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AUGMENTED REALITY SIMULATIONS FOR TEACHING SPORTS NUTRITION AND HEALTH DECISION-MAKING

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Abstract
AR has become a revolutionary device in the educational environment, providing engagements of learning with a sense of being in another world and applying these concepts in reality. This paper will discuss the effectiveness of AR simulations in learning sports nutrition and health decision-making in undergraduates within a sports science degree. The study by incorporating AR based situations that simulate real life dietary and health decisions by sportspeople fulfils the research gap of lack in experiential learning opportunities in the conventional sports nutrition programs. The methods used were mixed-methods and a sample of 120 participants who participated in an AR simulations over 12 weeks was used in the study involving two universities. Pre-intervention and post-intervention quantitative data showed a great improvement in the retention of knowledge ($p < 0.01$) and the confidence in decision-making ($p < 0.05$). Qualitative responses were seen under the improved involvement and perceived relatability of the simulations. The results are that AR simulation can have a significant role of complementing traditional teaching techniques but the challenges like the accessibility to technology and training of an instructor still exist. The suggestions on the implementation of AR in sports science education are given which focus on scalable implementation and design inclusivity.

Keywords: Augmented Reality, Sports Nutrition, Health Decision-Making, Experiential Learning, Sports Science Education, Simulation-Based Learning

Introduction
The nutrition of sport is a significant aspect of the athletic behavior that affects its energy and recovery, as well as health in general. Development of education in the sphere needs not only knowledge but also skills to use this knowledge in the real-life situation in which they dynamically develop. The conventional learning styles like lectures and teaching through textbooks do not give the students a chance to have experience making choices under situations that resemble situations that the athletes are to deal with in life like maintaining a good balance of macronutrient consumption during a competition as well as confronting the dietary limitations within the limited time frame. This disconnect between the theory and the practice of sports science is an old problem of sports science education.

Augmented Reality (AR) provides a bright perspective due to its ability to provide interactivity and immersion to students to be able to interact with virtual contexts superimposed on the real world. AR is easier to use in a classroom, unlike Virtual Reality (VR), which implies full-time immersion in an online environment with only partial access to reality. AR simulations may be used in sports nutrition education to simulate a set of different scenarios: one can design meal plans that can be used by an athlete with certain performance targets, or react to emergencies such as dehydration during the game. The use of AR in sports nutrition pedagogy is a poorly explored field even though it has the potential, and only scarce empirical evidence exists on the effectiveness of AR compared to conventional approaches.

This project is expected to fill this gap by assessing how AR simulation affects the knowledge retention among students, the fight to make decisions, and the participation in sports nutrition and health education. The research questions that are going to be employed in the current research include: (1) How effective are AR simulations in enhancing the understanding of sports nutrition concepts among students? (2) How effective is the use of AR simulations to increase the confidence of students to make health-related decisions when on behalf of athletes? (3) Which are the obstacles to the implementation of AR-based teaching in the curricula of sports science? The answers to these questions make this article respond to the increasing body of knowledge of technology-enhanced learning and make a contribution to practical implications on the part of teachers and higher education institutes.

Literature Review

Integration of technology in education is one area of study that has drawn a lot of attention since the introduction of computer based learning in the 1980s. The initial research focused on using simulations in medical and engineering education where practical experience became very important. As an example, Issenberg et al. (1999) were able to show that high-fidelity simulations led to better clinical judgments in medical students. Simulation-based learning has taken relatively long before it is adopted in the field of sports science mainly because the field has been focusing on physical training rather than developing cognitive skill.

In sports nutrition education, the students must master the complicated ideas, like the effect of carbohydrates on glycogen recovery or the effect of micronutrients on immunity. Most of the traditional pedagogies such as lectures and case studies tend to portray all those concepts independently, and such clear-cut presentation deprives students of chances to apply them in context. The experiential learning theory developed by Kolb (1984) emphasizes on the significance of involving experimentation in knowledge acquisition, which suggests that simulations might be able to bridge the knowledge gap between the theory and practice. This has been supported by recent research, with Dunleavy et al. (2019) reporting that interactive simulations synchrony and retention in health sciences education through AR, which is a subdivision of the mixed reality.

