



Knowledge, Attitude and Practice of Dental Students and Practitioners towards Virtual Reality Based Technologies in Central India: A Cross Sectional Survey

**Krishankumar S. Lahoti^{a*}, Sayali G. Dandekar^{a†}, Jaykumar R. Gade^{a#},
Megha J. Agrawal^{a†} and Karan V. Jaiswal^{a†}**

^a Department of Prosthodontics, Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Virtual reality based technologies, which are broadly used in aviation and telecommunication, is now emerging rapidly in the field of dentistry. This technology has progressed tremendously and is simultaneously being refined according to the requirements of the healthcare sector. Such technologies aid in better understanding in an educational setting and provide efficient learning ways which can reduce harm and help to improve patient treatment outcomes.

Aim: To assess the knowledge, attitude and practice of dental students and practitioners towards Virtual reality based technologies in Central India.

Materials and Methods: In this cross-sectional study a total of 270 dental students and practitioners across Central India were included. A questionnaire consisting of 26 Questions with regard to VRBT's was designed and the questionnaire was circulated through a web designed program. The responses were collected, and data were analyzed descriptively using SPSS Statistics for Windows version 24.0.

[#] MDS, Professor;

[†] PG Student (MDS);

*Corresponding author: E-mail: kk.lahoti@sdk-dentalcollege.edu.in;

Results: 90.37 % agreed that VRBT's could offer many advantages in comparison to conventional technologies used in dental education and practice. 91.1% had not used dental simulators but 35.93% of them believed that dental simulators can be used as a reliable evaluation tool in developing preclinical skills. 75.93 % estimated that VRBT's will gain popularity in dental practice within 5-10 years.

Conclusion: Learning and including these VRBT's as a part of undergraduate and continued education programmes could affect the willingness and utilization of these trends in future dental practice.

Keywords: Virtual reality based technology; survey; dental simulators; digital technology.

1. INTRODUCTION

Different digital applications like three-dimensional imaging as well as Computer aided design and computer aided manufacturing (CAD/CAM) are showing huge potential opening novel opportunities in clinical operational field and in education.

Virtual reality(VR) which is basically an artificial simulation of a real life environment or situation with the help of computer technology in which humans can interact with the help of specially designed electrical instruments like gloves, hand/body trackers, external sensors [1].

The developing field of Virtual reality is enabling applications offering efficient ways to improve manual dexterity and clinical skills which are paramount. Current dental education in India aim at psychomotor skill development through progression from instrument control to phantom head simulator followed by clinical performance on patients [2].

Virtual reality based technologies (VRBT's) offer advantages during the preclinical training and henceforth in routine dental practice compared to traditional solutions. VR is also a viable adjunctive non pharmacological analgesic for dental pain control and is known to reduce dental anxiety [3-4]. However, the infiltration rate and routine implementation of VRBT's is still unknown. Indian practice of is in its developing phase and still based on conventional techniques. Knowledge and specialized training for using such VRBT's is limited and known to very few. Therefore, this study was aimed to assess the knowledge, attitude and practice of dental students and practitioners towards Virtual reality based technologies in Central India.

2. MATERIALS AND METHOD

Study design: This is a cross-sectional study.

Study setting: The study was conducted in Central India in 2021 from 1/01/2021 to 30/06/2021 for duration of 6 months.

Study population: Dental students and General Dental Practitioners in Central India.

Inclusion criteria: All dental practitioners qualified to practice and students admitted in dental colleges. Inclusion criteria were independent of institute, gender, graduation year and curriculum content.

Exclusion criteria were invalid.

Study method: The study was carried out in Central India. A specially created web designed survey in Google forms was circulated among the students and General Dental Practitioners and the responses were recorded.

This questionnaire survey consisted of 26 questions based on the study conducted by Sabalic M et al, [5]. 4 demographic questions pertaining to Gender, year of dental school, Number of years practising dentistry, specialization were incorporated. 6 questions were knowledge based and remaining 20 questions were practice and attitude based.

The questionnaire assessed knowledge, attitude and practice of dental students and practitioners towards Virtual reality based technologies in central India (Table 1).

A total of 270 students and practitioners across Central India, were included in the survey.

