

Short Communication

Integrative Biomedical Sciences

Nursing Students' Perceptions of Biomedical Education with Augmented Reality

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Introduction

Innovative techniques provide a teaching strategy to improve education in biomedical sciences for nursing students [1]. With augmented reality (AR) technology, elements in the physical environment can be enriched or supplemented by computer-generated sensory inputs such as text, images, 3-dimensional (3D) graphics, and audio. AR has been paradigmatically applied worldwide to education of different disciplines, making some contributions to teaching and learning [2]. However, AR products on the market mainly focus on primary or secondary education where the pleasurable aspects of AR are promoted [3]. Although acceptance of using AR in healthcare education was reported [4], the actual impacts of AR applications in the training of healthcare professionals have not been well-studied [5]. In view of the potential advantages of integrating AR into nursing education, such as a better visualization of body structures [6], a survey was conducted to specifically assess the effectiveness of AR in improving the quality of biomedical education as perceived by nursing students.

Learning Experience with Augmented Reality

This survey focused on the biomedical sciences course taken by undergraduate students enrolled in the full-time Bachelor of Nursing program at The University of Hong Kong. Ethical approval for the study was granted by the Human Research Ethics Committee (HREC) of

The University of Hong Kong. A typical educational AR application "Brain AR App" (Harmony Studios Ltd., UK) was used to assist teaching and learning during five lectures whose topics are relevant to the content of the AR application. The teacher explained biomedical concepts by manipulating the digital content projected onto the screen to facilitate interactions with nursing students. The teacher also provided guidance on installing and using the AR software to ensure that the students understood the functions and were able to use the software appropriately on their own mobile device to learn at any time.

After comprehensive AR learning experiences, students were invited to complete a questionnaire for evaluation of their perceptions toward AR application in learning as well as their expectations on how to enrich the functions of educational AR software. Students were informed that participation would be entirely voluntary without affecting their learning opportunities and that all information obtained would be used for research purposes only. The questionnaire was anonymous. Of the 207 questionnaires distributed to the class, 101 were returned, giving a response rate of nearly 50%. The questionnaire consists mostly of items where the students were asked to indicate the extent to which they agree or disagree with a statement related to AR learning along the 5-point Likert scale, with 1 = strongly disagree and 5 = strongly agree. The number of students selecting particular rating option(s) was expressed as a percentage.

Participant Feedback

Effects of AR learning

The majority (79%) of nursing students agreed or strongly agreed that teaching with AR software is better than without. The major effects of AR software on learning (agreed or strongly agreed by more than 70% of students) include (i) facilitating understanding of knowledge (77%), (ii) promoting enjoyment in learning process (72%), and (iii) extending awareness toward abstract concepts (72%). The minor effects of AR software (agreed or strongly agreed by more than 50% but less than 70% of students) on learning include (i) consolidating memory of content (68%), (ii) enhancing attention or concentration in the lesson (66%), (iii) facilitating engagement in the course (66%), (iv) increasing ability to apply what have been learned (63%), (v) developing ability in self-directed learning (63%), (vi) improving efficiency of revision (62%), and (vii) developing ability in collaborative learning (51%). Nevertheless, only 20% of students agreed or strongly agreed that AR software can develop their communication skills. While AR learning was found to be effective both in lectures (supported by 55% of students) and at home (supported by 67% of students), 85% of students agreed that teacher's guidance is important for effective learning with AR software.

Expectation on new educational AR software

Most students agreed that more functions should be included in AR software. Detailed labels of 3D structures (91% agreed or strongly agreed) and definition of medical terms (88% agreed or strongly agreed) are their favourite items to add. Background music (38% agreed or strongly agreed) and sound effects (48% agreed or strongly agreed) are least-welcome items. Images of good quality (91% agreed or strongly agreed) and clearly classified topics (90% agreed or strongly agreed) are most essential in AR software to be developed. Besides, 75% of students agreed or strongly agreed that new AR software will be suitable for learning various aspects of biomedical sciences, particularly anatomy, as well as anatomy integrated with physiology. Consistently, 84% of students agreed or strongly agreed that new AR software with extended functions will be useful in enhancing their understanding of different biological systems.

