

Enhancing Knowledge, Skills, and Confidence of Oral Health Professionals Through Head Simulator Training: A Perceived Benefit

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Abstract

Researchers have revealed the advantages of experiential learning for students and professionals at all levels of the health care delivery system. The purpose of this study is to determine the effectiveness of the use of head simulators in dental school in acquiring proficient periodontal knowledge, dental skills, and confidence by practicing oral health professionals. Of the 117 purposive sampled participants surveyed using a 5-point Likert scale questionnaire, 60 respondents used head simulators during their dental school education. On the effect of the head simulator enhancing knowledge. The findings regarding the effect of the head simulator in dental school revealed varying perspectives. A significant majority of participants agreed the head simulator had a beneficial effect on their skills. Among these findings, a third of participants strongly agreed the use of the head simulator notably enhanced their skills. When considering the influence on knowledge, the responses were more evenly distributed. Almost 40% of participants agreed the head simulator positively affected their knowledge, while almost 20% of participants generally disagreed. Examining the effect on confidence, findings also depicted varying viewpoints among the participants with 42% acknowledging the head simulator had a positive effect on their confidence. The findings suggest that head simulators positively affect dental education, particularly in enhancing knowledge, skills, and confidence.

Keywords: confidence, dental skill, experiential learning, head simulator

1. Introduction

Simulation-based training has gained substantial attention and research over the past two decades as a method to improve learning and performance in the healthcare sector. These simulators, designed to replicate real-world scenarios, are extensively employed in preclinical training across various health care professions. Health care institutions use preclinical training simulators to equip students to diagnose illnesses, administer care, and perform surgical procedures (Joda et al., 2019). A study by Yamaguchi et al. (2013) underscored the effectiveness of training simulators in improving hand skills for dental procedures like tooth removal. Despite their utility, head simulators used in dental colleges have limitations that constrain students' learning of comprehensive knowledge and skills (Cook & Hatala, 2016). For instance, simulators may not accurately replicate the time constraints, resource limitations, and other practical considerations inherent in clinical practice. Oral health professionals who have only trained on simulators during their dental education may be unprepared for the realities of real-world patient care and may struggle to adapt to the demands of a clinical setting (Asao et al., 2017).

Oral health professionals play a crucial role in providing oral health care to patients. Dentists, dental hygienists, and dental assistants are trained through a combination of classroom learning and hands-on clinical experience (Peres et al., 2019). The use of simulation training in dental education has become increasingly popular to enhance the knowledge, skills, and confidence of oral health students in preparation for clinical practice. Simulation training is used to teach a range of skills from basic techniques and procedures to complex surgical procedures. Simulation training provides oral health professionals with the opportunity to practice and perfect their skills without the risk of adverse outcomes for real patients (Naik & Brien, 2013).

Simulation plays a pivotal role in dental education by facilitating practical learning opportunities that empower

students to develop and refine their skills as well as expand their knowledge in a secure and controlled setting (Li et al., 2021). Beyond hands-on training, head simulators are employed to appraise clinical competence. This enables educators to evaluate students' knowledge, skills, and confidence, and acquire feedback to offer tailored assistance as needed (Kiernan, 2018). In dental education, simulation has a strong and extensive academic history, and the integration of head simulators has evolved into a conventional approach to prepare oral health students for the complexities of real-world clinical scenarios (Mascarenhas et al., 2021). The advancement of simulation technology has notably improved head simulators, rendering them capable of delivering realistic and immersive training experiences.

Simulation-based training provides structured, valuable learning opportunities that are difficult to replicate in real life. Simulation-based learning can be tailored to suit learners of varying levels, from novice to expert. Beginners build skills and gain confidence in procedures and tasks, while experts enhance communication and teamwork skills and stay up to date on new technologies and treatments. Simulation-based training provides a gap-filling solution for complex procedures and unique diseases, which are rarely available for practice in clinical settings (Ayaz & Ismail, 2022). Therefore, integrating head simulator technologies into dental curricula with case-based scenarios allows students to achieve a level of competency needed to begin clinical practice and handle difficult situations with precision and proficiency.

