Assessing decision-making in education of restorative and prosthetic dentistry: a pilot study

Régis Iozzino a,b, Pierre-Antoine Champin PhD a,c, Raphaël Richert MSc a,b, Romain Bui a, Olivier Palombi DMD, PhD d, Bernard Charlin DMD, PhD e, Faleh Tamimi BDS, PhD f, Maxime Ducret DDS, PhD a,b,f

Institutions:

a Université Claude Bernard Lyon 1, Lyon, France
b Centre de Soins Dentaires, Hospices Civils de Lyon, Lyon, France
c Equipe TWEAK, Laboratoire LIRIS UMR 5205, Lyon, France
d Université Grenoble Alpes, Grenoble INP, Inria, CNRS, LJK, F-38000, Grenoble, France.
e CPASS, Faculté de Médecine, CPASS, Faculté de Médecine, Montréal, Canada
f Faculté de médecine dentaire, McGill University, Montréal, Canada

Corresponding author: maxime.ducret@universite-lyon1.fr

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ABSTRACT

Purpose: To evaluate whether a concordance assessment (CA) software application is able to assess decision-making in restorative and prosthetic dentistry. Materials and Methods: Vignettes representing 10 different clinical situations were integrated into a software
application. Each vignette included 3D digital models and a short case, as well as 5 therapeutic options rated on a 4-point Likert scale (−2 = strongly contraindicated; −1 = contraindicated; +1 = indicated; +2 = strongly indicated). A panel of 15 dental educators (9 educators from the prosthetic department [PD] and 6 from the conservative department [CD]) had to evaluate the indication of each of the 5 therapies for the 10 vignettes. Results: This pilot questionnaire showed good internal consistency on most therapies (Cronbach’s α = 0.86), with the exception of more recently introduced therapies (overlay/veneeralay and endocrown). On a maximum score out of 100, the average of CD educators (79.2 ± 3.2) was not significantly different (P = .73) from that of a PD educator (77.8 ± 3.5). Scores ranged from 66.8 to 89.6. Analysis of the expert panel’s responses also reported mostly (34/50) a distribution of responses that was characteristic of CA and uncertain situations. Conclusion: The present software application was able to reproduce and assess decision-making in dentistry with satisfying internal consistency of educators. Int J Prosthodont 2021. doi: 10.11607/ijp.7228

INTRODUCTION

Decision making in dentistry is a very challenging problem. Dentists are constantly faced with unique clinical situations that stem from the infinite diversity of possible scenarios encountered in restorative and prosthodontic practices (1)(2)(3). In addition, the constant arrival of new materials and therapeutic approaches adds further uncertainty to the decision-making process (4)(5)(6)(7). Various tools have been proposed to help decision-making, such as online portals for instant access to evidence-based publications, practice guidelines, or learning applications (1)(7)(8)(9). However, the available scientific evidence and practice guidelines are limited and cannot address the unlimited number of possible clinical scenarios. These gaps of knowledge are often filled by the clinicians with their “common sense”. 
However, differences in opinions across the profession leading to inconsistencies in the ways of teaching and practicing.

Concordance Assessment (CA) is an educational tool that assess ability to interpret clinical data under conditions of uncertainty (10)-(11)-(12)-(13). This tool takes into account the variability of expert opinions and considers multiple acceptable interpretations using a methodology called the aggregate scoring (14)-(15), which has been validated across a wide range of medical fields (15). Our hypothesis was that CA could be a relevant strategy for assessing competencies of decision-making in the uncertain situations of restorative and prosthetic dentistry.

This study aims to evaluate if an original CA software application is a valid tool to assess decision-making in restorative and prosthetic dentistry, in situations of uncertainty.

**MATERIALS AND METHODS**

*Software design*

The present application was a proof of concept designed to run on iPhones and iPads operating on iOS 12.1 or above, and developed using Xcode IDE (Integrated Development Environment). The program is written in the Swift programming language (version 4.2). The main design pattern was Model - View – Controller (MVC)(supplementary data 1). STL files were stored in a "Resources" folder, following the Apple guidelines. A two-byte attribute was used to store the triangle in 3 Dimensions (3D) files. Apple’s SceneKit framework has been used to display the volumes. The code, the STL files and the 10 vignettes in French were published and freely available on the GitHub (https://github.com/iozzinor/Script_app/) with comprehensive documentation (https://github.com/iozzinor/Script_app/blob/next/Script_odont/Utils/SCNNode%2Butils.swift).

