grades, and the responses from the attitudes towards medical physics data were coded and entered on a SPSS-17 database. The independent t-test was used to determine the statistically significant differences according to treatment –no treatment /the year of study (20052006/ vs. 20062007/) and the gender factors. Descriptive analysis was utilized to compute the means and standard deviations for the personal information variables and the attitudes towards medical physics items.

RESULTS

1. *The components of the proposed collaborative medical physics module:*

Results related to first question: [What are the components of the proposed collaborative medical physics module?]. Diane (2009) stated that a shared responsibility for learning describes learning as an inherently active process. Learning is an active search for meaning by the learner, constructing knowledge rather than passively receiving it, shaping as well as being shaped by experience. To stimulate an active search for meaning, the faculty must expect and demand student participation in activities in and beyond the classroom, design projects and endeavors through which students apply their knowledge and skills, and build programs that feature extended and increasingly challenging opportunities for growth and development. The collaborative diagnostics and application module developed for the present study, comprises the following components:

(1.1) an interactive medical physics WebCT virtual learning environment: WebCT is a software program that generates a course template. It is especially useful for busy professors, to enable them to create "sophisticated web-based learning environments". The aim behind the module WebCT component is to provide pre-medical candidates with shared workspaces for coordinating and recording their collaboration in scientific inquiry in the field of medical physics and its application to medicine. WebCT can be used as a complete on-line course, with no face-to-face contact, as it was in the WebCT version of Medical Physics (PHY231) module at the Arabian Gulf University (http://elearning.agu.edu.bh:8300/SCRIPT/PHY231/ scripts/serve home) or it can be blended into face-to-face sessions and used as a course supplement. As any other learning management systems, WebCT has a variety of tools, divided into four main groupings (communication, study, personal account information, and quizzes and surveys). For the purpose of this study, the major WebCT's tools selected to facilitate collaborations among the pre-medical students were the communication tools (bulletin board, private mail, calendar of course events, and on-line chat), in addition to icons for the course outlines and course content (Fig.1).

(1.2) the module activities component: This includes activity plans for inside and outside field visits worked out collaboratively by each subgroup of the students and their tutors. The activities were designed to further the students' skills and understanding in the taught subject.

(1.3) Medical physics diagnostic and application dialogues: comprise five diagnostics and applications learning problems and their related web-based materials that match with the module learning objectives and enrich the learning. The dialogues covered the topics of X-ray techniques, Ultrasound imaging, Doppler ultrasound, CT-Scan Imaging, and Magnetic Resonance Imaging (MRI). Appendix (1) shows a typical diagnostic and application dialogue format in X-ray techniques.

(1.4) The individual and group assessment: designed to guide pre-medical students learning process, and help them scientifically report and evaluate their collaboration inquiry experiences and the collaborative medical physics learning material as well as the module learning environments. Answering the questions and submitting the assignments successfully is the best way of knowing that one has achieved the required understanding of the topic and the objectives.

