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Computer Simulations in Medical Education: An Upward Trend

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Abstract: *The upward trend in medical education towards integrated, student center, active learning approach and e-learning has evoked the usage of advanced information technology (IT) in the undergraduate medical curriculum. Computer Simulations laboratories sessions invaded the curriculum as an effective teaching/learning modality and replaced efficiently the animal laboratories sessions in teaching the intended skills outcomes of different undergraduate Medical Courses: Physiology, Clinical Skills, Surgery and Pharmacology. This innovation in the undergraduate medical education has to be critically evaluated; weighing the possible advantages, disadvantages and pitfalls of this upward trend before designing any undergraduate Medical Curriculum. This paper spots the light on the computer simulations usage as an upward trend in Medical Education.*

Keywords: *Animal Experiments, Computer simulations, Laboratories, Medical Education, Physiology.*

I. Introduction

Medical Education is not merely a process of knowledge transfer, it involves; mastering clinical skills, showing affection and demonstrating professional attitude. Most of the medical courses outcomes address the three domains of learning; cognitive, affective and psychomotor.

For the past twenty years live animals laboratories experiments sessions formed the base for teaching and assessing the psychomotor and affective outcomes of different undergraduate medical courses; Physiology, Pharmacology , Surgery and Clinical Skills. Over these years different concerns have been cited regarding the usage of animal in medical education.

The upward trend in medical education toward integrated, student center, active learning, e-learning and distance education has evoked the usage of advanced information technology (IT) in undergraduate medical courses, thus the Computer Simulations laboratories sessions invaded the curriculum as an effective teaching/learning modality and replaced efficiently the animal laboratories sessions in teaching the intended skills outcomes of different undergraduate Medical Courses.

This paper spots the light on the computer simulations usage as an upward trend in Medical Education and its replacement of the animal laboratories in Physiology Courses in particular.

II. Computer Simulations-the upward trend

Although the usage of animal laboratories sessions have always formed the base of teaching/learning the intended skills outcome of the undergraduate medical Physiology Courses yet, the past four decays showed a steady decline in the usage . It was replaced by: problem sets, videos, slide-tape package and students were using computer – assisted instruction [1, 2, 3]. A comprehensive survey was conducted by the Association of American Medical Schools (AAMC) to assess the use of animal in medical education around 1990 confirmed this downward trend in the animal use in; Physiology Courses [4, 5].

The upward trend of the computer simulations in Physiology courses is owed to different concerns cited related to the animal use as the : cost, ethical issues, faculty attitude, student and public pressure and the availability of the computer simulations as valid alternative [3.6, 7].The discontinuation of animal laboratories in medical course is due to the: expenses of live animal laboratories; changes in the curriculum towards more integration and time compression; students' concerns as majority felt that experiments include needless pain and suffering to the animal and that computer simulations of the animal experiments is a good alternative to conventional animal experiments; lack of sufficient skilled faculty ; faculty's attitude and the availability of effective alternatives as the computer- assisted programs and videos [6,7,8,9].

With the increase invasion of the computer simulations sessions to the undergraduate medical curriculum, studies have been trying to assess the students' and faculty members' perceptions towards the usages of computer simulations as a teaching modality in practical sessions. Surveys revealed that the computer simulations session has many advantages as: saving the cost; saving the time; reduction in the number of animal used; greater control over the variables and the ability to isolate the mechanisms/events in the experiments. On the other hand certain disadvantages of the computer simulations session as a teaching modality of the practical session in undergraduate medical curriculum have been reported as: loss of student experience of working with live subjects; further distancing the teaching from the ultimate subject (Humans) ; loss of student exposure to the

practicality and complications of gathering valid data; the artificial nature of the system; inability to study species-specific response and inability to study interactions in the complex system [4,7,10,11,12].

III. Is computer simulations usage in Medical Education warranted?

The Laboratories sessions are considered as an active learning approach and experience where the educators have to define the learning objectives of the session and the students should have their opportunities to enhance their ability to reason from facts to principles in order to achieve the intended learning outcome of the session. The clear decline of the usage of classical animal laboratories in undergraduate medical courses e.g. Physiology , raised these questions for discussion "Can computer simulations sessions replace the live animal experimental sessions in teaching/ learning the intended skills outcome of the medical course? "Is computer simulations usage in Medical Education warranted? [13]

Computer simulations sessions is less costly in time and labor, it may have initial high cost in the development of the required programs/ simulated experiments that address the intended learning objectives of the sessions e.g. Respiratory or CVS Physiology, yet its running cost is cheaper compared to the procurement and maintenance of the animals also it has the ability to be used repeatedly [14]. This later advantage is of great importance for the consolidation of information from short term memory to long-term memory which is done when the information is rehearsed, failure to do so leads to loss of the information in the short term memory through the process of displacement or decay. Computer simulations sessions provide a good chance for the student to repeat the simulated experiment and rehearse the information which improves retention [14, 15].