1.1 Theoretical Framework

The health belief model (HBM) proposes that an individual's decision to use simulation is affected by their views about the perceived susceptibility, severity, benefits, and barriers associated with the simulation's ability to be effectively used by an oral health professional and student (Remien et al., 2019). The HBM gives insight into the factors that influence educational assessments to adopt the head simulator technology based on measured outcomes of dental student knowledge and skill. The HBM offers a framework that is crucial in determining the effectiveness of using head simulators in dental school to develop proficient dental skills by oral health profession students. Understanding the benefits associated with the use of head simulators, dental educators can design effective strategies to promote the adoption and integration of this technology into the dental curriculum. This can ultimately lead to improved dental education and better oral health outcomes for patients. HBM's perceived benefits will provide an in-depth exploration of the effectiveness of the use of head simulators in enhancing the knowledge, skill proficiency, and confidence of oral health care professionals (Abraham & Sheeran, 2015). HBM can therefore be used to explore how head simulators provide oral health care professionals with the opportunity to engage in self-directed learning that leads to more effective training programs and better equipped oral health care professionals who are better prepared to provide high-quality oral health care services to patients.

1.1.1 HBM Perceived Benefits in Relation to Knowledge, Skill Proficiency, and Confidence

Using HBM as a theoretical framework to understand the factors that influenced the professionals' participation in the training, a study found that the perceived benefit of head simulator training was improving the confidence of oral health practitioners and reducing errors in clinical practice (Solhi et al., 2010). Solhi et al. (2010) further suggested that head simulator training was effective in improving the knowledge and skills of oral health care professionals.

Through the application of the HBM, the current study explores the perceived benefits of head simulator training for oral health care professionals during their dental education.

Few studies have explored the skills, knowledge, and confidence that health professionals acquired using the head simulator technology during their school years. This demonstrates the need to assess the effectiveness of teaching technologies and implement appropriate infrastructures for effective education in the health professions. This current study aims to determine the effectiveness of the use of head simulators in dental school in acquiring periodontal knowledge, dental skills, and confidence by practicing oral health professionals.

2. Method

2.1 Research Design

A quantitative research approach was used to acquire data from practicing oral health care professionals using a survey through Jotform (version 4.0). Following other survey templates, questionnaires with a 5-point Likert scale produced the same results for both studies (see Appendix A) were generated as the data collection instrument (Avedian, 2014). The questionnaires underwent content validity analysis by a subject matter expert in oral health education and a research methodologist.

2.2 Sample and Recruitment

This study considered practicing oral health professionals associated with the Nebraska Dental Association (NDA) and the Ghana Dental Association (GDA) who have either used or did not use simulators during their training in dental school. The purposive sampling technique was adopted to select participants with the expertise to meet the purpose of this study. The targeted participants for the study were dental hygienists, dentists, and dental assistants. To initiate recruitment, a “cold call” email was sent to potential participants from the NDA after obtaining email addresses from a mailing list purchased from the Nebraska Department of Regulation and Licensure. The email invited them to participate voluntarily in the research. This email included a survey hyperlink to the online survey platform. The hyperlink to the survey provided essential study details including the background, purpose, potential risks and benefits, the Institutional Review Board approval number, an informed consent statement, and the questionnaire. Anonymity in participation was emphasized in the email to the prospective participants. Participants could opt out of the research study at any time with no penalty. Recruiting participants from GDA was done by posting the description of the research and the survey hyperlink on the Association’s WhatsApp platform. The survey platform had an integrated logic that sent an email notification after a survey submission, allowing anonymous tracking of the number of participant responses to the survey.

2.3 Data Collection and Management

The survey employed a closed-end, 5-point Likert scale format, with mandatory answer-required response multiple choice options, following the methodology described by Young (2015). Following a pilot study that led to several key improvements, the main data collection phase was executed, considering the suggestions and recommendations derived from the pilot study. Data collected were stored securely in Jotform (version 4.0). A logic called Unique Submission was enabled in Jotform (version 4.0), using internet cookies and/or IP addresses in building the survey that implemented a once-participatory response to prevent participants from submitting multiple entries. In addition, the collection of personally identifiable information was avoided in the survey creation and response submissions. Data cleaning was done to resolve inaccuracies, mitigate biases, and strengthen the credibility of research outcomes.