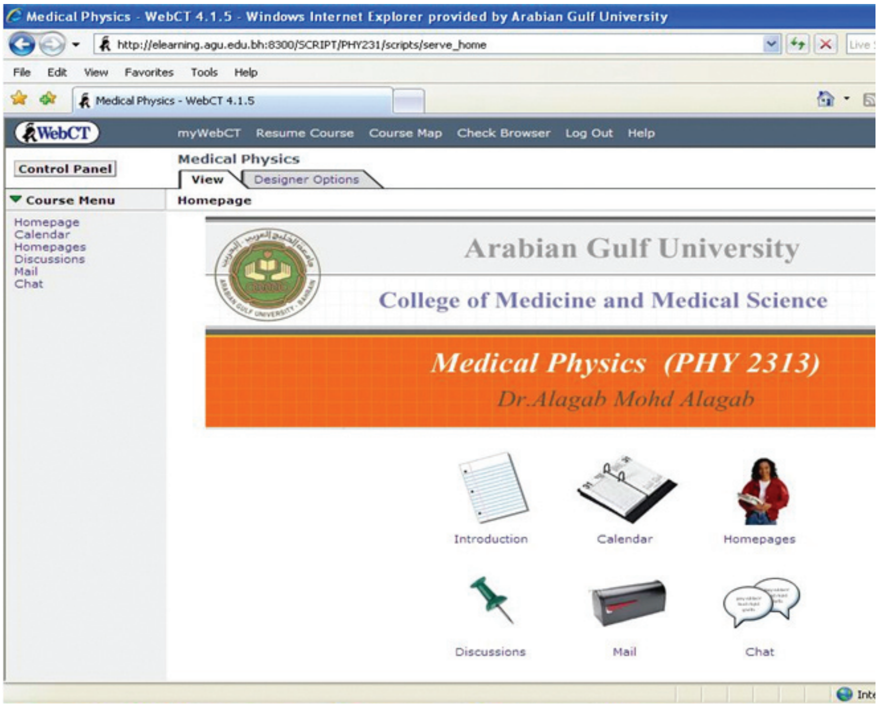

Fig. 1. The medical physics WebCT module homepage

2. *The development of the proposed collaborative medical physics module*:

Results related to the second question: [How can the systematic development, utilization and evaluation of the proposed collaborative module take place?] .The proposed collaborative learning activities development, delivery and evaluation were mainly based on the ASSUSSE model proposed by Heinich; et. al. (1989). The ASSURE model is ranked as one of the oldest classroom ID models purpose, it is a systematic approach to the selection, adaption and design of educational media and classroom materials which can best work under the instructor-directed and instructor-independent instructions. According to Gustafson (1983) class focus models assume there are already a teacher, some students, a curriculum, and a facility. The goal of the teacher is do a better job of instruction within these constrains. The better for this study is developing an ASSURE collaborative medical physics learning environment that motivate AGU pre-medical participates learning and help their learning to master the module goals. The main phases of the ASSURE models are:

(2.1) Phase I: Analyze learners' characteristics: Learners represent the target population for whom the teacher is seeking to develop an appreciate instruction. During learners analysis teacher/tutors need to deal with the target population entry behaviors, their prior knowledge of the topic, their attitudes towards the content and potential delivery system, their academic motivation, educational and ability levels , their general learning performances, their attitudes towards the organization giving their instruction and their group characteristics as well as stating specific entry competencies, and identify their learning styles and provides information (Dick, et.al.,2005). In the present study, the target population is around 150 male and female premedical students at AGU who registered for their second semester at the college of Medicine and Medical Sciences. Around %98 of the members were gulf region countries citizenship i.e. (Bahrain, Kingdom of Saudi Arabia, Oman, Kuwait, Quarter, and United Arab Emirates). Moreover, they are highly motivated to study medicine and medical sciences.

(2.2) Phase II: State the objectives: The second step of the ASSURE model is to state the objectives of your learning. Commonwealth of Learning (2005) summarized benefits from stating and using objectives as follow: learning objectives help instructional designers chose media, create activities and plan self-test and assessments. For tutors objectives show them what they should expect from their students to be able to and what the main points of the course are. Finally, students can use objectives to help them chose a course, check their progress and so on. In the present study, for any diagnostics and application dialogue of the module, the learning objectives were clearly stated (see appendix 1: X- Ray and medical diagnostic techniques).

(2.3) Phase III: Select/Modify / Design Material and Media: After identifying the audience, and stating the learning objectives, the instructor task is to build a bridge between these two points. To do this, propose three options: select available learning material, modify existing material or design new material. In the present study the author has designed the WebCT vertical learning environment and developed the medical diagnostic dialogues, and selected the websites and internet resources that suite the course objectives and modified some of the learning resources and material and activities.