The sample size was calculated using sample size formula for qualitative data for similar type of study conducted by Sabalic M et al. [5].

$$n = \frac{4pq}{L^2}$$

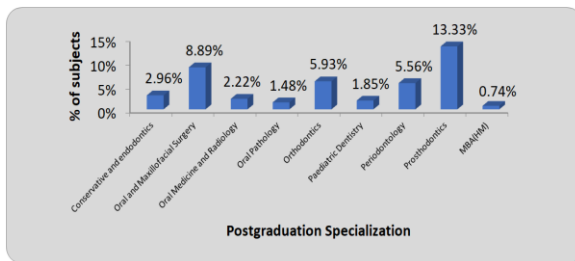
Where p= 60%

$$\begin{aligned}
 L &= \text{Allowable error} \\
 &= 10\% \text{ of } P = \frac{10 \times 60}{100} \\
 &= 6 \\
 q &= 100 - P = 100 - 60 = 40 \\
 n &= \frac{4 \times 60 \times 40}{6^2} \\
 &= 266.66 \\
 n &= 270 \text{ subjects needed in the study}
 \end{aligned}$$

Sampling method: The questionnaire was sent to a larger pool of participants and the collected responses were included in the analysis through simple random sampling method.

Subsequently, the questionnaire was randomly administered to be answered on an anonymous basis and the responses were collected. The results of the survey were tabulated in Google Sheets.

Data Analysis: Data was analysed descriptively using SPSS Statistics for Windows version 24.0



3. RESULTS

The questionnaire was completed by a total 270 respondents which included 154 practitioners and 116 students. Around 46% have been practising dentistry for an average of 5-10 years. Among the 270 respondents 61.1% (165) were female and 38.89% (105) were male. 42.96% (116) of the respondents belonged to one of the post graduation speciality. Prosthodontists (13.3%), Oral and maxillofacial surgeons (8.89%) and Orthodontists (5.93%) were among the major respondents.

Although most of the respondents have not used any form of VRBT's the overall attitude could be considered positive based on the collected responses. 28.15% respondents knew that not all digital scanning systems use reflective powers for digital scanning. 50.37% respondents knew that it was possible to measure shade during scanning/impression making. 68.15% respondents knew that VRBT's enables reliable,

minimally invasive implant placement without flap elevation.

55.56% of participants were aware that 3D digital models of dental cast have the same accuracy and precision as the traditional while 58.15% believed that virtual articulators are a precise tool for full analysis of occlusion in a real patient. 47.78% participants were unfamiliar with the term haptic technology. A majority of the participants (91.1%) had not used dental simulators but 35.93% of them believed that dental simulators can be used as a reliable evaluation tool in developing preclinical skills. 47.04% of the respondents claimed to have not used any kind of virtual reality based software. 36.67% never had an opportunity to use any virtual reality based hardware while CAD/CAM was among the most frequently (30.74%) used hardware technology. 53.70% said they were not taught about any of the VRBT's during the dental school (Fig. 1) and remaining 46.3% respondents had used some form of technology or had knowledge acquisition through advanced speciality courses, conference workshops or continuing dental education programs. 91.85% of total respondents believed that it is important to invest in new technologies for success in dentistry. 61.1% had a positive opinion regarding the effectiveness of dental simulators in clinical skill acquisition. 94.06% respondents were positive regarding the effectiveness of virtual reality-based technologies in reducing patient's anxiety/fear (Fig. 2). 17.78% already use some type of VRBT in their dental practice while 93.33% respondents said that they plan to use some or the other VRBT's in future (Fig. 3). 68.15% believed that virtual reality-based technologies could be more cost-effective in long term compared to traditional solutions.

90.37% agreed that VRBT's offer many advantages in comparison to conventional technologies used in dental education and practice and 75.93% estimated that VRBT's will gain popularity in dental practice within 5-10 years (Fig. 4). The greatest advantage as selected by 32.59% was the possibility to repeat the procedure several times. 5.19% of the respondents said that simulation technology does not have any significant advantage compared to the phantom head. The greatest disadvantage of virtual simulation technology for preclinical education is the significant cost to purchase equipment according to 36.26% respondents. The second disadvantage as per 25.19% was that most equipments are still in the

experimental phase and do not entirely simulate real clinical situations.

4. DISCUSSION

The results of the present study showed that there was an overall positive attitude towards VRBT's among the students and practitioners which is consistent with the studies from UK, Sweden, Switzerland, Netherlands [5-9]. A systematic review by Joda et al in [10] emphasized the importance of VR in dental undergraduate and post graduate education and considered it a promising tool for complex procedures.