2.4 Data Analysis

The sample demographics, including level of education and profession, were described using measures of central tendency. As part of the data analysis process, cleaned data was validated in Airtable and analyzed with the Statistical Package for the Social Sciences, version 29. This sample data analysis was based on descriptive and inferential statistics. A correlation analysis was conducted to explore the correlation between the use of head simulators and knowledge, skill, and confidence. The significance level was set at $p < 0.05$, following Laerd Statistics (n.d.).

3. Results

In total, the survey was completed by 117 participants, with 55 indicating their gender as male, 61 as female, and one participant choosing not to specify their gender preference. The 117 participants included 88 dentists, 27 dental/oral hygienists, and 2 assistants with postsecondary diploma education (see Table 1).

Table 1. Frequency distribution for profession and educational level of participants in the survey

Profession	Level of education				Total
	Associates	Undergraduate	Graduate	Postgraduate	
Dentist	1	2	24	61	88
Dental/Oral hygienist	7	8	10	2	27
Dental assistant	0	1	1	0	2
Total	8	11	35	63	117

Among the participants, 60 individuals indicated they engaged with head simulation in their dental program experience. Conversely, 57 participants stated that they did not use head simulation during their dental program. Of the total 117 respondents on utilization of simulation in dental programs across the different professions, 46 dentists, 13 oral hygienists, and 1 dental assistant reported using simulations during their dental programs. A total of 30 participants responded to having engaged with head simulators in their first year of the dental program. After analyzing data on the utilization of head simulators across distinct phases of participants’ academic progression. For 20 participants, involvement with head simulators commenced in their second year, while 3 individuals

reported interacting with head simulators during their third year. Finally, 7 participants engaged with head simulators during their fourth year.

3.1 Head Simulator Use and Perceived Enhancement in Periodontal Knowledge

As summarized in Table 2, a total of 60 participants completed the survey about the effect of head simulator use on enhancing their periodontal knowledge. A majority of the participants, representing 38.3%, agreed that the head simulator positively influenced their knowledge. Additionally, 23.3% were neutral, while 18.3% disagreed, and 15% strongly disagreed. Only 5% of the participants strongly agreed with the positive effect of the head simulator.

Table 2. Perceived enhancement of periodontal knowledge due to head simulator use among oral health professionals

Rating	<i>n</i>	%
Strongly Agree	3	5.0
Agree	23	38.3
Neutral	14	23.3
Disagree	11	18.4
Strongly Disagree	9	15.0
Total	60	100

3.2 Head Simulator Use and Perceived Enhancement in Skill Proficiency

Among the cohort of 60 participants exposed to simulations, the survey aimed to assess the effect of head simulator utilization on the advancement of their skill proficiency. A significant majority, comprising 51.7% expressed agreement with the positive influence of the head simulator on their skills. Moreover, a notable 33.3% strongly concurred. Conversely, each category of “Strongly Disagree,” “Disagree,” and “Neutral” received only 5% of responses from the participants. (as indicated in Table 3), emphasizing the overwhelmingly favorable perception of the head simulator’s role in fostering skill development.

Table 3. Perceived enhancement of skill proficiency due to head simulator use among oral health professionals

Rating	<i>n</i>	%
Strongly Agree	20	33.3
Agree	31	51.7
Neutral	3	5.0
Disagree	3	5.0
Strongly Disagree	3	5.0
Total	60	100

3.3 Head Simulator Use and Perceived Enhancement in Confidence

Among the 60 participants in dental programs who had experienced simulations, 41.7% concurred that the head simulator positively affected their confidence. Additionally, 33.3% strongly agreed that employing a head simulator significantly improved their confidence. A minority, comprising 15%, maintained a neutral perspective, while 6.7% disagreed, and 3.3% strongly disagreed concerning the simulator’s influence on confidence (see Table 4).