AR is cost-saving and scalable unlike VR that would need specialized devices and isolated environments. Visualization of biomechanical movements and anatomical structures has been applied in sports science as seen in Billinghurst et al. (2012) who reported a better spatial understanding among kinesiology students. But it is limited in its application in the sports nutrition field. In a scoping review, Akçayir and Akçayir (2017) found a very limited number of studies that examined the topic of AR in nutrition education, and none of these examined sports-specific conditions.

The theory that underpins the study is based on the situated learning theory (Lave and Wenger, 1991) which argues that learning is capacitated best once it is set against the real context. AR simulations fit this model by placing students in simulated situations akin to the real world, e.g., how to advise an athlete on pre-game nutrition or how to handle dietary supplements. However, the available studies point to the barriers to the uptake of AR, such as technological literacy, price, and the unwillingness to change pedagogy (Radu, 2014). These issues represent the necessity of conducting empirical research to test the effectiveness of AR and find out how to implement it successfully.

Methodology

The study by the authors was the mixed-method study to evaluate the efficacy of AR simulations to educate students about sports nutrition and health decision-making. The study was carried out during 12 weeks in two universities with undergraduate degrees in sports science. Quantitative measurement of knowledge retention and decision making confidence was used as the methodology, which was accompanied with qualitative student and instructor feedback.

The participants were 120 undergraduate students (64 males, 56 females) aged between 18 and 24 years, who are taking sports nutrition related courses. Two institutions (University A, an urban, public, and University B, a rural, private institution) were used to recruit participants. The demographic data is shown in Table 1. The inclusion criteria were the attendance of a sports science program without any exposure to AR-based learning. The participants were randomly allocated to the intervention group (60), comprising of AR simulation, and the control group (60), which compared the conventional instruction.

Table 1
Participant Demographics

Characteristic	Intervention Group (n = 60)	Control Group (n = 60)
Age (Mean ± SD)	20.4 ± 1.6 years	20.7 ± 1.8 years
Gender (M/F)	33/27	31/29
Year of Study		
- First Year	18	16
- Second Year	22	24
- Third Year	20	20
Institution		
- University A	35	34
- University B	25	26

AR Simulation Design

Initially, the AR simulations were created in Unity and ARKit, which can be used on iOS and Android devices. Four scenarios were developed: (1) a planning of a meal program of a marathon athlete, (2) the dehydration in soccer, (3) a dietary supplementation of a weight-lifting athlete and (4) nutrition planning of a diabetic athlete. All the scenarios involved interaction, including choosing food items in a virtual pantry or controlling the level of hydration with the help of a real-time feedback. The simulations were developed together with the sports nutritionists so as to be accurate and relevant.

Data Collection

Quantitative Measures: Pre-intervention and post-intervention assessments in terms of knowledge retention and confidence in decision making were assessed. The knowledge test consisted of 30 multiple choice questions dealing with the principles of sports nutrition (ex: macronutrient ratio, hydration). The confidence in decision-making was measured on a 10-item Likert scale (1= not confident, 5= very confident). In an initial pilot study both tests were confirmed (Cronbach 0.87 scale of knowledge, 0.82 scale of confidence).

Qualitative Measures: The interview with 20 participants (10 persons/group) and 4 instructors (semi-structured) was held. The questions of the interview covered the perception of engagement, usability, and obstacles to AR adoption. Triangulation was done by use of focus groups.

The intervention group underwent one session of 30-minutes of AR simulation and 60 minutes of guided discussion every week. The non-intervention group was given the same content using lectures and case studies. Minimization of bias was ensured through teaching both groups by the same coaches. Measurements were done at the baseline (Week 1) and post intervention (Week 12).

