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RESEARCH ARTICLE

Dental students' and lecturers' perception of the degree of difficulty of caries detection associated learning topics in Brazil

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Abstract

Purpose: It aimed to explore the degree of difficulty of caries-detection-associated-topics perceived by dental students and lecturers as pedagogical step in the development of learning objects for e-learning. **Methods:** A convenience sample comprising ninety-eight subjects from different academic levels (undergraduate/graduate students and pediatric dentistry lecturers) participated. Two spreadsheets (isolated/relative) were created considering key topics in the caries detection process. The isolated evaluation intended to explore each topic in an isolated way, while the relative intended to classify, comparatively, the participants' perceived difficulty per topic. Afterwards, data were analyzed. All values on spreadsheets were combined obtaining the subject's final perception. Associations between the subjects' degree of the perceived difficulty and academic level were estimated. ANOVA was used to determine differences regarding the perception among evaluated topics in distinct groups. **Results:** Caries histopathology and detection of proximal carious lesions were the topics perceived as the most difficult in the process of caries detection by both students and lecturers. Differentiation between an extrinsic pigmentation and a brown-spot (caries lesion) as well as differential diagnosis between caries and enamel developmental defects or non-carious lesions were considered as more difficult by undergraduates in comparison to graduates/lecturers (regression-coefficient = 14.54; Standard Error = 3.34; $P < 0.001$ and 8.40, 3.31, and 0.01 respectively). **Conclusion:** Topics as histopathology and detection of proximal caries lesions were identified as the most difficult despite the academic level. However, some topics are differently perceived according to the group. These results are useful for developing pedagogical material, based on the students real learning needs/expectations.

Key Words: *Cariology; Dental education; Difficulty; e-learning; Learning objects; Perception*

INTRODUCTION

Dental caries is still one of the most prevalent chronic diseases in the world and represents a considerable health problem for many populations and its governments [1]. In this sense, adequate caries diagnosis is fundamental for planning and implementing health policies looking for the control of the disease and to respond to the necessity of delivering an improved education in Cariology for dental students as future practitioners [2]. Several systems for caries detection, a part of the diagnostic process, have been used in the world providing important information about the disease and also guiding professionals in making treatment decisions [3,4]. Nowadays, one of the most spread and used systems is the ICDAS (International Caries Detection and Assessment System), which was idealized in 2002 as an attempt to standardize and globalize the diagnosis of dental caries [5]. Although this system has shown to be useful and to improve the accuracy of the process [6], developing teaching tools are important and necessary to achieve and disseminate effectively new concepts and paradigms, facilitating their understanding and use and possibly,

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reducing its difficulty into the clinical scenario.

Learning processes involving theory and practice in health sciences have been reported difficult especially for the translation of theoretical concepts as well as visual appreciation of the taught methods into clinical practice [7,8]. Due to that, the development of educational tools based on the student/lecturers' perception of the difficulty of associated concepts has been considered necessary. Thus, the aim of this study was to describe the important pedagogical steps that were designed and applied prior to the development of a teaching tool of the Caries lesion development and the detection of lesions using the Information and Communication Technologies (ICT). We intend to show that even knowing that ICT sophisticated tools can be very useful; they may not achieve a successful learning by themselves, unless they are preceded and supported by pedagogical planning.

METHODS

This project was developed in collaboration between the School of Medicine and the School of Dentistry from the University of Sao Paulo. This is the first phase in the development of a Caries lesion development and the detection of lesions learning model using the Virtual Man Project and the ICT.

Participants

A cross-sectional study was conducted with a convenience sample of undergraduate and graduate students as well as lecturers at the Department of Orthodontics and Pediatric Dentistry, School of Dentistry, University of Sao Paulo, Sao Paulo, Brazil. All volunteers signed an informed consent for participation.

Participants comprised different academic levels (undergraduate students vs. graduate students/pediatric dentistry lecturers). Last year dental undergraduate students who attended full-time or nighttime course at our School in 2013 were invited to participate. They were at their final course stage, had been exposed to all curricular contents regarding Cariology and participated of an eight-hour theoretical/practical activity (lecture and laboratory) concerning caries diagnosis and lesions' detection using the ICDAS during their last semester. Regarding graduate students and lecturers, the main difference between them was the higher clinical and teaching experience of the latter in comparison to graduate students. However, both groups were already involved in teaching and training activities in the field of Cariology.

