Evaluation of a head mounted camera for clinical dental teaching

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IN BRIEF

- This paper evaluates a head mounted camera for use in clinical teaching.
- The device improved the level of detail observed during dental procedures, and the level of feedback to learners.
- It also provided better learner support by both enabling the learner to observe a dental procedure being undertaken from the viewpoint of the operator and permitting the teacher to view a learner undertaking a procedure.

EDUCATION

Objective To evaluate the potential of a novel head mounted camera to both improve the level of detail observed by learners/teachers observing dental procedures being undertaken and to improve the level of feedback given to learners. **Design** Questionnaire. **Subjects and methods** Qualified members of the dental team and those in training evaluated the usefulness of the application of a novel head mounted camera in their clinical teaching within Dundee Dental School and Hospital. **Results** A total of 210 questionnaires were issued and received for analysis. Although the device generally improved the level of detail observed by learners/teachers and improved the level of feedback given to learners, there was scope for improving upon image quality. The lighting of the environment in which the camera was used was a critical factor in optimising success. The different members of the dental team displayed different expectations of the device. This was attributed in part to their level of previous exposure to clinical work. In applying this technology it is therefore important to understand the needs of the user. **Conclusions** The camera system did enhance the learning experience but required further refinement in relation to image quality.

INTRODUCTION

It is well known that watching a clinical procedure being undertaken either in real time or upon playback is a valuable teaching aid for both teacher and learner.[1,2] Traditionally this has been achieved by either small groups of students observing a qualified dentist treating a patient or the dental teacher watching a student carry out a procedure. Neither situation is ideal for the confined space of the oral cavity compromises the view. Furthermore it is incredibly labour intensive to watch a student perform an entire operative procedure from start to finish. Although observing a procedure at predefined interim stages (such as cavity preparation, lining and restoration) is commonly used to optimise the use of staff resources, only snapshots of performance are gleaned. Valuable opportunities for learner support are thus missed and the teacher has little idea of how the end point was achieved.

Although the dental literature does contain a number of technical reports on camera systems in clinical teaching, surprisingly little has been reported on the student perception of the use of close up cameras in clinical teaching. Gillings[3] found such technology helpful to enhance the student experience when demonstrating dental technology and in addressing the teaching of large classes. Robinson and Lee[4] and Britto *et al.*[1] both showed that watching a clinical procedure being undertaken either in real time or on playback of a video was a valuable teaching aid. Giving videotape feedback to learners on their performance in carrying out a clinical procedure is also said to be of great benefit.[2] All of these papers, with the exception of Kardash and Tessler,[2] focussed on the teacher demonstrating to students. We therefore sought to evaluate, in Dundee Dental School and Hospital, a head mounted video camera system (Fig. 1) developed by the authors and the Medical Physics Department of Ninewells Hospital, Dundee to determine its usefulness both for teacher demonstration and assessment of students carrying out operative procedures. We specifically sought to see if this technology:

- Improved the level of detail observed when observing dental procedures being undertaken
- Improved the level of feedback to learners
- Provided better learner support.

MATERIAL AND METHODS

The camera evaluated in this study (Fig. 1) was mounted upon a headband worn by the student or staff operator. Illumination of the operating area was provided by two bright white LED headlamps. A small red laser beam allowed the wearer to target the camera upon the area of work. For portability this was all battery powered and a radiofrequency transmitter, incorporated in the device, permitted real time images to be sent to a receiver for display on either a monitor or capture

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on a recording device for later playback. This arrangement obviated the need for trailing cables. Inertia sensors, incorporated into the headband, triggered a freeze frame mechanism on the display monitor, so that rapid head movements of the wearer did not result in sea sickness of the observers. The associated sensory conflict, from such head movements, has been reported to induce motion sickness in pilots using helmet mounted displays (HMDs).[5] Although the red guide laser beam was safe to the eye all patients on whom the device was used wore laser safety glasses to ensure optimum protection.