The knowledge about this technology among the respondents could be considered inadequate or limited which can be attributed to the fact that a significant percentage of respondents were have not been taught about the VRBT's. 47.04% of the respondents have never used any kind of VR based software and 36.67% never have had an opportunity to use VR based hardware technology. Despite the technological advancements, there is only limited integration of virtual technologies in dental education as well as in practice. Most known VRBT used or known by the respondents was CAD/CAM.

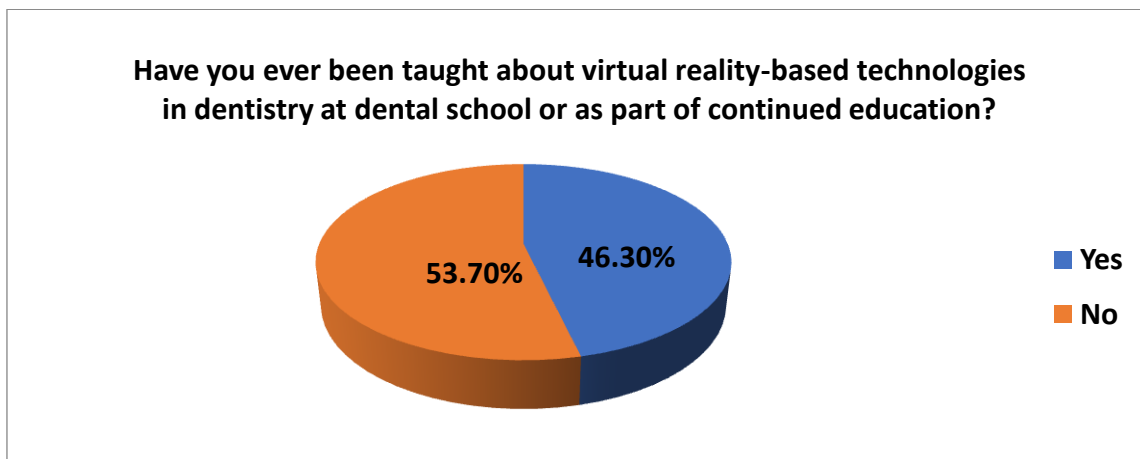


Fig. 1. Have you ever been taught about virtual reality-based technologies in dentistry at dental school or as part of continued education?

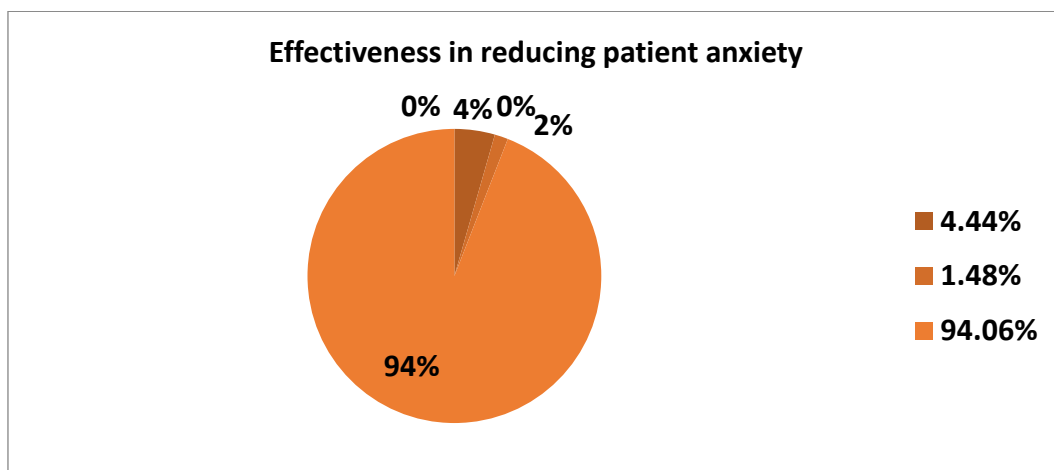


Fig. 2. How would you rate the effectiveness of virtual reality-based technologies (eg. 3D goggles demonstrating dental procedures or playing a video of choice) in reducing patient's anxiety/fear?