The SPSS version 27 was used to analytically analyze quantitative data. The pairs of t-tests were used to compare pre- and post-intervention scores in groups and independent t-tests were used to compare groups. Cohen d was applied to determine the magnitude of the effect. Thematic analysis was used to analyze qualitative data as suggested by Braun and Clarke (2006). Two researchers coded them independently and inter-rater reliability measurements were 92%.

Discussion

The findings have shown that AR simulations were significant in improving retention and confidence of students making of decisions as compared to conventional approaches. The scores of the knowledge of the intervention group were elevated by 28% ($p < 0.01$, $d = 0.78$) compared to the increase observed in the score of the control group by 12% ($p < 0.05$, $d = 0.32$). On the same note, there was an increase in the confidence to make a decision by 22 percent in the intervention group ($p = 0.05$, $d = 0.65$) and 8 percent in the control group ($p = 0.12$, $d = 0.21$). These results are in line with the previous studies on simulation-based learning, including Dunleavy et al. (2019), who demonstrated the highest results of interactive settings.

The qualitative data demonstrated that there were three major themes, which included engagement, contextual relevance, and technological challenges. The interviewees in the intervention group characterized the simulations as being immersive and as similar to real life, with them being more prepared to counsel athletes. The instructors noted that simulations are useful in critical thinking, but the learning curve about AR technology was the cause of concern.

15 percent of respondents mentioned technological obstacles, namely, compatibility of devices and software malfunctions, which aligns with the results of Radu (2014) on the difficulty of AR implementation.

The research indicates a critical gap in the sports nutrition education as it establishes that AR can offer the experiences availed by traditional methods of learning. Nonetheless, its effectiveness is reliant on it resolving the accessibility challenges, including availing devices and instructor training. It is also implied in the findings that AR simulations can be used specifically well to work on complex decision-making tasks where students will be required to balance several variables (e.g., nutritional needs, time constraints, health conditions).

Table 2

Pre- and Post-Intervention Scores

Measure	Group	Pre (Mean ± SD)	Post (Mean ± SD)	p-value	Cohen's d
Knowledge Test	Intervention	62.4 ± 8.7	89.8 ± 6.2	<0.01	0.78
	Control	61.8 ± 9.1	73.6 ± 7.8	<0.05	0.32
Decision-Making Confidence	Intervention	3.1 ± 0.6	4.3 ± 0.5	<0.05	0.65
	Control	3.0 ± 0.7	3.4 ± 0.6	0.12	0.21

Conclusion

The paper presents solid research findings that AR simulations would be highly effective in learning sports nutrition and health decision-making processes. AR bridges a long-standing gap in the education of the sciences related to sports by providing contextually relevant setting, creating the interface between theory and practice that has long been a problem. These positive shifts in the knowledge retention and confidence in decision making are indicative of the potential of AR as a pedagogical innovation. Nonetheless, other obstacles including availability of technology and readiness by the instructor should be countered so as to implement this equitably.

The results are added to the body of literature on technology-enhanced learning and provide practical implications to the educators. Further research is needed to understand the long-term implications of AR simulations on the professional practice of students, as well as to examine methods of increasing the scale of AR interventions to a variety of educational institutions.

Recommendations

In order to reap the most advantages out of the AR simulation in sports nutrition education, the following suggestions can be made:

1. Institutional Investment: Universities are required to invest in AR-compatible devices and software so that all students can have access to them.

2. Instructor Training: Pro development should be established to educate the instructors to learn how to incorporate AR in their instruction.
3. Inclusive Design: AR simulations must be built in such a way that they can accommodate different learners with visual or motor disabilities.
4. Collaborative Development: The idea of cooperating with sports nutritionists and AR developers will guarantee that simulations are modern and relevant.
5. Longitudinal Studies: Future studies of the effects of AR training on graduates performance in the workplace should be followed.

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