This work commenced in 2004. A telephone call to the Secretary to our local Medical Research Ethics Committee revealed that research ethics approval was not required for this work as it utilised commercially available equipment, albeit in novel combination, and formed part of taught course evaluation. A questionnaire was devised (by means of a focus group of all potential users) to evaluate usefulness of the camera in clinical teaching. It was piloted and then finalised in a form that was suitable for all members of the dental team to complete from the perspectives of either device wearer or viewer. It consisted of a series of statements to which the respondent was requested to indicate their level of agreement by means of a 5 point Likert Scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = strongly agree). It was so constructed that statements on device evaluation were kept separate from suggestions for technical modi fications. This was thought important for perceptions are known to influence our evaluation of service quality.[6] To maximise the comprehensiveness of the evaluation space was left for free text comments. Any improvement suggestions were categorised and articulated to the device design team to assist in further development and refinement. The statements may be viewed in Table 1.

A relational database was created using Paradox (Paradox Version 3.5, Borland International, CA 95067-0001, USA) for data input, from the completed questionnaires, and flexible interrogation. Subsequent statistical analyses

Table 1 Summary of all questionnaire responses

Statement	Mean (S.D.)	n	Median & Mode	Comment
This technology enhances my learning/ teaching experience	4.01 (0.72)	203	4, 4	☺
I found the picture quality adequate for the purpose.	3.41 (0.99)	197	4, 4	
The images were sufficiently stable for me to see what was going on.	3.57 (0.93)	194	4, 4	
I can see what is going on better than watching from the chairside	3.77 (1.06	182	4, 4	☺
This technology hinders my learning/ teaching experience.	2.02 (0.99)	193	2, 2	☺
This technology lets me monitor more closely what the operator is doing.	3.98 (0.80)	181	4, 4	☺
Playing back images of the procedure helps improve the quality of feedback given/received.	3.90 (0.69)	140	4, 4	☺
The camera was comfortable to wear once I got used to it.	3.26 (1.01)	91	3, 4	
The laser light guide was distracting.	2.82 (1.05)	145	3,2	
In its present form the technology was easy to use.	3.15 (1.02)	111	3, 4	
This technology offers no benefit to the learner/teacher.	1.93 (0.92)	181	2,2	☺
The equipment improves communication between teacher and learner.	3.84 (0.73)	169	4,4	☺
I found using this technology intimidating (ie people watching what I am doing).	2.40 (1.06)	107	2,2	☺
To see a procedure carried out in the line of vision of the teacher/operator is extremely helpful.	4.16 (0.72)	172	4,4	☺

Responses were coded 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = strongly agree. Where ☺ is included in the comment column the camera, in its present form, clearly enhanced the learning experience – other areas require further improvement.

Table 2 Future developments – Breakdown of all responses

Statement	Mean (S.D.)	n	Median & Mode
It would be useful to be able to record/playback Video.	4.19 (0.59)	183	4, 4
It would be useful to have the capacity to communicate directly with a teacher/student via an earpiece whilst a procedure is carried out	3.59 (0.96)	168	4, 4

Responses were coded 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = strongly agree.

Fig. 1 The head mounted camera in use

Table 3 Breakdown of environments and circumstances in which camera was evaluated

Environment	Number of responses	Comments
Clinical	70	dental operating light, various operators
Operative Techniques Laboratory	82	Adequate lighting, various operators demonstrating cavity preparation to dental students
Operative Techniques Laboratory	12	Adequate lighting, inexperienced camera operator demonstrating to therapy students
Prosthetics Teaching laboratory	12	Poor lighting, new operators demonstrating partial denture Surveying to colleagues and Dental students
Prosthetics Production Laboratory	10	Good bench lighting. Technicians demonstrating denture wax up to colleagues
Restorative Production Laboratory	12	Good bench lighting. Technicians demonstrating male female components of bridgework and also Porcelain build up of crowns.
New clinical Skills phantom Head laboratory	9	Good clinical lighting, Teachers of conservative dentistry demonstrating and viewing head camera to one another for first time.

Table 4 Breakdown of questionnaire returns according to designation of respondent

Designation of respondent	Number of returns
Dental student	125
Dental instructor/technician	22
Dental nurse	3
Dental therapy students	11
Dental SHO/SPR	7
Dentist (other than specified above)	37

were performed using statistical programs within Excel (Sample Descriptive Statistics) and Prism (GraphPad Prism®, Version 4, GraphPad Software Inc., San Diego, CA 92121, USA)(Non parametric One Way Analyses of Variance – Kruskal-Wallis Analysis of Variance by Ranks and Dunn's Multiple Comparison Post Testing). The threshold for statistical significance of all comparative tests was a P value of less than 0.05.