*3D files*
Clinical-like situations were prepared with typodont resin teeth (Kavo Dental, Lognes, France). 10 cavities were realized with different tooth structure loss on second maxillary premolar and first maxillary molar (supplementary data 2). Cavities were mesio-occlusal, disto-occlusal or mesio-occluso-distal (MO/DO/MOD) with different wall thickness. 7 Vital Teeth (VT) and 3 Endodontically Treated Teeth (ETT) were included (3D files were generated using a technic previously described (16). Using an intraoral scanner (Trios 3®; 3Shape, Copenhagen, Denmark), the 10 prepared typodont teeth were scanned, converted to the STL format and included in a specific clinical scenario.

3D-CA construction

Each vignette was designed to follow the CA’s guidelines for treatment format, each of them composed of (17)(Figure 1):

- a wording: a short text explaining the patient case
- 5 therapeutic propositions: 1) direct composite, 2) inlay or onlay, 3) overlay or veneerlay, 4) endocrown or crown bonded, 5) crown with post and core
- a 3D files in a binary STL format
- a 4-point Likert scale (-2: strongly contraindicated, -1: contraindicated, +1: indicated, +2 strongly indicated) for evaluating each therapeutic proposition.

A randomization process allows to shuffle the questions when the user starts a new session.

3D-CA evaluation

Finally, this educational material was adjusted according to advices given by colleagues on the face validity of the tool, and then submitted to a panel of 15 volunteer educators (here called expert panel’s). 9 panelists belong to the prosthetic department (PD) and 6 to the conservative department (CD). They were all involved in the clinical education of restorative and prosthetic dentistry. In absence of patients and students, this study was not
considered as biomedical research according to the French legislation. The present research was realized in accordance with Helsinki declaration and with agreement of the French national University Numérique “Santé et Sport” (UNESS). The panel was composed of volunteer educators informed that the aim of the study was to validate an innovative educational tool. User were identified with a nickname and no personal data was collected. Due to the novelty of the testing method, panelists were shortly briefed about the definitions of therapeutics, CA and clinical reasoning before starting a session. The structure of a session file was the following: short user information (nickname), 10 vignettes and closing of the session.

**Data collection, score calculation and analysis**

The first draft of this application was only available on one iPad and required to be weekly plugged to the computer hosting the XCode application, because of the implementation facility. The code allowed data transmission via a TCP/IP connection and session results were sent using an HTTP connection. The server-side application was written in python, and data were extracted and converted into an Excel spreadsheet.

Score calculation was realized following the recommendations for CA (17). It was assumed that each possible answer was considered correct according to how many panelists endorse it (termed ‘aggregate scoring’ (17)). The most frequently chosen response was considered the most correct and coupled with 100% of the score. Inversely, responses chosen less frequently were awarded partial credit proportionally to the number of panelists. Each evaluation was then multiplied by two to obtain a final score on 100 to get a percentage score, as recommended (17).

Distribution of answers was classified into ideal (high quality), unanimous or unconcordant (uniform divergent) profile according to guidelines of Lubarsky et al (18) (supplementary data 3). A statistical software (IBM SPSS Statistics v24) was used for
analyzing Pearson correlation coefficient, significative difference, and internal consistency (Cronbach’s alpha). After normality was confirmed with Shapiro-Wilk test, a Student t-test was used to evaluate the difference between the 2 groups of educators. Cronbach’s alpha was calculated to determine the internal consistency and interpreted as questionable when < 0.80 and satisfying when ≥ 0.80 (18)(19).

RESULTS

Experience and score

The users reported a good immersivity of the software during the evaluation, and a feeling of uncertainty in numerous situations. This uncertainty of panel during the questionnaire was highlighted by a majority (34/50) of the items presented ideal profile characteristic of CA. Several other items were characteristic of unanimous (2/50) or unconcordant (14/50) decisions. However, multiple users described several limitations of this first software application, including difficulties to clearly define indications and limitations of recent therapeutics such as overlay, veneerlay or endocrown.

The panel obtained final scores in a range from 66,8 to 89,6 out of 100 (average 78,4 ± 6,5)(Table 1), without significant difference between CD and PD educators (p = 0.73). A negatively correlation (-0,69) was observed between those that in average indicate the most the therapeutic “crown with post and core” and the final score (out of 100)(Table 1).