(2.4) Phase IV: Utilize Media and Materials: Selecting, modifying, or designing new material, are followed by the planning of how to use the materials and deciding how much time will be spent using them. In the present study the instructors (author) previewed the materials, prepared the learning environments (both traditional and virtual), and prepared the audiences for the collaborative learning and present of the material according to the proposed collaborative teaching strategy.

(2.5) Phase V: Require Learner Participation: To assure learning, learners must practice what they are expected to learn (objectives) and should be reinforced for the correct response. To satisfy this requirement, the study developed the learning activities associated with each dialogue so as to facilitate participants respond to the instructions and help them to receive feedback on the appropriateness of their performances and responses. The study emphasizes the importance of keeping learners actively and collaboratively involved in the inside and outside learning activities.

(2.6) Phase VI: Evaluate and Revise: The final phase of the ASSURE model is evaluation. Evaluation is necessary for dealing with the impact and effectiveness of the learning. In the present study, evaluation was conducted so as to assess and to assure both learner achievement of the objectives the feasibility of the collaborative learning of medical physics from a medical physics student's point of view. And finally assess the impact of collaborative learning on participants' attitudes towards medical physics diagnostics and application as well as their motivation to learn medical physics.

3. *Utilizing the proposed module for teaching medical physics:*

There has been a great interest in the use of collaborative learning in higher education, especially the use of cooperative learning techniques (Slavin, 1987, in Mhairi (Vi) Maeers, 2000). Collaborative learning support teaching strategies and learning environments in which learners engage in a common task in which each individual depends on and is accountable to each other. In collaborative learning activities, small groups of students work together in searching for understanding, meaning or solutions or in creating an artifact of their learning such as a product. In medical physics collaborative learning activities usually include collaborative searching of knowledge, group projects, and other learning activities such as the problem-based learning (PBL) activities used by the college of Medicine & Medical Sciences at AGU for teaching the Medical Sciences and Clinical Clerkship phases. Diane (2009) believed that the components of good active learning activities are the same, whether presented in traditional or in online environments. These activities should have a definite beginning and ending; has a clear purpose or objective; contain complete and understandable directions; have a feedback mechanism; and include a description of the technology or tool being used in the exercise. Based on these directions and the principles of learning (i.e. learning devices) derived from the different schools of learning the components of the collaborative medical module were developed and prepared.

It is worth mentioning that the medical physics module at AGU used to be taught by a team of professors who were staff members at AGU and have qualifications related to the application of physics into the field of medicine, and interested in such applications. The activities of the present study took place during the second semester of the academic year 20062007/, and at that time the medical physics module was taught by five staff members and one senior lab technician who used to participate in teaching and follow up the practical sessions of the module. Four of the course (module) instructors were from College of Medicine & Medical Sciences and the fifth (the author) was from the Graduate College who is an assistance professor of instructional design and distance education and got his university degree in physics and education. Teaching sessions were presented in the form of formal lectures and tutorials (2 sessions per week) and one practical session a weak. The latter may be in the form of demonstration, a video presentation, hands-on experience, a field visit to one of the hospital diagnostic /laboratory/therapy centers. Formal classroom sessions were of 45 minutes duration, while the practical sessions were of 1 hour and 45 minutes duration. This is to allow for a "breather" between different classes or sessions. Every teaching session should be summarized as power point presentations format to highlight the learning objectives within the topics and themes of the module and then uploaded into the online module site. References to learning, extra learning resources and sessions-related questions were highly recommended so as to encourage the student towards the self-learning strategies and activities. This would also help a premedical student to learn to the required and appreciate level of mastery and explore him to a student's dependent learning approach rather than a teacher centered one that he was familiar with at secondary education. In addition to teaching and supervising the practical (experimentation) part of the module, the author was assigned to teach four units of the course including: introduction to the course, units and measurements, electric charge, force, and voltage and electric circuit. The practical demonstrations of the module were redesigned to include two parts. Part one; taught at AGU physics laboratory: the experiments of this part were designed to give pre-medical candidate the opportunity of acquiring the necessary skills and techniques in the manipulation of apparatus, and the use of understanding of the instruments employed. This part includes 10 physics experiments (measurement of errors, resistance, resistivity, oscilloscope, speed of sound in a tube, converting lens, the compound microscope, the diffraction grating, the Geiger counter, units & resistivity rates and dictionary). Part two of the practical session supposed to be conducted at Sylmaniya Medical Complex (SMC) or any clinical lab that owns the needed diagnostics instrumentation techniques such as x-ray and ultrasound systems. The learning material of this part were developed by the author and included five clinical diagnostics applications aimed at tying the principles and laws of physics to its current clinical diagnostics applications from field experience. The topics of this part include five diagnostic techniques represented in: X-ray, Ultrasound, Doppler-ultrasounds, Magnetic Resonance Imaging (MRI), and T-scan techniques (see appendix 1).