RESULTS

A total of 210 completed questionnaires were received for analysis. Due to both the multi-functionality of the questionnaire employed and the failure to complete all relevant sections by some the numbers of respondents in the results tables does not always correspond to this total.

Table 1 summarises the number of responses, mean, mode and median scores for each evaluation aspect of the questionnaire. The symbol ☺ is used to identify those areas where the device was successful in achieving its educational aims. It should be noted, however, that in the other areas the device was broadly helpful but clearly further improvement work was required to bring the user experience up to the level achieved in the areas marked ☺. Table 2 summarises the number of responses, mean, mode and median scores for the future development aspect of the questionnaire. It is clear that the respondents feel that it would be useful to be able to record/playback video and would perhaps like the capacity to communicate by means of an earpiece with a teacher/student whilst carrying out a procedure.

Table 3 summarises the environments and circumstances in which the camera was evaluated. One way non parametric analyses of variance by ranks, using the Kruskal-Wallis test, indicated statistically significant effects of environment/circumstance for the response to all evaluation questions at $P < 0.001$ with the exception of question 8 ($P < 0.05$) and questions 7, 9 and 10 ($P < 0.05$). Subsequent localisation using Dunn's Multiple Comparison Test indicated camera operator inexperience and less than ideal lighting to be the major factors contributing to a less than ideal experience.

Table 4 gives a breakdown of the

questionnaire returns according to the designation of respondent. One way non parametric analyses of variance by ranks, using the Kruskal-Wallis test with localisation using Dunn's post testing, of questionnaire responses according to the designation of returnee, demonstrated significantly different responses for dental therapy students compared to other groups. These related to questions 2, 3, 4 and 6 and also in their response to questions on future developments. Therapists were more dissatisfied ($P < 0.05$) with the image quality than dental students and instructors/technicians allocating a median score of 2 compared to 4. They were more concerned about the stability of the image ($P < 0.01$) than the dental instructor/technicians, median rating this as 3 compared to 4. They could see little advantage of playing back images to enhance the learning experience ($P < 0.01$), compared to the dental instructor/technicians who gave a median score of 4 compared to the 3 of the therapists, and were less impressed ($P < 0.001$) with the ability of the camera to help them monitor more closely what the operator was doing than both the dental students and dental instructor/technicians (whose median scores were 4 compared to 3 for the therapists). With specific reference to possible future developments the therapists, although supportive (median score 4) of developing video playback were less so ($P < 0.05$) than the SHO/SPR's (median score 5). They were however neutral (median score 3) on developing earpiece communication between teacher/student whilst carrying out clinical procedures. In this regard the dental technicians were significantly more receptive to this development than the therapists ($P < 0.05$) (median score 4).

Free text comments were made by 37 respondents in the space left for this purpose in the questionnaire. The majority of these offered advice on the design of the head camera to make it easier to wear. Other comments requested improvements in image resolution.

DISCUSSION

In general this technology improved the level of detail observed when dental procedures were undertaken. It also enhanced the level of feedback that could be given to learners undertaking operative procedures. Its potential to enhance learning in a variety of environments was demonstrated. This agrees well with previous reports on the usefulness of static camera systems in clinical teaching.[1-4] It is however important to note an absolute requirement of adequate lighting to ensure success. As is evident from the evaluation this was not always achieved in all the environments where the device was used. Although in common with others[1] there is a need to improve image resolution of the system to optimise the learning experience, it is pleasing to note that image stability, despite the camera being mounted on the head, does not appear to be a problem. Video camera technology is rapidly advancing and it is therefore possible to improve upon the present equipment by replacing the original camera with a more up to date model.

A challenge to potential users, and of some interest, is the different perceptions of this technology by the various members of the dental team. To some extent this may be a consequence of the different environments in which it was applied. It could also be possible that the previous chairside experiences of the therapy students, who had all previously worked as dental nurses and would have observed many clinical procedures closely, made the application of this technology less relevant to this group. Notwithstanding this the system did achieve its aims and further refinement and development, in light of the experiences reported here, is underway. This will involve the use of focus groups.

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