

# Integrating scientific research into undergraduate curriculum: A new direction in dental education

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## ABSTRACT

**Background:** The advantages of involving students in scientific research have been well-documented. Many educational organisations and universities have placed emphasis on integrating scientific research into the undergraduate curriculum.

**Aims:** The objective of this paper is to elaborate on the importance of integrating scientific research into the undergraduate curriculum and to propose a model on how to integrate it into the current curriculums.

**Methods:** In this proposed model, students would be exposed to research in each academic year from the 1<sup>st</sup> year up to the 5<sup>th</sup> year. In the 1<sup>st</sup> year, students would attend lectures introducing them to scientific research. In the 2<sup>nd</sup> year, students would be distributed among the faculty members and would be exposed to a more detailed research science by having lectures that explain research problems, and the objectives of the study. In the 3<sup>rd</sup> year, students would have detailed lectures about study designs and how to write one. In the 4<sup>th</sup> year, students would have lectures about biostatistics, in addition to, lectures that explain how to write the 'Results' section of their study in a manuscript format; then they would be trained to conduct the study and collect pertaining data. In the 5<sup>th</sup> year, students would have lectures on the components of the 'Discussion' and 'Conclusion' sections as well as how to write them appropriately in a manuscript format. Finally, they would be taught on how to finalize editing of their research manuscript in preparation for publication. In the internship programme, they would be obligated to conduct another study independently, in order to evaluate their understanding.

**Conclusion:** The undergraduate research is a cumulative learning experience which requires the support of the institute and faculty. Establishing a dental student research journal would encourage students to conduct and publish their research.

**Keywords:** Curriculum, dentistry, scientific research, student research journals, undergraduate student

## INTRODUCTION

Scientific research grows around the world. It is important to develop students' research skills before graduation by involving and teaching them how to conduct scientific research while they are

still studying their courses. Many universities have integrated scientific research within their curriculum.

Most healthcare professionals agree that high-quality care is achieved when practice is based on evidence. There is an increasingly growing trend towards integrating scientific research training into undergraduate medical education, and this is widely discussed in the literature. Some studies recommend integrating research along with clinical training,<sup>[1]</sup>

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Many learning theories have put emphasis on active learning activities, and conducting scientific research is one example of these. It has been suggested that training in scientific thinking and research methodology should become an integrated part of the medical undergraduate curriculum.<sup>[2]</sup> The aim of this paper is to elaborate on the importance of integrating scientific research into the undergraduate curriculum and to propose a model on how to integrate it into the current curriculums.

### Advantages

The advantages of involving students in scientific research have been well-documented whereby students learn how to conduct literature searches, collect and analyse data. Engaging students in undergraduate research would enable them to begin thinking like a specialist or scientist,<sup>[3]</sup> achieve more sophisticated levels of intellectual development,<sup>[4]</sup> promote the acquisition of research knowledge and skills, understand scientific findings, analyse literature critically, speak effectively and act as a leader with clear career goals.<sup>[5]</sup>

Several studies mention that students' experience in research helps them to develop higher order research competencies such as critical thinking, problem-solving, life-long learning, hypothesis formulation, methodology delineation and results interpretation<sup>[6]</sup> and improves their oral and written communication skills as well.<sup>[7]</sup> Pascarella and Terenzini, in their study, noted that the undergraduate research programme had several positive effects on students who participated in them, such as greater knowledge retention and greater likelihood of enrolling in graduate school.<sup>[5]</sup> Nadga found that students who participated in the University of Michigan's Undergraduate Research Opportunity Program had higher retention rate compared to those who did not participate in the research programme.<sup>[8]</sup>

### Educational organisation

Many educational organisations and universities have placed emphasis on integrating scientific research into the undergraduate curriculum. The World Federation for Medical Education recommends in its 'Standards for Quality Improvement in Medical Education' that the interaction between medical research and education activities should be reflected in the undergraduate curriculum, and should encourage and prepare students to engage in medical research and development.<sup>[9]</sup>

The Boyer Commission on Educating Undergraduates in the Research University (1998) recommended making research-based learning the standard in the undergraduate curriculum.<sup>[10]</sup> The American Dental Association also has included the integration of research in its Accreditation Standards for Dental Education Programs.<sup>[11]</sup> Likewise, the Accreditation Requirements

for DDS or DMD programmes from the Canadian Dental Association's Commission on Dental Accreditation of Canada (2010) require a faculty commitment to research and scholarly activity with student involvement.<sup>[11]</sup> Furthermore, in 1978 the council on undergraduate research was founded to support undergraduate research in the US undergraduate institutions.<sup>[4]</sup>

Many dental schools in the United States and Canada have integrated scientific research into their curriculum.<sup>[11]</sup> Different methods were discussed in the literature regarding engaging students in undergraduate research activities by medical schools such as research-driven curricula, research electives<sup>[12]</sup> and compulsory research projects for graduation.<sup>[6,13]</sup>