Table 4. Perceived enhancement of confidence due to head simulator use among oral health professionals

Rating	<i>n</i>	%
Strongly Agree	20	33.3
Agree	25	41.7
Neutral	9	15.0
Disagree	4	6.7
Strongly Disagree	2	3.3
Total	60	100

3.4 Correlations Between Enhanced Periodontal Knowledge, Enhanced Skill, and Enhanced Confidence

Exploring the correlations between enhanced periodontal knowledge, skill, and confidence, there was a weak correlation between enhanced periodontal knowledge and skill from using head simulator ($r = 0.08$). Therefore, this correlation was not statistically significant ($p > 0.05$). Enhanced periodontal knowledge and confidence also showed no significance with Pearson correlation being 0.195 ($p > 0.05$). The correlation between enhanced skill proficiency and confidence was strongly significant ($p < 0.001$). This suggests that skill proficiency and confidence in clinical practice increased notably after using head simulators during dental school for oral professionals (see Table 5).

Table 5. Correlations between the perceived effectiveness of head simulator use among oral health professionals in enhancing knowledge, skill proficiency, and confidence in clinical practice

		Enhanced periodontal knowledge	Enhanced skill proficiency	Enhanced confidence
Enhanced periodontal knowledge	Pearson Correlation	1	0.084	0.195
	Sig. (2-tailed)		0.522	0.135
	N	60	60	60
Enhanced skill proficiency	Pearson Correlation	0.084	1	0.691**
	Sig. (2-tailed)	0.522		<0.001
	N	60	60	60
Enhanced confidence	Pearson Correlation	0.195	0.691**	1
	Sig. (2-tailed)	0.135	<0.001	
	N	60	60	60

Note. **. Correlation is significant at the $p < 0.01$ level (2-tailed).

3.5 Translating Knowledge, Skills, and Confidence from Head Simulators to Clinical Application

Out of 46 dentist participants using simulation during their studies, 36.9% found it relevant to acquire necessary dental skills through head simulators, while 39.1% considered it very important. Moreover, 36.9% highlighted the significance of applying knowledge from head simulations to clinical practice, with 30.43% emphasizing its high importance. Additionally, 10.9% found it moderately important, 13% slightly important, and 8.7% deemed it not important to translate skills from head simulators to clinical practice.

4. Discussion

Dental simulators are designed to mimic real-world situations, which has led to their wide use at various stages of dental health professionals' preclinical training in the diagnosis of disease, treatment, and surgical skills (Joda et al., 2019). Furthermore, according to Tavkar and Pawar (2017), dental simulation technology improves the quality of dental education through the skills and confidence dental students acquire by using various instruments in the oral cavity, which is essential for patient safety. Our study aimed to evaluate the effectiveness of using head simulators in dental school and the resulting effect on practicing oral health professionals to enhance periodontal knowledge, dental skills, and confidence.

In determining the effect of using a head simulator on enhanced periodontal knowledge, our results showed that most oral health professionals who engaged with head simulators during their dental school years agreed in response to the statement that head simulators had a positive effect on their periodontal knowledge. The researchers attribute this to the concept of experiential learning, where hands-on experiences can deepen one's

knowledge (Bowling & Underwood, 2016). Likewise, Ko and Kim (2014) found that simulation did not notably affect the enhancement of students' critical thinking. This was evident as a considerable number of participants disagreed that training with simulators significantly improved their comprehension of periodontal knowledge. Koukourikos et al. (2021) suggested simulation as a pivotal pedagogical tool that enables students to seamlessly connect theoretical knowledge with real-world scenarios that allow them to acquire invaluable experience within a controlled environment. This experiential approach not only deepens students' comprehension of healthcare science but also furnishes them with the indispensable practical skills required for success in their careers (Koukourikos et al., 2021). In essence, simulation plays an indispensable role in nurturing healthcare professionals who are well-rounded and proficient, as suggested by the responses from participants who were oral health care professionals.

Our results show a strong agreement among participants regarding the positive influence of head simulators on their skill development. The results lead to an interesting suggestion regarding the perceived benefits of head simulator use in dental education. Reviewing these results within the framework of the HBM, we believe the perceived benefits of head simulation outweigh the institutional barriers. The perceived value of simulator-based training in enhancing skill proficiency, viewed in this context, is consistent with Koukourikos et al. (2021).