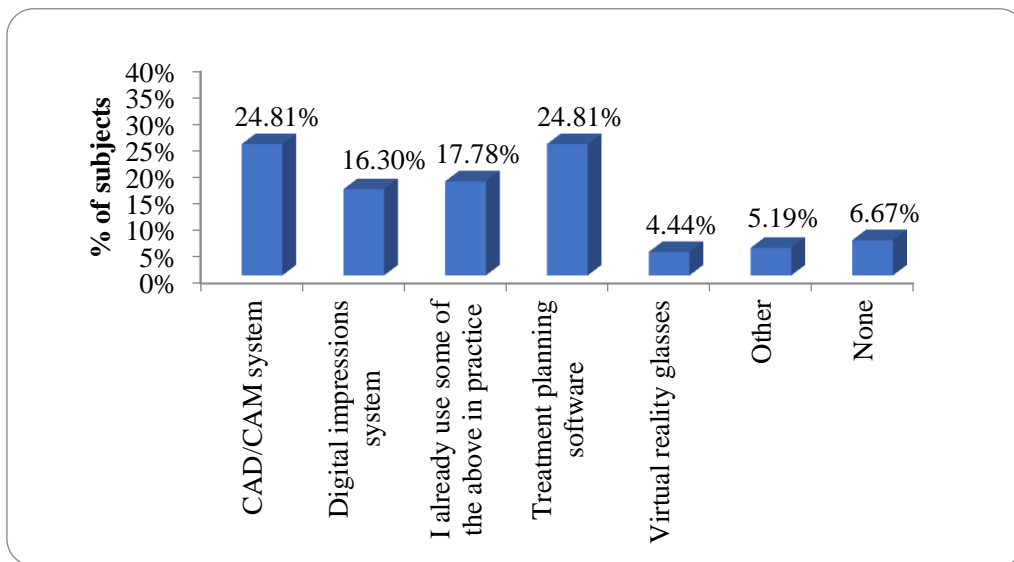


Fig. 3. Do you plan to use virtual reality or augmented reality technologies in your (future) dental practice?

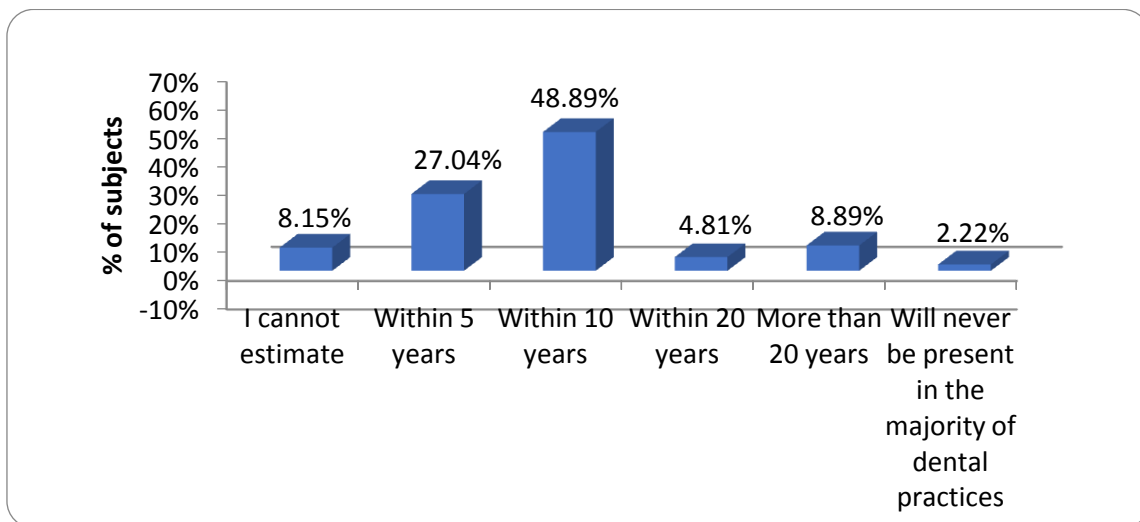


Fig. 4. I estimate the use of virtual reality-based technologies will be in the majority of dental practices