Evaluation of the questionnaire

The questionnaire presented good internal consistency for the most common therapies such as composite, inlay-onlay and crown with post and core (Table 2). The consistency was questionable for the recently introduced therapies such as overlay-venerlay (Cronbach’s alpha score = 0.68) and endocrown-crown bonded (Cronbach’s alpha score = 0.69) (Table 2).
These 10 clinical vignettes were relatively balanced in terms of response options as recommended (17)(18). Each of the 4 points of the Likers scale was chosen between 23,5 to 27,5% of the time, regardless of the department to which the educator belongs (supplementary data 4). Heterogeneity were observed among of the therapeutic types, especially for crown with post and core that was rarely (18,0%) considered as indicated or totally indicate, and most of the time (82,0%) considered as contraindicated or totally contraindicated. Similarly, composite was rarely considered as totally indicated (6,0%) by the panelists. Inversely, indirect therapeutic such as inlay-onlay, overlay-veneerlay were more often considered as indicated or totally indicated (respectively 72,7% and 66,6%).

DISCUSSION

The present pilot study reports the first psychometric evaluation of an original mobile application developed for assessing the decision-making in restorative and prosthetic dentistry with 15 educators. Our first results suggest that user’s experiences were playful, and that panelists’ responses had satisfying similarities with CA, that encourage a deepest educational investigation with students and practitioners.

Previous online tools were proposed to drive students and practitioners during this decision-making by providing instant access to evidence-based publications, but the aim of education is to train reflective approach and not replace it (1)(13). The present educational solution is the first to propose to manipulate 3D files that mimic decision-making in situation of uncertainty. Even if the users reported good immersivity, further technological evolution are ongoing using 3D color files generated by the new intraoral scanners, such as .ply or .obj files (20).

A reported limitation was sometimes confusion generated by association of therapeutics, such as endocrown and crown bonded, and the overcharge created by the direct appearance of the 5 therapeutic solutions. Indeed, 3D files bring more information compared
to current CA that use mainly text, image, and sound. A perspective could be to propose each therapeutic one after one, dissociate, and randomly during the test, to reduce the overcharge and avoid a direct comparison between therapeutics.

The results reported here suggested that the panelists seem to follow a close behavior of those described for CA, with an internal consistency that can go up the standard required for CA. Moreover, panelists obtained scores that are similar to previous studies that used CA (21)(22). The distribution of responses was also mostly characteristic of uncertainty situations reported for CA (14)(18). However, several unanimous or unconcordant distribution were also observed, but guidelines for constructing CA reported and assumed that 20–30% of CA items could be discarded or modified (19).

Variability of practices between educators, regarding therapeutic approaches, could be problematic for learning, and Gagnon et al. reported that a minimum of 15 to 20 panelists to obtain the high internal consistency (0.70–0.90) reported for CA (18)(24)(25). This variability was reported in the present study, especially for two members with a score below 70, that was correlated with an increase indication of crown with post and core. This result could be due to the heterogeneity decided initially during the selection of panelists for this pilot study. This situation is also common with CA, and if these data must be used in future for assessment of students and practitioners, composition could be optimized to increase the internal consistency (19)(25)(26).

The best example of this variability is about the recent therapeutic such as overlay, veneerlay and endocrown, that created a questionable internal consistency inside educators. This result is coherent with the current debate and dissimilarities in decision-making that were reported in restorative and prosthetic dentistry, especially regarding the need of cuspal coverage using overlay, veneerlay and endocrown during the management of posterior teeth (4)(6)(8). This application, by collecting the panelist comments during decision-making, will
also help educators to use this diversity of practices as a powerful reflective tool. Indeed, CA could be adapted as a learning tool, called Learning by Concordance (LbC). Students could compare their decision with comments and decisions of panelists, to playfully train the decision-making skills (15)(23)(26)(27).

Finally, one major limitation of the present study is the lack of validation with students or practitioners. Indeed, several challenges have been encountered during the development of the software application because of the wish to make this tool usable on user’s smartphones to facilitate hybrid teaching (7). However, this decision requires to follow numerous guidelines and updates, that are hardly compatible with a public university resource. The presented study was a proof of concept, and collaborative developments and evolutions are required before to integrate it into daily teaching practice. The decision to share the code of this software will allow to develop a future collaborative tool.

CONCLUSION

The present software application was able to reproduce and assess the rare unanimity of decision-making in restorative and prosthetic dentistry. Satisfying results were reported about user experience and the internal consistency of educators, that encourage to deeply investigate this tool for a largest validation with students and practitioners.

ACKNOWLEDGMENT

We would like to thank the members of the panel for their participation.

BIBLIOGRAPHY


Table 1: Expert panel scores and average of decisions for each therapeutic. PD, Prosthetic department. CD, Conservative department.