Similar to findings reported by Cummings and Connelly (2016), our participants who participated in head simulator sessions observed improvements in critical thinking and skill proficiency. The responses from the oral health professional participants who had first-hand experience with simulations provide the perceived effect of head simulators on their confidence levels. A majority of participants concurred that the use of head simulators had a positive effect on their confidence, with an appreciable number of the participants expressing strong agreement with the statement that employing a head simulator significantly boosted their confidence. The use of simulators likely played a pivotal developmental role in their clinical capabilities. This finding underscores the potential of simulation-based training not only to enhance skills but also to foster a strong sense of self-efficacy. This aligns student feedback in a recent study on active engagement in simulations that led to enhanced learning experiences, ultimately contributing to an increase in student competence (Al Gharibi & Arulappan, 2020). However, responses from a small portion of the sample population highlighted the existence of a subgroup of oral health professionals for whom simulator-based training did not align with a noticeable improvement in self-confidence. Although experiential learning through simulation can enhance students' confidence by offering a controlled setting for them to refine their skills, this is not yet universally understood or true for all students.

The correlation between the improvement in periodontal knowledge and the acquisition of skills by using head simulators was weak. This suggests that gaining knowledge in periodontics did not strongly correspond to an increase in practical skill proficiency among participants who used head simulators. In essence, while participants may have acquired knowledge, that knowledge did not necessarily translate into enhanced practical skills. Furthermore, the correlation between the enhancement in periodontal knowledge and confidence level was not significant. This indicates that the augmentation in periodontal knowledge did not align with an increase in confidence among participants in this study and oral health professionals did not necessarily exhibit greater self-assuredness in their clinical practice.

The correlation between the enhancement in skill proficiency and confidence demonstrated a strong and highly significant level of correlation. This highlights the substantial and meaningful connection between skill proficiency and confidence. Consequently, these results imply practical skills cultivated through head simulator training played a pivotal role in bolstering the confidence of oral health professionals throughout their dental school education. In contrast to the largely theoretical training students have received up to this point, simulation-based education helps students advance their understanding, skills, and confidence while also giving patients and health care professionals a sense of safety (Aebbersold, 2018). Consistent with the study by Li et al. (2021), with repeated practice on head simulators, dental students develop a greater sense of mastery and control over complex dental procedures. This can help reduce anxiety and stress when treating patients, leading to better patient experiences and outcomes.

To further delineate the effectiveness of head simulator training in preparing oral health professionals with the essential dental skills required for their clinical practice and the ability to apply this knowledge to deliver high-quality oral healthcare, questionnaires were administered to dentists who had experienced head simulators during their dental school years. Notably, the responses from the participating dentists highlighted the significance of using head simulators for acquiring essential dental skills, underscoring their pivotal role in skill acquisition. Furthermore, additional inquiry aimed at determining the practical application of head simulation-acquired knowledge, skills, and confidence in real clinical settings was administered. In this regard, an appreciable number of the dentist participants indicated the ability to translate what they learned using head

simulators into their clinical practice was important. Dentist participants stressed the value of translating the knowledge, skills, and confidence gained through head simulation into their clinical practice. Consistent with the study by Li et al. (2021), with repeated practice on the simulators, dental students develop a greater sense of mastery and control over complex dental procedures. This can help to reduce anxiety and stress among dentists when treating patients, leading to better patient experiences and outcomes.

4.1 Limitations and Suggestions for Future Research

Recruiting an adequate number of participants was a challenge in our study. Although the sample size was sufficient to run our statistical analyses, a larger sample would have improved the generalizability of our results. It is suggested that future studies take into consideration the sample number to optimize the power of the study to arrive at conclusions. Additionally, we did not specifically account for the timing of head simulator training in oral health education; the time in a student program when simulation training is introduced may have affected the results. The results of the current study show a range of perspectives among participants regarding the effect of head simulators on their periodontal knowledge. Future research is needed to determine the factors that influence the suggestion of the use of head simulators that enhance periodontal knowledge in dental school and translation of knowledge, skills, and confidence to clinical practice. Given this study surveyed only dentists who had engaged with head simulators in determining the relevance of the use of head simulators in acquiring skills required in dental practice, the results cannot be generalized to a larger population of oral health professionals who lack this key experience. Further studies are recommended to consider other oral health professionals for better comprehension of the relevance of head simulator use in acquiring requisite dental skills and translating knowledge, skills, and confidence to clinical practice.

