



OMARC: An online multimedia application for training health care providers in the assessment of respiratory conditions



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ABSTRACT

Objectives: OMARC, a multimedia application designed to support the training of health care providers for the identification of common lung sounds heard in a patient's thorax as part of a health assessment, is described and its positive contribution to user learning is assessed. The main goal of OMARC is to effectively help health-care students become familiar with lung sounds as part of the assessment of respiratory conditions. In addition, the application must be easy to use and accessible to students and practitioners over the internet.

System description: OMARC was developed using an online platform to facilitate access to users in remote locations. OMARC's unique contribution as an educational software tool is that it presents a narrative about normal and abnormal lung sounds using interactive multimedia and sample case studies designed by professional health-care providers and educators. Its interface consists of two distinct components: a sounds glossary and a rich multimedia interface which presents clinical case studies and provides access to lung sounds placed on a model of a human torso. OMARC's contents can be extended through the addition of sounds and case studies designed by health-care educators and professionals.

Validation and results: To validate OMARC and determine its efficacy in improving learning and capture user perceptions about it, we performed a pilot study with ten nursing students. Participants' performance was measured through an evaluation of their ability to identify several normal and adventitious/abnormal sounds prior and after exposure to OMARC. Results indicate that participants are able to better identify different lung sounds, going from an average of 63% (S.D. 18.3%) in the pre-test evaluation to an average of 90% (S.D. of 11.5%) after practising with OMARC. Furthermore, participants indicated in a user satisfaction questionnaire that they found the application helpful, easy to use and that they would recommend it to other persons in their field.

Conclusions: OMARC is an online multimedia application for training health care students in the assessment of respiratory conditions. The software integrates multimedia technology and health-care education concepts to facilitate learning, while being useful and easy to use. Results from a pilot study indicate that OMARC significantly helps to improve the capacity of the users to correctly identify lung sounds for different respiratory conditions. In addition, participants' opinions about OMARC were quite positive: users were likely to recommend the application to other persons in their field and found the application easy to use and helpful to better identify lung sounds.

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1. Introduction

As part of a patient's physical assessment, health care providers such as nurses and physicians are often faced with the problem of correctly characterizing sounds from the chest/thorax, typi-

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cally using a stethoscope. Most of the currently available training resources associated with health assessment come from traditional learning resources, such as textbooks. Sometimes these textbooks also have sounds and videos provided in audio CDs or DVD-ROMs [1–3,8,9]. These are valuable resources; however, often the sounds are presented in isolation of a clinical scenario which would enhance comprehension of the materials to be learned. In some higher education institutions, students may have access to life-size training computer-operated mannequins which may cost from several hundreds to thousands of dollars [4–7]. The price of these training mannequins and the complexity of setting them up limit their accessibility. In many cases, students have opportunity to use these resources only a couple of times during a course. On the other hand, educational tools such as mobile apps have been shown to be similarly effective to a high-fidelity human patient simulator with regards to retaining new knowledge and teaching cardiopulmonary assessment skills, as indicated by Yoo and Lee [34]. In this work we introduce OMARC, an online multimedia application designed to support the training of health care professionals to identify and assimilate lung sounds. OMARC stands for Online Multimedia Application for the Assessment of Respiratory Conditions. By developing OMARC, this research explores the use of multimedia applications for training health care providers to identify sounds from a patient's thorax (i.e., the chest region). Since practicing health care professionals may also need to refresh these same skills from time to time, they are also a target audience for OMARC and we certainly expect that they would also benefit from it.

In addition to addressing the limitations of existing training material, a major consideration that this research aims to address is the possibility of offering a training application that is available to people who might be at a remote location, a rural setting, or studying online, and might not have ready access to the facilities and resources of higher education institutions such as universities or colleges. Our proposed solution for these circumstances is to make the multimedia training application available over the internet by using a widely available multimedia platform to present web-based applications. From a remote location, any smartphone, tablet or other internet-enabled computer or device with a web browser and the Flash Player installed, would allow users online access to OMARC.