<table>
<thead>
<tr>
<th>Expert</th>
<th>Score (/100)</th>
<th>Average decisions</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Composite</td>
</tr>
<tr>
<td>1 (PD)</td>
<td>82.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2 (PD)</td>
<td>69.1</td>
<td>-1.3</td>
</tr>
<tr>
<td>3 (PD)</td>
<td>83.9</td>
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<tr>
<td>4 (PD)</td>
<td>87.9</td>
<td>0</td>
</tr>
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<td>5 (PD)</td>
<td>74.6</td>
<td>0.1</td>
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<tr>
<td>6 (PD)</td>
<td>77.3</td>
<td>-1.4</td>
</tr>
<tr>
<td>7 (PD)</td>
<td>76.6</td>
<td>-1.4</td>
</tr>
<tr>
<td>8 (PD)</td>
<td>82.6</td>
<td>-0.9</td>
</tr>
<tr>
<td>9 (PD)</td>
<td>66.8</td>
<td>1.1</td>
</tr>
<tr>
<td>10 (CD)</td>
<td>76.7</td>
<td>-0.4</td>
</tr>
<tr>
<td>11 (CD)</td>
<td>89.6</td>
<td>-1.1</td>
</tr>
<tr>
<td>12 (CD)</td>
<td>82.7</td>
<td>0</td>
</tr>
<tr>
<td>13 (CD)</td>
<td>73.7</td>
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<tr>
<td>14 (CD)</td>
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<tr>
<td>15 (CD)</td>
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<td>Average</td>
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<td>SD</td>
<td>6.5</td>
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Table 2: Internal consistance of questions

<table>
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<th>Types of Questions</th>
<th>Number of items</th>
<th>Alpha de Cronbach</th>
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<tbody>
<tr>
<td>1 (Composite)</td>
<td>10</td>
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<tr>
<td>2 (Inlay-Onlay)</td>
<td>10</td>
<td>0.75</td>
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<tr>
<td>3 (Overlay-Veneerlay)</td>
<td>10</td>
<td>0.68</td>
</tr>
<tr>
<td>4 (Endocrown-Crown bonded)</td>
<td>10</td>
<td>0.69</td>
</tr>
<tr>
<td>5 (Crown with post and core)</td>
<td>10</td>
<td>0.84</td>
</tr>
<tr>
<td>1+2+5</td>
<td>30</td>
<td>0.86</td>
</tr>
<tr>
<td>3+4</td>
<td>20</td>
<td>0.56</td>
</tr>
<tr>
<td>1+2+3+4+5</td>
<td>50</td>
<td>0.64</td>
</tr>
</tbody>
</table>
Figure 1: Illustration of the software interface.

- Clinical scenario
- New clinical information
- Four-point Likert scale

Hypothesis

Likert scale anchor descriptors

A 23-year-old patient comes with a cavity under an amalgam on the 16. After having removed the restoration and cleaned the decay, you would like to restore the tissue loss.

If your were thinking... and you see... hypothesis becomes

- Composite Resin
- Inlay / Onlay
- Veneer / Overlay
- Endocrown / Luted Crown
- Sealed crown with CIB

-2 Strongly contraindicated | -1 Not indicated | 1 Indicated | 2 Highly indicated

-2 -1 1 2
-2 -1 1 2
-2 -1 1 2
-2 -1 1 2
-2 -1 1 2

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Supplementary data 1: Illustration of the software architecture
Supplementary data 2: The 10 clinical situations including 7 vital teeth (VT) and 3 endodontically treated teeth (ETT)
Supplementary data 3: Ideal (a), unanimous (b) and unconcordant (c) distribution of responses.
Supplementary data 4: Frequency of each Likert scale points. according to the type of therapeutic

<table>
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<tr>
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<th>All</th>
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<th>Inlay/onlay</th>
<th>Overlay/veneerlay</th>
<th>Crown and endocrown</th>
<th>Post and crown</th>
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<td>27.5</td>
<td>30.0</td>
<td>8.7</td>
<td>8.7</td>
<td>34.3</td>
<td>66.7</td>
</tr>
<tr>
<td>Not indicated (-1)</td>
<td>24.5</td>
<td>33.3</td>
<td>18.7</td>
<td>25.3</td>
<td>25.7</td>
<td>15.3</td>
</tr>
<tr>
<td>Indicate (+1)</td>
<td>23.5</td>
<td>30.7</td>
<td>32.7</td>
<td>20.0</td>
<td>16.0</td>
<td>15.3</td>
</tr>
<tr>
<td>Totally indicated (+2)</td>
<td>24.5</td>
<td>6.0</td>
<td>40.0</td>
<td>46.0</td>
<td>24.0</td>
<td>2.7</td>
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