Setting and data collection

In order to learn and understand the caries lesion detection process using a visual scoring system such as the ICDAS, it is necessary to have previous knowledge of the physiopathology and development of the caries disease. Thus, considering it as a knowledge unit, our first step was to determine key topics involved in the caries disease physiopathology and the diagnosis process. Two spreadsheets were created aiming to explore the participants' perceptions of the difficulty regarding competences and skills expected from an undergraduate student related to the performance of caries detection adequately. These topics has been recently discussed within one of the domains that represent the broad categories in Cariology, included in the First Consensus Workshop on the development of a European curriculum in Cariology for undergraduate students [9]. The addressed caries lesion-detection topics are presented in Table 1.

The first spreadsheet (an isolated evaluation of topics) intended to explore each topic in a single way. Participants had to weigh their level of difficulty in learning for each topic on a scale from 1 to 5, where 1 = extremely difficult, 2 = very difficult, 3 = difficult, 4 = not difficult and 5 = easy. The second one (a relative evaluation of topics) intended to classify, among the explored topics, the participants' perceived difficulty. They had to score each item from 1 to 11 (total of included topics), considering 1 = most difficult and 11 = easiest to be learned. The spreadsheets were completed by participants in a single session, after explanation of the methodology. Afterwards, the results were tabulated and analyzed to explore differences in the evaluations per groups.

For analysis, groups were merged according to their level of academic background, all undergraduate students (from full-time and nighttime courses) as well as the graduate/lectures groups. Firstly, spreadsheets were independently analyzed and afterwards, and to obtain a final score per participant, scores from both evaluations per topic were multiplied as an attempt to combine both isolated and relative assessments.

Table 1. Addressed caries lesion-detection topics to undergraduate dental students in Brazil

	Topics
1	Histopathology aspects of the developing stages of caries lesions
2	Differentiation of sound surface and the first visual change in enamel
3	Visual detection of caries lesions in smooth surfaces
4	Differentiation of an extrinsic pigmentation and a brown spot caries lesion
5	Visual detection of caries lesions in occlusal surfaces
6	Visual detection of caries lesions in proximal surfaces
7	Tactile detection of caries lesions in smooth surfaces
8	Tactile detection of caries lesions in occlusal surfaces
9	Tactile detection of caries lesions in proximal surfaces
10	Radiographic correlation of the ICDAS (International Caries Detection and Assessment System)
11	Differential diagnosis between caries and enamel developmental defects or non carious lesions

Statistical analysis

Associations between participants' degree of perceived difficulty and level of academic background, were estimated by Poisson and Linear Regression. This depended on the nature of the variables. Repeated measures analysis of variance was used to determine differences regarding the perception among evaluated topics in groups. A level of significance of 5% ($P < 0.05$) was adopted.

Ethical approval

The present study was evaluated and approved by the Ethical Committee for Research in Human Subjects, Dental School, University of Sao Paulo, Brazil under the protocol 206.345/ 2013.

RESULTS

Ninety-eight subjects agreed to participate in this study. Thirty-six were undergraduate students from the full-time course and thirty-one from the nighttime course. Sample also comprised twenty-four graduate students in Pediatric Dentistry (five MSc and nineteen PhD students) as well as seven senior lecturers in/from the same area.

No significant differences were found in the degree of perceived difficulty per topics between undergraduate students from full-time and nighttime courses. Graduate students and lecturers groups showed no differences in the isolated evaluation of difficulties regarding the key topics. However, graduate students scored lower the histopathology of dental caries than senior lecturers both in relative ($P = 0.01$) and final (combined) score assessments ($P = 0.05$).

Undergraduate students reported a significantly greater difficulty in comparison to graduate students/ lecturers regarding visual detection of caries lesions in smooth and occlusal surfaces; differentiation of extrinsic pigmentations and brown spot caries lesions as well as in differential diagnosis between caries lesions and enamel developmental defects or non-carious lesions (Table 2). This trend was mostly observed for all manners of assessing subjects' perception of their difficulties (Table 2 and Fig. 1). When the relative and combined assessments were considered, the tactile detection of lesions in smooth surfaces was considered easiest by graduate students/ lecturers than for undergraduate students.

For undergraduate students, several topics were perceived as having a higher level of difficulty, as ex-