4. *Evaluating the impacts of the proposed module on subjects' learning outcomes:*

Results related to study third question: [What were the effects of the proposed collaborative learning approach on AGU first year students' achievement in medical physics? To test the impact of the proposed collaborative approach on subjects' achievement; control and experimental groups' scores in medical physics final exam data was collated and analyzed. Using SPPS, subjects' means, standard deviations, and tests correction coefficient as well as t-test results were computed and tabled. To test the impact of the collaborative learning on subjects' achievement in medical physics, experimental and control group subjects' scores in final examination in medical physics data was analyzed and summarized. Table (3) shows the control group (20052006/) and the excremental group subjects' means, standard deviations (Std.) and standard errors mean (Std. Error mean) in the final medical physics test results.

Table 3. Control & Experimental Group Medical Physics Final Test Statistics.

Final Test	Group	No.	Mean	Std. Deviation
	2005/2005	142	76.5211	14.56836
	2006/2007	150	77.4425	11.81764

Table (3) indicates that excremental group subjects` mean in the final medical physics exam is greater than the mean of the control group in the final exam i.e. (excremental group mean = 77.44, Std. 11.44, control group final test mean=76.52, Std. =14.56). While table (4) indicates that data analysis resulted in a significance correction among subjects` midterm and final exam scorers in medical physics. An independent -samples t-test was conducted to compare the achievement of the experimental "treatment with collaborative learning" and control group "no treatment". Data analysis reveals no significant difference in the scores for experimental group (M=77.44, SD=11.82) and no collaboration (M=76..52, SD=14.57) conditions; t(290)=-0.552, p= 0.05. These results suggest that collaborative learning does not affect subjects achievement in medical physics final exam i.e experimental group mean (M=77.44) in the final medical physics exam is greater than the control group mean (M=76.52) in the same exam, no significance results were reported. Table (4) presents the experimental and control group medical physics final test independent t-test results.

To explore the effects of collaborative learning on subjects achievement related to gender factor, a dependent sample t-test was conducted. Table (5) presents the experimental group (20062007/) means, standard devotions and standard error means related to gender (male, female).

Table (5) indicates that males` mean in the final medical physics exam is almost equal to the females` mean in the final exam (i.e. males` mean = 77.47, Std. 13.02, females` mean=77.43, Std. =11.20). Table (6) presents the experimental and control group medical physics final test independent t-test results related gender (male, female).

Data analysis results revealed no significant difference in the excremental group medical physics final scores related to gender (male, female). For the male group (M = 77.47, Std. =13.02), for the females group (M=77.43, Std. =11.20) conditions; t (148) =023, p =0.05).

The study farther assessed the effect of collaborative approach for teaching medical physics on subjects` gain in achievement i.e. (gain in achievement refers to participant`s score in the final test – the participant score in the midterm test). Table (7) shows the control group (20052006/) and the excremental group subjects' means, standard deviations (Std.) in the gain from the med test to the final medical physics test results.