As an educational tool, VR can provide enhanced opportunities for acquisition of clinical and technical skills [11-14]. Buchanan in [15] also advocated use of VR by stating that students trained with VR simulators learned faster, practised more procedures per hour, accomplished same level of competence as traditional preclinical laboratories. Roma et al in 2004 stated that contemporary non assisted students received 5 times more instructional time from faculty compared to VR students. Teaching through traditional manikins with dental models improve students hand eye coordination but verbal descriptions of tactile sensation is difficult

to explain [16]. This is where the new technology of Haptics comes into play wherein "haptics refers to the area of robotics and VR which deals with simulation devices that sense pressure, vibration and other senses related to touch [2]. Such technology would enable the students to touch and feel the dental hard and soft tissues. Haptic virtual technology could also be used to differentiate skill performances between novice and expert students [17]. VR simulation can also serve as a useful cognitive tool in procedures for post graduate training in various specialities for procedures like hard and soft tissue surgeries [18] including reconstructions and removal of

glands, administration of anaesthetics, tooth preparation [10].

Conventional techniques involve use of dental materials like impression elastomers, alloys and resin based materials. Adverse reactions like toxicity, inflammation and allergic reactions to dental materials are not common but still events can happen which can be local or systemic. Dental staff is also at risk from chronic contact with such materials. VR technology can help eliminate the use of some of the conventional materials in practice and learning.

Also virtual reality technology can boost the dental practice directly by assisting in a range of indications in maxillofacial surgery like 3D reconstructions; implant and orthognathic surgeries [10]. 3D imaging has a very important role to play in the routine practice. Use of VR based 3D planning softwares and navigation systems increase the accuracy of the procedures by extending the safe limits for both experienced and inexperienced operators by better visualization and orientation of critical landmarks [19]. VR also aids in reduction of patient anxiety as it can act as a non invasive method acting as an attention grabbing medium [3,4,20].

VRBT's offer assistance in while phantom heads lay out efficient ways to teach procedures safely, adjunctive training with VR seems to enhance skill acquisition and reduce faculty supervision time [11]. But VR based skill acquisition is still not suitable as a sole method of teaching or feedback [12,13,21] as there are a number of uncertainties and limits with the implementation for clinical routine at present. Poorly designed virtual simulators can lead to defective learning instead of benefiting the students in correct skill acquisition. However these uncertainties are anticipated to be solved by the continuous progress in information technology sector [10].

According to the overall analysis, the attitude of respondents was positive but the knowledge and implementation could be considered insufficient which can be attributed to the disadvantage of high cost. The clinical practice could be benefited if the current education programmes impart knowledge about VRBT's. The routine use of such technologies can elevate the outcomes surpassing few disadvantages of traditional techniques.

Further research is required to evaluate these technologies as very limited data is available

demonstrating the importance and limitations of virtual reality into dental education and practice. Forthcoming research should focus on including VR as an aid in interactive learning and objective evaluation as also its implementation to deliver high quality and safe therapy outcomes. Still there is no data on established educational standards for dental simulators and how the variable fidelity of different simulator systems can affect the skill acquisition [22]. Studies to explore the value of these technologies in deliberate practice and the degree of realism and precision they offer are required.

5. CONCLUSION

In terms of knowledge, 50% or less of the dental students, educators and practitioners had correct knowledge regarding the usage, accuracy, advantages and range of functions provided by the VRBT's.

While the overall assessment stated that even though very few have actually had an opportunity to use these technologies, most of them felt that these technologies could prove to be effective in education and dental practice in terms of cost efficiency in the long run, decreasing patient anxiety, improving dexterity.

Learning and including these VRBT's as a part of undergraduate and continued education programmes could affect the willingness and utilization of these trends in future dental practice.

CONSENT AND ETHICAL APPROVAL

The research protocol was approved by the Institutional Ethics Committee (SDKS/PG/STRG/Pros3/dated 21-12-2020). Informed consent was obtained from all the participants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Table 1. Questionnaire