Table 2. Values for the difficult perception of topics related to Cariology

Topics	Isolated evaluation				Relative evaluation					Combined evaluation				
	UG Median (Q1-Q3)	G/L Median (Q1-Q3)	RR	CI	UG Mean (sd)	G/L Mean (sd)	Coef	SE	P-value	UG Mean (sd)	G/L Mean (sd)	Coef	SE	P
T1. Histopathology aspects of the developing stages of caries lesions	3 (2-3)	3 (3-3)	1.04	0.90-1.21	4.59 (±3.38)	5.90 (±4.48)	1.30	0.81	0.11	13.77 (±12.63)	19.51 (± 16.86)	5.74	3.06	0.06
T2. Differentiation of sound surface and the first visual change in enamel	4 (3-4)	4 (3-4)	1.05	0.95-1.17	7.25 (±3.41)	8.61 (±4.6)	1.35	0.80	0.09	26.98 (±15.54)	34.83 (± 23.62)	7.85	4.00	0.05
T3. Visual detection of caries lesions in smooth surfaces	4 (3.5-4)	4 (4-5)	1.10	1.03-1.18	8.08 (±3.16)	10.58 (±4.28)	2.49	0.77	0.001	32.52 (±15.51)	46.93 (± 21.84)	14.41	3.85	0.0003
T4. Differentiation of an extrinsic pigmentation and a brown spot caries lesion	3 (2-3)	3 (3-4)	1.22	1.05-1.41	5.91 (±3.06)	7.77 (±4.37)	1.86	0.76	0.01	17.19 (±12.36)	27.32 (± 18.85)	14.54	3.34	<0.001
T5. Visual detection of caries lesions in occlusal surfaces	4 (3-4)	4 (4-4)	1.11	1.01-1.21	7.50 (±2.81)	8.87 (±4.04)	1.36	0.70	0.05	28.17 (±13.36)	36.58 (± 18.77)	8.40	3.31	0.01
T6. Visual detection of caries lesions in proximal surfaces	3 (2-3)	3 (2-3)	1.08	0.88-1.32	5.34 (±2.95)	5.22 (±3.92)	-0.11	0.71	0.86	13.94 (±9.41)	14.83 (± 12.52)	0.89	2.27	0.69
T7. Tactile detection of caries lesions in smooth surfaces	4 (4-4)	4 (4-5)	1.02	0.93-1.11	8.55 (±2.67)	10.12 (±3.82)	1.57	0.66	0.02	34.41 (±13.64)	41.45 (± 20.06)	7.03	3.46	0.04
T8. Tactile detection of caries lesions in occlusal surfaces	4 (3.5-4)	4 (3-4)	0.92	0.83-1.01	7.62 (±2.63)	8.40 (±4.50)	0.82	0.72	0.25	30 (±13.09)	31.61 (± 20.13)	1.61	3.39	0.63
T9. Tactile detection of caries lesions in proximal surfaces	3 (2-3)	2 (1-3)	0.85	0.72-1.02	5.40 (±3.03)	5.51 (±4.16)	0.11	0.74	0.87	15 (±10.91)	13 (± 11.65)	-2.00	2.42	0.41
T10. Radiographic correlation of the ICDAS (International Caries Detection and Assessment System)	4 (4-4)	4 (3-4)	0.93	0.84-1.02	7.86 (±3.41)	8.48 (±4.47)	0.61	0.82	0.45	13.77 (±12.63)	33.29 (± 21.83)	1.55	3.92	0.69
T11. Differential diagnosis between caries and enamel developmental defects or non carious lesions	3 (3-3)	4 (3-4)	1.31	1.17-1.47	5.40 (±3.25)	7.93 (±4.57)	1.36	0.70	0.05	16.91 (±12.40)	31.45 (± 20.45)	8.40	3.31	0.01

Isolated evaluation: Poisson regression; UG, undergraduate group; G/L, graduate/lecturers group; Q1-Q3 = 1st and 3d quartile; RR, rate ratio; CI, confidence interval. Relative evaluation and combined evaluation: Linear regression; UG, undergraduate group; G/L, graduate/lecturers group; sd, standard deviation; Coef = Regression coefficient; SE, standard error.

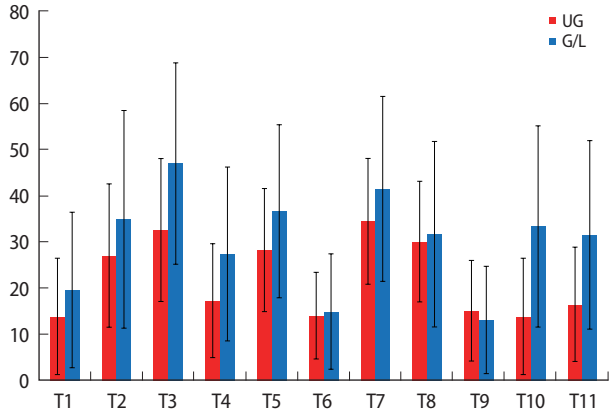

Fig. 1. Analysis of the combined final score regarding the participants' perception of the degree of difficulty per topics. UG = Undergraduate students group; G/L = Graduated/Lecturers group. For topics from T1 to T11, please refer to Table 1.

posed in Fig. 1. Among these topics, we can highlight the aspects related to examination of proximal caries lesions, differential diagnostic between caries lesions and other manifestations (pigmentations/defects), correlation of clinical examination and histopathology of caries or radiographic signs of caries lesions (Fig. 1). On the other hand, for graduate students/lecturers, only part of these topics, as histopathology of caries and the visual and tactile detection of caries lesions in proximal surfaces were the topics reported as the most difficult to be learned (Fig. 1).