5. Conclusion

The current study presents findings that substantiate a clear link between the use of head simulators in dental programs and the perceived improvements in periodontal knowledge, skill proficiency, and confidence among oral health professionals. This study also suggests the effectiveness of simulator-based education in enhancing knowledge, skills, and confidence is not uniform and may be influenced by individual variables or the specific nature of the simulator experience. Nonetheless, due to the overwhelmingly positive responses in all three aspects, it can be confidently elucidated that there is a significant correlation between the use of head simulators and the enhancements in periodontal knowledge, skill proficiency, and confidence among practicing oral health care professionals.

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Authors' contributions

The study design and revisions were done by Dr. Samuel Eguasi Inkabi and Dr. Josh Bernstein. Dr. Samuel Eguasi Inkabi handled data collection, analysis, and results interpretation. The manuscript was drafted by Dr. Samuel Eguasi Inkabi and revised by Dr. Josh Bernstein. All authors reviewed and approved the final manuscript. Equal contributions were made by both authors to this study.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Obtained.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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Appendix A

Survey Questionnaires

SECTION 1

Background Information

Sex*

- a) Male b) Female c) Prefer not to say

Age*

- a) 20–29 b) 30–39 c) 40–49 d) 50+

Profession/Occupation*

- a) Dentist b) Dental/Oral Hygienist c) Dental Assistant

Level of Education*

- a) Associates b) Undergraduate c) Graduate d) Postgraduate

SECTION 2

RQ.1. What is the perceived effectiveness of head simulators use among the various oral health professionals in enhancing knowledge, skill proficiency, and confidence in clinical practice?

Did you use any simulation during your dental program?*

- a) Yes b) No

Did you have an orientation to the purpose of the head simulators?*

- a) Yes b) No

At what level in your program did you start using head simulators?*

- a) First year b) Second year c) Third year d) Fourth year

The use of the head simulator in dental school enhanced my Periodontal knowledge.*

- a) Strongly Disagree b) Disagree c) Neutral
d) Agree e) Strongly Agree

The use of the head simulator in dental school enhanced my Skill proficiency.*

- | | | |
|----------------------|-------------------|------------|
| a) Strongly Disagree | b) Disagree | c) Neutral |
| d) Agree | e) Strongly Agree | |

The use of the head simulator in dental school enhanced my Confidence.*

- | | | |
|----------------------|-------------------|------------|
| a) Strongly Disagree | b) Disagree | c) Neutral |
| d) Agree | e) Strongly Agree | |

Simulation training is effective in my ability to Give appropriate diagnosis.*

- | | | |
|----------------------|-------------------|------------|
| a) Strongly Disagree | b) Disagree | c) Neutral |
| d) Agree | e) Strongly Agree | |

Simulation training is effective in my ability to Reduce errors in treatment procedure.*

- | | | |
|----------------------|-------------------|------------|
| a) Strongly Disagree | b) Disagree | c) Neutral |
| d) Agree | e) Strongly Agree | |

Simulation training is effective in my ability to Interact responsibly with patients.*

- | | | |
|----------------------|-------------------|------------|
| a) Strongly Disagree | b) Disagree | c) Neutral |
| d) Agree | e) Strongly Agree | |

How relevant is the use of head stimulators in acquiring skills required in dental practice? *

- | | | |
|------------------|-----------------------|---------------------|
| a) Not important | b) Slightly important | c) Fairly important |
| d) Important | e) Very important | |

Rate the translation of what you learned using head simulation to your clinical practice? *

- | | | |
|------------------|-----------------------|---------------------|
| a) Not important | b) Slightly important | c) Fairly important |
| d) Important | e) Very important | |

All oral health profession students should receive training using head simulators.*

- | | | |
|----------------------|-------------------|------------|
| a) Strongly Disagree | b) Disagree | c) Neutral |
| d) Agree | e) Strongly Agree | |

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