To test the significance of subjects` gain in achievement from midterm test to final test;

Table 4. Experimental & Control Group Medical Physics Final Test Independent Samples Test Results.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									%95 Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Final test	Equal variances assumed	.029	.865	-.595-	290	.552	-.92141-	1.54865	-3.96943-	2.12661
	Equal variances not assumed			-.592-	271.634	.555	-.92141-	1.55746	-3.98763-	2.14481

Table 5. Experimental Group Gender (male-female) Final Test Statistics.

Gender	N	Mean	Std. Deviation
Male	52	77.4731	13.01539
Female	98	77.4263	11.20077

a. G = 2006/2007

Table 6. Excremental Group Gender (male-female) Independent t-test Results.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									%95 Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Final test	Equal variances assumed	.965	.328	.023	148	.982	.04675	2.03434	-3.97335-	4.06685
	Equal variances not assumed			.022	91.527	.983	.04675	2.13023	-4.18436-	4.27786

a. G = 2006/2007

an independent samples test was administrated. Table (8) presents the independent samples test results.

Data analysis results revealed that; the experimental group taught through collaborative approach scored significantly more gain (M = 15.1289, SD = 16.84061) than the control group that did not use collaborative approach (M = 6.1225, SD= 21.26310), t (290) = -4.023, $p < .05$. i.e. collaborative approach for teaching medical physics proved its` strength in empowering subjects gain development in achievement.

Table 7. Control & Experimental Group (final - med) tests gain statistics.

G	N	Mean	Std. Deviation
2005/2005	142	6.1225	21.26310
2006/2007	150	15.1289	16.84061

5. *Collaborative learning and attitudes towards medical physics*

Results related to study question: [To what degree did the collaborative learning motivate the participants to favorable learning outcomes and enhance their attitudes toward medical physics?] In their discussion of the role of media and technology in learning (Heinich, et.al.1989) told us that: attitudes are admittedly difficult to evaluate and assessed. For some attitudinal objectives, long term observation is required to determine if the goal has been attained in day-to-day instruction teachers and trainers should rely on what they can observe here and now. To evaluate the attitudinal components of the collaborative medical physics learning outcomes the study developed an attitude scale (questionnaire) which was adapted from the instrument developed by Heinich, et.al.(1989) for assessing learners' attitudes towards biological sciences. The attitudes yardstick consisted of 14 statements express feelings towards physics applications in medicine, premedical physics participants were asked to respond to each statement on the extent

Table 8. Subjects (final - med) Gain Independent Samples Test Results.

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								%95 Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	1.240	.266	-4.023-	290	.000	-9.00633-	2.23856	-13.4122-	-4.6005-
Equal variances not assumed			-3.998-	268.56	.000	-9.00633-	2.25270	-13.4415-	-4.5711-

to which he/she agree on a Likert five point scale. The choices are: (5) strongly agree, (4) agree, (3) be undecided, (2) disagree, and (1) strongly disagree. Around (28) students who participated on collaborative learning for medical physics completed an attitudes survey questionnaire. Attitudes data analysis results (Table 9) indicates the following:

i. The overall subjects' responses means on the attitude scale varying from above average ($m \geq 3$), average (m between 2.5 and 3) and below average ($m \leq 2.5$).
ii. The statement «medical physics diagnostics and applications are very interesting to me» score the highest rating (m = 3.21, Std. = 1.37), then come the statement «I really like medical physics diagnostic & applications» (m = 3.18, Std. = 0.23) and the statement» in general, I have a good feeling toward medical physics diagnostic & applications» (m = 3.14, Std. = 0.197) respectively.
iii. The statement «medical physics diagnostic & applications make me feel uncomfortable, restless, irritable, and impatient» was rated above average although it is a negative statement (m = 3.07, Std. = 0.199)These results represents a strong indicator that subjects do not favor practicing and conducting a medical physics diagnostics testing by themselves.
iv. In general; data analysis reveal that subjects own moderate attitudes towards medical physics diagnostics and application, which can be improved through systematic and well planned collaborative learning activities, more training and field visits. Table (9) represents a descriptive statistics for subjects' attitude towards medical physics.