DISCUSSION

This is the first study that explores the subjects' degree of difficulty of learning topics associated to caries detection based on both students' and lecturers' perception. It aims the planning of learning objects development based on students' real needs/expectations in order to stimulate the ideal achievement of knowledge and skills to perform this step clinically.

The main difference, concerning perceived difficulty was observed between groups with different levels of academic background. No differences were identified in the perceptions of undergraduate courses regardless time period (full-time and nighttime) that is why data regarding these students were merged for analysis. It could be assumed that, a student that has not been recently taught about the explored topics may perceive them as difficult as those who did. In fact, those aspects, perceived as the most difficult, may not reflect its degree of knowledge [10]. On the other hand, we could speculate that recognizing the perceived difficulties could contribute, not only for planning the contents of further teaching/learning interventions, but also motivate future learners, since their difficulties could be contemplated in learning tools.

Though one can consider that graduate students and lecturers groups have different levels of expertise in the caries detection process, graduate students in our school have received theoretical and practical training in Cariology as part of their background. In addition, they also act as trainees and tutors of undergraduate students in the laboratory and clinic in different topics including Cariology, corroborating their experience in this field and balancing possible divergences. Our results confirm this assertive, since graduate students and lecturers mostly had similar perceptions about the explored topics in caries detection.

The key topic of knowledge about histopathology of caries lesions was considered for all participants as one of the most difficult to be learned. In addition, it was considered more difficult for graduate students than for senior lecturers. The complexity in the integration of static images and dynamic physiologic processes [11] can explain these findings regarding the cognitive learning process, even for higher-level students [10]. The existing correlation between histological depth and clinical appearance of caries lesions in the different stages is one of the main advantages of the ICDAS [5]. However, it is a challenge to visualize these characteristics in a pedagogical environment and extrapolate them into clinical practice [12], making learning and assimilation processes more complex. These aspects can also emphasize the need of finding manners to explore that in further learning tools.

Besides histopathology, detection of proximal caries lesions was another common difficulty regardless the level of academic background. Detection of proximal caries lesions and its management has been matter of concern in the last decade [13-15] due to the inherent difficulty in the visual and tactile access to those surfaces. This complication has led to the development and use of complementary methods assisting the detection of this type of lesions [15-17]. Since this is a practical/clinical challenge, it is comprehensible that the perception of difficulty reported by participants in this study was similar. Moreover, practical skills directed to caries detection on these types of surfaces could be explored further during the learning process.

Differences were found when comparing perceived difficulties reported by undergraduate students versus graduate students/senior lecturers. The lack of clinical experience (limited contact with caries detection) and less accumulated knowledge could be pointed out as possible reasons why students considered some clinical situations as more difficult to be learned than lecturers. Some trivial aspects for lecturers, as differential diagnosis between caries lesions and extrinsic pigmentations or enamel defects/non-carious lesions, as well as correlation between clinical appearance of caries lesions and their radiograph-

ic signs, could not be simple to their students understanding. Based on that, we can argue that academic background could have interfered in the perception of difficulties concerning learning these topics. These findings are especially important when developing pedagogical methodologies and should be considered when creating teaching resources related to caries detection.

Usually, instructional material is prepared based on teacher's point of view. As our findings suggest, differential perception could be evidenced when teaching some specific points. Students' perceptions could help teachers in preparing learning material for their students, minimizing the inclusion of exclusively lecturers' impressions and considering possible difficulties the students reported in learning processes. We believe that educational tools addressed in order to also satisfy student's needs/expectations could contribute to knowledge acquiring, but especially in motivation to develop skills in certain area/field.

The results of this study are directed for the development of a learning object as a first phase of a pedagogical planning, as mentioned above. It is clear that the sample used in this screening may not reflect the global scenario about the perceived difficulty in this field. In this sense, more studies should be performed in order to explore this characteristic in different contexts.

In conclusion, histology of caries lesions and caries lesions detection on proximal surfaces are the topics perceived as most difficult in the process of caries detection by students and lecturers. Nevertheless, some topics including differential diagnosis between caries lesions and other manifestations, as pigmentations and enamel developmental defects are considered more difficult by undergraduate students than graduate students and lecturers.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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