Computer simulations sessions provide the opportunity for the learners to have an effective complex learning in an enjoyable, engaged, relaxed atmosphere where the experiment's variables can be controlled, the experiment can be repeated and the fear of failure and loss of experimental specimen is eliminated. Learning is not merely cognitive and emotion is essential in patterning thus engagement of the learner in an enjoyable atmosphere with no fear enhances learning, knowledge retention and encoding into long term memory [12, 16, 17].Since learning is developmental and not all learners learns and progress at the same time, the computer simulations can be adjusted to accommodate students' variability and learning levels. It can accommodate the appropriate level for each individual learner to obtain the intended learning objectives [14, 18]. As each learner has a unique system for learning, individual learning styles must be addressed whether it is a relatively simplistic approach such as the VAK learning style set (visual, auditory, kinesthetic) or more complex learning styles sets such as Gardner's multiple intelligences. The leaning /teaching experience by computer simulations sessions involve a variety of senses and offers multiple ways for the learner to access information [14, 19].

Computer simulations can demonstrate easily the phenomena which may not be normally observable in animal experiments. It can also be designed and used by the students to judge their achievement of staged learning objectives, as they can have built in self -assessment. Views arguing that simulations are based on a series of simplifying artificial assumptions that do not add new information to the learning experience hold no validity [12, 19-22].

Although there is adequate studies supporting the fact that computer simulations sessions have efficiently succeeded in teaching the intended learning objectives and that the knowledge acquired during these sessions was well in par with the live animal experimental sessions yet it is a critical to suggest that the computer simulations sessions would replace the animal laboratories completely in the undergraduate medical curriculum. There is still evidence suggesting that for some students animal laboratories provide opportunities to integrate and understand complex physiological concepts above and beyond what simulations can offer. In this context, although interactive technologies such as computer simulations are very useful and have been widely adopted by many colleges for various reasons, it is inappropriate to declare that they represent a complete educational replacement for animal laboratories [23-25].

IV. Selecting a pedagogical approach

The question raised here is "Can Computer simulations sessions replace the live animal experiments laboratories in Medical education?" The answer will remain an area of debate and it is up to the institute to decide the appropriate didactic approach to address each specific learning outcome in their curriculum. In this context, identifying the benefits and reasons behind this trend and guiding its implementation is the efficient and practical pedagogical approach. The replacement of animals with simulators will need adequate planning and training of staff and an initial investment of fund which is likely to pay off in the long run. Since it is the duty of the instructors to provide the students with the learning objectives, it is then their responsibility to decide the suitable teaching/learning modality to address the intended learning objectives as far as possible. Changing the teaching faculty's attitude toward using the computer simulations can be achieved by disseminating information about the existing alternatives and their educational benefits via electronic databases, publications, websites and workshops and conferences which makes it easy to persuade them to adopt it. The developments of customized

soft wares that address the needs of the teacher/students and avoiding technological redundancy would help the teachers make a right choice [22, 27]

Different learning modalities provide different experiences. Effective teaching/learning requires a diversity of strategies and approaches. Students vary in their learning styles and characteristics. When selecting laboratories that do and do not use living organisms, instructors must keep in mind that students may differ in their educational preferences. Students' cognitive preference can affect their performance in different subject areas; and they receive higher grades when their learning style is complementary to the teaching style of the instructor. If sufficient instructional time is available, using both live animal and computer simulations would likely produce better learning outcome than either would individually [27-28].

Meeting the learning objectives of the laboratory course in undergraduate medical curriculum may not be entirely possible with the use of alternatives. In such cases effort should be made to minimize the live animal experiments sessions needed. Model suggested that the "most effective way to help students understand physiological interactions on a systemic basis is to first use technological approaches to proceed from simple to more complex models and then to test the hypotheses based on model behavior in an investigative experience with a living preparation" . This should be kept in consideration when designing, implementing and evaluating undergraduate medical curriculum [28-30].

V. Conclusion

The past four decades have seen a steady decline in the use of animals in laboratory sessions with an upward trend of using computer simulations. Computer simulations have proved to be an effective pedagogical approach because of their ability to: address the intending learning objectives in an enjoyable way; provide self-assessment and exclude out the individual physiological effects. The effective implementation of this trend needs orientation and support for the teaching faculty to adopt this teaching modality and to tailor it with the learning objectives to optimize and enhance students' learning experience.

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