6. *Participants overall evaluation of the collaborative experience*

Results related to question: [What are the participants overall evaluation for the collaborative learning experiences in medical physics?] To deal with subjects overall evaluation for the collaborative learning experience, around fifteen candidates from those who participated in the attitudes survey responded to a personal interview sessions with the module instructor (the author). It is worth mentioning that the interview questions are:

i. How do you evaluate collaborative learning in medical diagnostic and applications?
ii. How do you fine and evaluate the internet resources and websites suggested for learning the module objectives?
iii. State the most difficulties that face you during your study of the medical diagnostics and applications resources?
iv. Do you recommend collaborative approach, mainly the field visits in teaching the module of medical physics?

The advantages and the most beneficial aspects of the collaborative medical physics module were reported as follow:-

i. Participants reported that collaborative learning approach is very effective for teaching and learning medical diagnostics and applications. Moreover, the collaborative

Table 9. Descriptive statistics for the attitudes scale.

Item#	Item statement	N	Mean	Std. Error	Std. deviation
S01	Medical physics diagnostics & applications are very interesting to me.	28	3.214	.2590	1.3705
S02	I don`t like medical physics diagnostics & applications, and it scares me to have to take it.	28	2.43	.232	1.230
S03	I am always under a terrible strain in medical physics diagnostics &applications activities.	28	2.64	.242	1.283
S04	Medical physics diagnostics &applications are fascinating and fun.	28	2.86	.228	1.208
S05	Medical physics diagnostic & applications make me feel secure, and at the same time it is stimulating.	28	3.07	.199	1.052
S06	Medical physics diagnostic & applications make me feel uncomfortable, restless, irritable, and impatient.	28	2.54	.238	1.261
S07	In general, I have a good feeling toward medical physics diagnostic & applications.	28	3.14	.197	1.044
S08	When I hear the statement medical physics diagnostic & applications, I have a feeling of dislike.	28	2.89	.264	1.397
S09	I approach medical physics diagnostic & applications with a feeling of hesitation.	28	3.00	.224	1.186
S10	I really like medical physics diagnostic & applications.	28	3.18	.225	1.188
S11	I have always enjoyed studying medical physics diagnostic & applications in college of medicine.	28	2.89	.214	1.133
S12	It makes me nervous to even think about doing medical physics diagnostic & applications experiment.	28	3.11	.208	1.100
S13	I feel at ease in medical physics diagnostic & applications and I like it very much.	28	2.96	.221	1.170
S14	I feel a definite positive reaction to medical physics diagnostic & applications it's enjoyable.	28	3.07	.224	1.184

approach facilitates further discussions between the students and their tutors and helps them to pick the exercise from the field (from the real applications of physics in the medical fields).

ii. Majority of the participants reported that although the collaborative learning motivate them to read about the applications of physics into the medical field, extra efforts and time needed to go through the material and conduct fields visits to the medical centers or submit an interview with their professors around the application of physics in medicine represents the most obstacles.

iii. Participants reported that they gained useful knowledge of various internet resources, but the problems associated with internet resources was that some websites are not active and not easy to navigate.

iv. Although collaborative learning is highly recommended for medical physics and others branches of science, but the time table and the study plan need to be reconstructed and designed in a manner to suit this approach.

DISCUSSION & CONCLUSIONS

The primary goal of this study was to develop a collaborative learning module in medical physics and to test its impact on the Arabian Gulf University first year students at college of Medicine and Medical Sciences achievement and attitudes towards learning and studying medical physics. To develop the proposed collaborative medical module, the study utilized the ASSURE Instructional Design Model proposed by Heinich;

Molenda; and Russell (1989). ASSURE ID is a class focus model that assumed there are already a teacher, some students, a curriculum, and a facility. The goal of the teacher is to do a better job of instruction within these constrains. The better job for the present study was to develop a collaborative medical physics learning environment that motivate medical physics candidates to positively participate in the teaching/learning process and help their learning for mastering the module objectives and develop learning skills for their further education.