How to use AR software

Nearly half of the students thought that 15 to 30 minutes should be spent on AR learning every day. Only 6% of students thought that 1 hour (or more) should be

spent on AR learning every day. Furthermore, half of the students thought that AR learning should constitute 10 to 30% of a lecture. Only 3% of students thought that AR learning should constitute 50% (or more) of a lecture. Less than 20% of students preferred lecture notes as the physical object to be "augmented" by AR applications, whereas 60% of students preferred 3D model of the human body (or body part) as the physical object to be "augmented" by AR applications.

Discussion and Implications for Educators

It was suggested that educational settings with AR are better than typical approaches using non-interactive media (e.g. books and videos) [7,8]. In this study, nursing students' perceptions of the effectiveness of AR technology in biomedical education were investigated, and the findings support that teaching design with an AR component surpasses existing resources, at least in some respects, for the training of nurses.

The use of AR to facilitate biomedical education was found to be a promising approach to most nursing students in this survey. Since AR learning provides a lively and interactive way in which biomedical knowledge is delivered in a 3D manner, students can more effectively acquire the knowledge, especially abstract concepts that are relatively difficult to present clearly using traditional media. For example, the brain structures illustrated in "Brain AR App" helped students understand physiological concepts such as information flow along neural pathways that mediate sensorimotor functions. Through the dynamic properties of AR software, promotion of enjoyment, improvement in engagement, and enhancement of attention in the learning process can also be achieved. In fact, students demonstrated excitement or even laughed when the AR application was presented to them during the teaching sessions, suggesting that AR technology strengthens students' motivation in learning. Students may come together to discuss the contents in the AR software, thus developing collaborative learning. Nevertheless, AR applications are not effective in developing communication skills probably because students mainly learn via the mobile device as the interface without the need of extensive communications with other people. Overall, the benefits of AR learning outweigh its limitations. Indeed, the vast majority of nursing students agreed that AR software is useful in the learning of different biological systems and various aspects of biomedical sciences. How significantly AR learning would improve academic performance of students awaits further investigations.

Notably, AR software was considered by students as effective both at home and during lectures. Therefore, the benefits of AR learning can be optimized if the teacher applies the AR software in lectures and then encourages the students to have further study with the AR software at home. Ideally, AR learning is helpful to students in both contexts given that guidance from the teacher is provided. What students expect in AR software is more than simply the appearance of 3D structures on top of a physical object. In general, they preferred 3D structures which are clearly labeled or annotated and are supplemented with images of good quality. Like other teaching materials, content in AR software should be clearly classified. For example, inclusion of sub-headings or buttons that correspond to various learning issues in the curriculum would be desirable in the development of educational AR applications. However, sound effects may cause distraction to students and should therefore be avoided.

While nursing students generally agreed that AR learning is advantageous, only 6% of them thought that 1 hour (or more) should be spent on AR learning every day and only 3% of them thought that AR learning should constitute 50% (or more) of a lecture. Instead, half of the students thought that AR learning should constitute 10 to 30% of a lecture. This implies that the application of AR as a supportive tool to aid teaching and learning would be in the best interest of students.

Currently, few studies focus on design and development of AR-based teaching materials specific for biomedical courses in higher education, as evidenced in recent reviews [9,10]. Even though some AR materials are available for higher education in biology, they are mostly prototypes restricted to certain anatomical structures rather than a comprehensive set of materials to be systematically included into curricula [11]. Educators have been encouraged to explore the applications of AR technology in optimizing the education of health providers, thereby improving patient outcomes [6]. This study provides educators with information on how AR can be appropriately integrated into learning activities, hence facilitating curriculum design for nursing education. Moreover, the opinions from students can be taken into consideration when developing educational software for nursing studies in the future. It is optimistically anticipated that the introduction of AR into biomedical education of nursing students will become a globally effective approach to productive and rewarding learning experience.

Declarations

Ethics approval and consent to participate

Ethical approval for the study was granted by the Human Research Ethics Committee (HREC) of The University of Hong Kong. Written informed consents were obtained from all participants.

Consent for publication

Not applicable.

Availability of data and material

Data and material are available on request.

Competing interests

The author declares no competing interests.

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Authors' contributions

Dr. Chun-Wai Ma designed the study, analyzed the data, and wrote the manuscript.

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