Universities such as McMaster University, Canada (since the late 1990s), Miami University, Ohio, US, University of Sydney, Australia, Queens University, Canada, University of Newcastle, UK, University of Adelaide, Australia, Marquette University School of Dentistry,<sup>[14]</sup> The University of Nevada, Las Vegas, School of Dental Medicine,<sup>[15]</sup> and the University of Colorado, School of Dentistry, have implemented integration of scientific research into their curriculum.<sup>[4]</sup> The UCLA School of Dentistry initiated an independent research course for students in 1994.<sup>[16]</sup> Some of the universities in the Kingdom of Saudi Arabia have integrated research into the curriculum, like College of Medicine in King Saud bin Abdulaziz University for Health Sciences and Qassim University. Many studies have revealed that medical research can be successfully integrated into undergraduate medical training.<sup>[2,13,17]</sup>

There are four main ways of engaging undergraduates students on research and inquiry:<sup>[18]</sup> (1) Research-led: Learning about current research in the discipline, (2) Research-oriented: Developing research skills and technique, (3) Research-based: Undertaking research and inquiry, (4) Research-tutored: Engaging in research discussions.

### Attitude

Attitude and perception of undergraduate students have been investigated in many studies. Students were particularly interested and very satisfied with their experience in scientific research.<sup>[14,18,19]</sup> Students felt a positive experience after conducting scientific research.<sup>[15,19,20]</sup> Moreover, students who participated in the Mentored Student Project programme demonstrated success in fostering positive attitudes towards scientific research skills.<sup>[7]</sup> A number of factors can affect student attitude and experience with a compulsory, short-term research project, like previous attitudes, perceived quality of supervision and perceived relevance to their professional future.<sup>[21]</sup>

## METHODS

### Model of integrating research into undergraduate curriculum

In this model, students would be exposed to research in each year of the undergraduate programme by conducting research (step by step) from the 1<sup>st</sup> year up to the 5<sup>th</sup> year.

In the 1<sup>st</sup> year, students would attend lectures introducing them to scientific research and explaining the importance of dental science research along with a brief background on the types of study designs and the components of a manuscript.

In the 2<sup>nd</sup> year, students would be distributed among the faculty, for example, every three students would be supervised by a faculty member. No single student would work alone in order to foster team work. In this year, students would be exposed to a more detailed research via lectures that explain research problems, research questions and the objective of the study. The student would become familiar with the components of the 'Introduction' section of a manuscript by learning how to write it, how to conduct a literature review, how to select a topic and how to write the objectives appropriately. By the end of the 2<sup>nd</sup> year, students would be obligated to finish writing their research's 'Introduction' section.

In the 3<sup>rd</sup> year, students would have detailed lectures about study designs and how to write one. This is the time they would select the proper study design for their study. By the end of this year, students would be obligated to finish writing the 'Materials and Methods' section for their study.

In the 4<sup>th</sup> year, students would have lectures about biostatistics and how to write the results of their study in the manuscript. They would be trained to conduct the study and collect the data. At the end of the 4<sup>th</sup> year, students would be obligated to finish writing the 'Results' section of their manuscript.

In the 5<sup>th</sup> year, students would have lectures on the components of the 'Discussion' and 'Conclusion' sections of a manuscript and on how to efficiently write them based on their study. At the end of the 5<sup>th</sup> year, the students should review and finalize editing their research manuscript in preparation for publication.

During the internship training programme, students (interns) would be obligated to conduct another study independently, in order to evaluate their understanding. In this manner, they would have finished two scientific studies before receiving their bachelor degree.

## Barriers

Studies have reported many barriers encountered by undergraduate students when conducting scientific research, such as: Inadequate time for research, inadequate experience and limited time for faculty to mentor undergraduate students, inadequate funds, defective infrastructure and lack of institutional motivation.<sup>[1,5,11]</sup> Overwhelming academic workload and insufficient thorough instructions on the basics of scientific research at the colleges were also contributing barriers.<sup>[6]</sup> Brazilian students perceived that lack of institutional incentive is the most significant barrier to their participation in research activities.<sup>[19]</sup>

## CONCLUSION

The undergraduate research is a cumulative learning experience. It is recommended to engage students in research from the early stages<sup>[22]</sup> It not only provides an environment for them to learn how research is conducted but it also helps them to experience how research contributes to improving the practice<sup>[23]</sup> The basic requirement for integrating research into the undergraduate curriculum is commitment. Thus, developing institutional awareness and establishing a mission is important in the integration of scientific research into the curriculum. Research funding should also support undergraduate research for this concept to function efficiently. Role-modelling by faculty members will also predict the success of a research. Establishment of dental student research journal might encourage students to conduct and publish their research. This model will enable undergraduate students to experience scientific research, prepare them to become confident learners and improve their critical and analytical skills.

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### Conflicts of interest

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