The treatment was administrated on a sample of (292) participants who registered for medical physics at the Arabian Gulf University at two successive academic years; group 1 nominated as control group; participated in medical physics during the second semester of the academic year (20052006/) and taught the course by using the conventional teaching method, while the experimental group (group 2) composed of the students who participated in medical physics during the second semester of the academic years (20062007/) and taught the course using the proposed collaborative approach.

To answer the study questions; a combination of quantitative and qualitative methodology was used. For collecting the quantitative data; the study used three instruments; subjects` personal data was collected from their files accessed at the registration unit; medical physics achievement data was collected form midterms and final test results, attitudes & motivation toward studying and learning medical physics was collected by administrating an attitudes towards medical physics scale which was adapted from Heinich; Molenda; and Russell (1989) instrument used for assessing attitudes towards biological sciences. The qualitative data was collected by conducting a personal interview with around 10 of the participants was so as to deal with their opinions on the collaborative approach for teaching medical physics.

An independent-samples t-test was conducted to compare achievement in medical physics for the experimental group who were taught by the proposed collaborative material (group 20062007/), and the achievement of the control group who were taught the course by using the traditional teaching (no collaboration). Data analysis revealed that; the proposed collaborative approach has no significance effect on subject's achievement in the final medical physics exam. Also the proposed collaborative treatment resulted in no significance differences related to gender (male, female) of the participants.

An independent-samples t-test was also conducted to compare the experimental and control groups gain in achievement from the midterm test to final test. Data analysis revealed that there was a significant difference in subjects gain; for the experimental group ($Mg = 15.129$, $SDg = 16.841$)) and the control group ($Mg = 6.123$, $SDg= 21.263$), $t(290) = -4.023$, $p < .05$. These results suggest that collaborative learning really does have an effect on subjects scores related to gain. Specifically, our results suggest that when learners use collaborative learning, their gain proved to increase. Concerning the effect of the proposed treatment on subject's attitudes towards medical physics; data analysis revealed that subjects own moderate attitudes towards medical physics diagnostics and application, can be improved through a systematic and well planned collaborative learning activities, and more training and field visits.

Medical physics participants reported that; collaborative learning is very effective method for teaching medical physics diagnostic and applicants, but they need extra time to conduct field visits and report on these visits. Participants also reported that; collaborative approaches motivate their learning engagement and facilitate the interactions and discussions with other colleagues and tutors and help them in picking the learning experience. The participants reported that: accessing the internet resources and some of the recommended learning websites- that not active- represent the most technical problems associated with the collaborative medical physics experience.

In conclusion the collaborative medical physics` module proved to be successful in supporting and scaffolding a premedical candidate who engaged in problem-based activities within a relevant context of clinical and medical diagnostics techniques and facilitate their social interactions. Collaborative learning made easy for the first year medical students at AGU to share their individual learning experiences with each others, and helped them to conduct field visits and gain knowledge that expand their experiences in the real and current applications of physics into medicine. Theses findings supported by many study results, for example Barbara (1993), mentioned that ; students learn best when they are actively involved, and Hake (1998) concluded that; the interactive engagement methods of teaching can increase the course effectiveness compared to traditional teaching and the work of Blakely et. al. (1999) found that; the problems solving strategies gained by the students through the course were immediately transferable in other academic context.

Although the activities of the collaborative learning at AGU were limited to the medical physics curriculum, the results are promising and far-reaching. Even if the results did not prove quantitative significance outcomes of the collaborative approach on subjects` achievement in medical physics; a significance effect of collaboration on subjects' gains in medical physics was found. This significance in participants gain in achievement from midterm to final test indicated that collaborative methods of learning can enhance learners gain as well as their achievement for the long run. But the success of this approach associated with believes of the learners and their tutors on the pedagogical impact of collaboration on real-world experiences (visiting a clinical diagnostic system and conducting an interview with a consultant or reading a diagnostic results in groups); their attitudes towards the subject as well as enforcing their motivation to learn about physics and its applications in the medical fields.