The prototype developed during this research project integrated lung sounds with interactive multimedia elements in the context of a clinical setting describing two case studies. These case studies described the change in the patient's condition through multiple visits to the health-care provider. The prototype has been developed in Adobe's Flash Builder and ActionScript [17] and has a database back-end which is accessed through Apache [18], MySQL [19], the Zend Framework [28], and PHP [20]. There are numerous applications currently available for accessing lung (and heart) sounds, including some that can be used in multiple platforms and are free to download [10–16]. However, pulmonary auscultation findings must be interpreted carefully and put into context with other clinical findings [42]. What makes OMARC unique is that it presents a narrative about abnormal lung sounds, using interactive media showing the locations in the chest where these sounds are usually found, and describing the patient conditions that are associated with these sounds via sample case studies designed by professional nursing practitioners and educators, whereas other software simply presents the sounds in isolation without any additional information.

OMARC offers a truly interactive multimedia experience that integrates educational technology a way that is affordable and easy to use but most importantly, facilitates learning. OMARC has been used to perform a pilot study to find out whether it actually addresses the limitations of traditional learning resources, while

avoiding the costs and accessibility limitations of high-cost training solutions such as mannequins. The participants in the study were ten first year nursing students at Memorial University of Newfoundland. The case studies presented to the participants were fictional case studies developed by Dr. Karen Andres and Dr. Creina Twomey, and the sounds used were licensed for research and academic use from the audio CD of "Auscultation Skills: Breath and Heart Sounds" by Wolters Kluwer Health [2]. The application was designed and implemented by Mr. Pranjali Patra and Dr. Oscar Meruvia and the statistical analysis of the results of the study was done by Dr. Lourdes Peña-Castillo. The user study was reviewed and approved by Memorial University Interdisciplinary Committee in Ethics in Human Research ICEHR # 20141133-SC.

In the pilot study we found that the multimedia software application is associated with an improvement in the user's ability to identify the different types of lung sounds, when compared to the use of a sounds glossary. Not only did the results of the pilot study show a statistically significant improvement in the trainees' ability to identify lung sounds, but feedback from the participants was overwhelmingly positive. For instance, 70% of participants stated that the application helped them learn the sounds or that they would recommend the application to other persons in their field.

This research project started out as a vision to improve the current learning resources available for nursing students to gain expertise in health assessment in a way that is innovative, accessible and affordable. As noted by Ribbons [31], in an environment of increasing economic constraint, it is necessary for nurse educators to design and implement cost-effective teaching and learning strategies. We found lung sounds assessment is one of the most important elements to teach students learning health assessment [42,43]. Different approaches to solve the problem were considered and initially it was devised that something in the format of a serious game could be attempted [21–27]. However, there are several existing serious games for health professionals and serious games development requires more human and material resources than the ones available for this project. Hence, we chose to develop a multimedia application to support lung sounds assessment. Multimedia computer-based learning tools have been previously created for pulmonary auscultation, and there is evidence that multimedia training improves learning and performance skills [36–38]. For example, Sestini et al. [36] found that medical students who attended a multimedia seminar on lung sounds during which digitized lung sounds were played and the corresponding time-expanded waveform and frequency spectrum were commented on and displayed on a computer, had significantly lower inaccuracy score than those students who did not attend the multimedia seminar. However, none of these multimedia tools present lung sounds within the context of case studies in the way OMARC does.

As we worked through the design of the software, it became evident from early on that we could not just simply introduce a new application to the community but that it had to be shown that the application enhanced student learning related to health assessment. Based on a review of the state of the art, it is clear that there are many websites and mobile apps focused on health assessment and student learning [10–16]. However, few of these tools have been shown to enhance student learning. This shortcoming has already been pointed out by Yoo and Lee [34]. In their study, students using a mobile app retained their knowledge of lung assessment longer than students using a high-fidelity human patient simulator. A contribution similar to OMARC is that presented by Hou et al. [35], where a computer-aided learning system for assisting teachers and nursing students in auscultation techniques was developed. It allows teachers to record lung sounds and to provide these sounds with additional figures and videos, allowing nursing students to self-study auscultation techniques. Their results from a user study with 15 nursing students show that

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