(1) Gender:	(a) male (b) female
(2) Year of study in dental school? (If you have graduated, please choose N/A and answer the next question.	(a) 1 (b) 2 (c) 3 (d) 4 (e) Internship (f) N/A
(3) If you have graduated, please write a number of years practising dentistry upon graduation. If you are a postgraduate, please specify the branch of specialization	
(4) Institution/ University of graduation or post graduation	
(5) Reflective powder or spray is required for all digital scanning/impressions systems in order to precisely register tooth topography.	(a) Yes (b) No (c) Do not know
(6) 3D digital models of dental casts still do not have the same accuracy and precision as measurements made on traditional models.	(a) Yes (b) No (c) Do not know
(7) It is possible to automatically measure teeth shades during teeth scanning/digital impression taking.	(a) Yes (b) No (c) Do not know
(8) Haptic technology provides tactile sensation of virtual objects in a simulated environment.	(a) Yes (b) No (c) Do not know
(9) The virtual articulator is a precise tool for the full analysis of occlusion in a real patient.	(a) Yes (b) No (c) Do not know
(10) Virtual reality-based technology enables reliable, minimally-invasive implant placement without flap elevation.	(a) Yes (b) No (c) Do not know
(11) The most reliable evaluation of students progress in developing preclinical skills can be done by using:	(a) Acrylic teeth mounted on a mannequin (b) Extracted animal teeth mounted on a mannequin (c) Extracted human teeth mounted on a mannequin (d) Virtual reality-based simulation technology (eg. DentSim) (e) Computer (f) Do not know
(12) Have you ever used a dental simulator?	(a) DentSim (b) Simodont (c) hapTEL (d) Other (e) No
(13) Have you ever used virtual reality-based computer software?	(a) Dental implant treatment planning software (b) Orthodontic treatment planning software (c) Prosthodontic treatment planning software (d) 3D Imaging diagnosis software (e) Smile design software (f) Other (g) I have never used virtual reality-based software.
(14) Have you ever used the following	(a) CAD/CAM

virtual reality-based hardware technology?	(b) Digital impression scanner (c) 3-D goggles (d) I have never used virtual reality-based hardware technology (e) Other
(15) How often do you use virtual reality-based technologies in dental education/practice?	(a) Never (b) Rarely (c) Sometimes (d) Often (e) On everyday basis
(16) Have you ever been taught about virtual reality-based technologies in dentistry at dental school or as part of continued education?	(a) Yes (b) No
(17) If yes, which course(s) were you taught about virtual reality-based technologies?	
(18) How would you rate the importance of investing in new technologies for success in dentistry?	Unimportant (a)1 (b)2 (c)3 (d)4 (e)5 Very important
(19) How would you rate the effectiveness of dental simulators in clinical skills acquisition?	Not effective (a)1 (b)2 (c)3 (d)4 (e)5 Very effective
(20) How would you rate the effectiveness of virtual reality-based technologies (eg. 3D goggles demonstrating dental procedures or playing a video of choice) in reducing patient's anxiety/fear?	Not effective (a)1 (b)2 (c)3 (d)4 (e)5 Very effective
(21) Do you plan to use virtual reality or augmented reality technologies in your (future) dental practice?	(a) Treatment planning software (b) Digital impressions system (c) Virtual reality glasses (d) CAD/CAM system (e) Other (f) No/none. (g) I already use some of the above in practice.
(22) Do you think that virtual reality-based technologies are more cost-effective in long term compared to traditional solutions (eg. digital vs conventional PVS final impressions)?	(a) Yes (b) No
(23) Virtual reality-based technologies offer many advantages compared to conventional technologies used in dental education and practice?	I completely disagree (a)1 (b)2 (c)3 (d)4 (e)5 I completely agree

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- (24) I estimate the use of virtual reality-based technologies will be in the majority of dental practices:
- (a) within 5 years
 - (b) within 10 years
 - (c) within 20 years
 - (d) more than 20 years
 - (e) will never be present in the majority of dental practices
 - (f) I cannot estimate
- (25) The greatest advantage of virtual simulation technology for preclinical dental education compared to conventional methods (phantom head with acrylic teeth) is:
- (a) less teaching staff are needed for supervision and evaluation of students' work
 - (b) use of computer technologies motivates students and facilitates learning process
 - (c) the possibility to repeat the procedure several times (eg. Cavity preparation)
 - (d) standardised, objective evaluation and self-evaluation of students' success in completing the task
 - (e) other
 - (f) simulation technology does not have significant advantages compared to the phantom head
- (26) The greatest disadvantage of virtual simulation technology for preclinical education is:
- (a) most equipment are still in the experimental phase and do not entirely simulate real clinical situations
 - (b) limited number of preparations/dental procedures that can be practised
 - (c) haptic technology is still not sophisticated enough to achieve realistic tactile sensation
 - (d) significant cost to purchase equipment
 - (e) other
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