Some of the participants resist collaborative learning activities; this simply because some of them lack an understanding of the philosophies underpin collaborative learning, others lack the skills needed to actively participate in collaborative context i.e. such as the social skills or technical skills related to navigation on the learning management system (WebCT in this study), and make use of the communications tools. Some of our participants think studying and learning physics is not of the same importance as other subjects like (biological sciences or biochemistry) for studying medicine. This is why they lack motivation and interest in studying and learning medical physics (most of the students used to answer: we have no time for the lap work, our schedule is very crowded and busy when asked to visit a medical complex and report on a diagnostic system). To over come such problems; the college of medicine and medical sciences administrators and the medical physics educators at AGU need to discuss with their students at their induction programs/sessions the importance of studying basic sciences (medical physics , or any other basic science subject) prior their study of medicine and clinical classes.

Findings of this study represent a valuable tool to help medical physics educator to make the transfer from the classroom to the actual workplace. The study highly recommend training science educator on how to plan and develop their collaborative class activities and how to evaluate the outcomes of group work. Educators needed to use alternative assessment techniques which are vital to collaborative learning and not limited their focus on their student's achievement.

A limitation of the present study could be the differences in the participants within the control and exponential group and the timing for the treatment. One of two groups taught the course in the academic year 20052006/; while the other taught the course in the academic year 20062007/ and this may have an effect on the internal validity. Another limitation was that the collaborative temperament was administrated for around six weeks after the midterm examination with no supervision for the field visits. Lastly the generalization of the results is limited because it was conducted at a single institution with only one course for around (%40) of the course time, therefore further research on more courses is needed to cross- validate the study findings.

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Appendex

X- Ray and Medical Diagnostic Dialogue (sample)

Aims

Helping medical physics candidate to relate the theory and principles of X-ray to the known uses and applications in the field of medicine & medical sciences.

Objectives

By the end of the dialogue you should be able to:
1. Explain the physics behind X-ray
2. Explore the basics of x-ray
3. Account and discuss X-ray uses in medicine.

Learning sites

Locate the following websites:
1. http:// www.en.wikipedia.org/wiki/X_ray
2. http://www.oakwood.org/?id=1015&sid=1
3. http://www.teachingmedicalphysics.org.uk
4. http://www.xraymedicalgroup.com/interventional-radiology-la-mesa-santee-grossmont-ca.htm

Tutorial

Read through the topics and then try to answer the following questions:
1. What is the physics behind X-ray?
2. According to the authors of the first topic define what X-ray is; and state some of its uses in the medical field?
3. From your reading in the second website:
4. What is central idea of the topic/ article?
5. What are the types of X-ray?
6. What is a chest X-ray test?
7. Where are these tests usually done?

Experience from the field

Working in your own subgroup; visit a physician at Sylmaniya Medical Complex, K. of Bahrain, (SMC) who use X-ray techniques in checking & diagnosing his patients, have a dialogue with him around the uses and applications of X-ray technique in the medical field. Submit a written report on your visit. Your report should include the following elements:
1. Introduction to X-ray and its uses in medicine
2. A short descriptions of the visited system components
3. How the system operate
4. What are the necessary precautions to avoid the test side effects?
5. How can doctors make use of the recorded data
6. Discuss the mostly expected side effects for both : a. Doctors / physicians, b. Patients
7. Discuss the sources of the expected errors when using such a system from:
8. Physics specialist point of view and;
9. From a Physician/ Doctor point of view
10. Conclusion

Submit

Printed as well as an electronic (soft) copy of your find report to your course instructor at: alagabm@agu.edu.bh