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ECHO: An Information System for the Monitoring and Evaluation of Dental Student Activity in a Pre-Doctoral Clinic

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Abstract. The main goal of dental education is to develop health professionals who will maintain and improve the oral health of patients. This requires the quantitative and qualitative assessment of dental student activity. The aim of this work is to describe the ECHO information system that was developed at Timone Hospital (France) for the monitoring and evaluation of dental student activity and to present the results of a qualitative evaluation of student perceptions of this system. According to the analysis of the UML model of care-related procedures and data, the pre-existing process of student evaluation was characterized by redundancy between administrative and educational data. ECHO was developed in PHP/MySQL and designed to centralize the two types of data in a unified computerized process. The qualitative evaluation of dental student perceptions of ECHO was performed using an anonymous online Google Form questionnaire. Among the respondents (102/254 students), 96% stated that ECHO is easy to use, 86% that it saves time, and 81% that it gives them a better overview of their activity. After several years of use, ECHO has solved many of the difficulties related to the use of internship paper booklets, while also providing a documentary database of the activities of our dental department. The student activity data stored in ECHO are directly accessible by faculty members and can be reused to facilitate departmental management and research and to improve patient follow-up.

Keywords. Dental Informatics, Information System, Dentistry, Education.

1. Introduction

The main goal of dental education is to develop health professionals who will maintain and improve the oral health of patients [1]. This implies turning undergraduate students into practicing dentists throughout their preclinical training [2,3], which in turn requires the quantitative and qualitative assessment of their clinical activity. In French pre-doctoral dental clinics, dental care is mainly delivered by undergraduate students under the supervision of licensed practitioners/teachers [2,4]. Depending on the type of care,

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the acts performed by students are validated by a specific practitioner/teacher. The latter must check the quality of each step of the clinical procedure before the student can proceed to the next step, and must conduct an overall evaluation at the end of the care session. In most such clinics, the clinical activity of each student is recorded in an internship paper booklet that is evaluated in its entirety on a bi-annual basis. This paper booklet, not linked to the hospital information system, make the monitoring of student activity time consuming and represents both an organizational and human resource challenge for faculty members. For students, the time spent on managing and tracking their own activity in the booklet comes at the expense of time spent on clinical learning.

At the Dental Department of Timone Hospital (AP-HM – Assistance Publique Hôpitaux de Marseille, France), a pre-doctoral clinic where about 250 students manage 25,000 patient visits each year, an information system for the monitoring and evaluation of dental student activity was developed to simplify this evaluation process. This system called ECHO was launched in 2018 and has since been adopted by all students and faculty. The aim of this work is to describe the functioning of ECHO and to present the results of a qualitative evaluation of dental student perceptions of this information system.

2. Materials and Methods

ECHO was developed following the analysis of a Unified Modeling Language (UML) model of the care-related (medical, administrative, and educational) procedures and data recorded as part of the pre-existing processes at the end of each care session. This new information system was designed to meet the following requirements: 1) to facilitate the quantitative and qualitative recording of all student activities; 2) to help monitor the completion of mandatory procedures; and 3) to allow for the validation of students' essential clinical skills. It also had to meet the requirements classically expected of computer registries, namely: a) to ensure short training time with easily navigable screens; b) to be web-based; c) to include drop-down menus and logic checks; d) to comply with General Data Protection Regulation and internet security standards; h) to allow for printing out summary data; i) to be linked to but not act as a substitute for electronic dental records (EDRs) [5].

ECHO was registered with the Data Protection Officer (formerly named CIL – *Commission Informatique et Liberté*) of Timone Hospital under #2018-01. Its back-end was developed in PHP/MySQL with the open source MVC framework Laravel [6], and its front-end is based on the opensource framework Bootstrap [7]. The database was designed using Laravel schema designer [8], which allows automatic generation of models and migrations tables for the Laravel framework. ECHO is hosted on an Apache server managed by the digital services department of Timone Hospital.

In the months following the launch of ECHO, a qualitative evaluation of dental student perceptions of this information system was conducted using an anonymous online Google Form questionnaire. The questionnaire was available from 2018/03/13 to 2018/03/27. Students were invited to participate by email, with a recall notice at 7 days.

3. Results

According to the analysis of the UML model of care-related procedures and data, the pre-existing process of student evaluation was characterized by redundancy between

administrative and educational data. Indeed, each type of data was collected separately on different media (i.e., administrative data on paper forms and academic data in the internship booklet). ECHO was designed to centralize both types of data in a unified computerized process.

After each session of care, the procedures performed are entered by the student in ECHO and validated by the practitioner/teacher who supervised the session of care. The practitioner/teacher assigns a qualitative grade and an autonomy grade for each procedure (from A to C); he/she can also provide a general appreciation of the care session in the free text field. Each procedure is assigned a different weight in the overall grade. Students' skills acquisition is assessed based on the repeated performance of procedures. The possibility of creating non-billable procedures (including educational procedures), which are not listed in the national procedure codification system, allows for the evaluation of skills that are not necessarily linked to technical procedures. Figure 1 presents the simplified UML class diagram of ECHO.

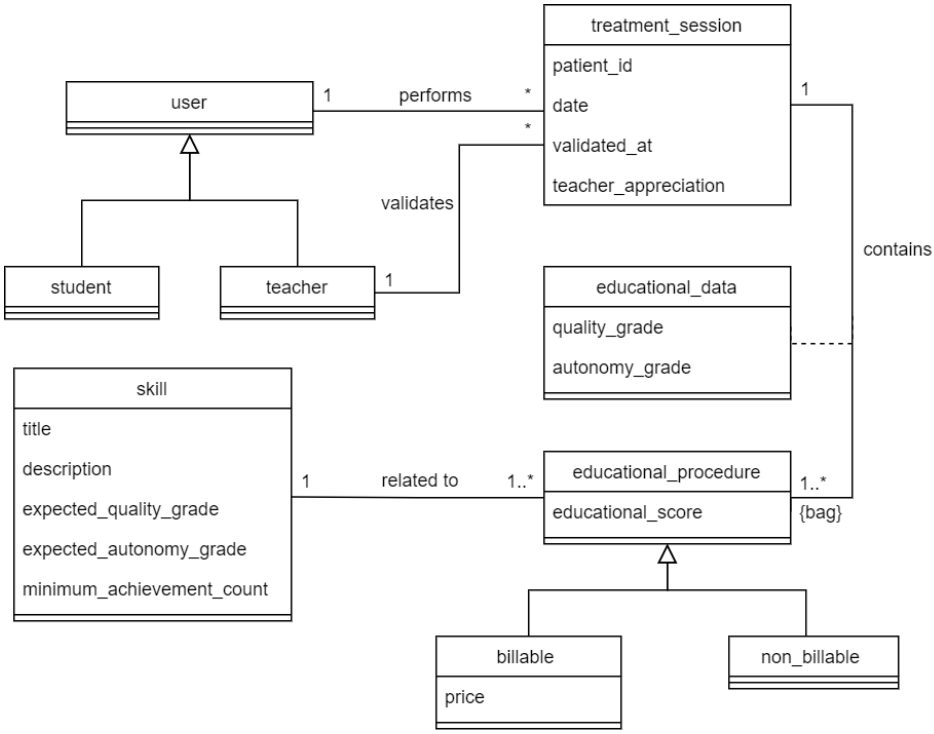

Figure 1. Simplified ULM class diagram of ECHO

ECHO is linked to the hospital information system via dedicated web services, which facilitates the management of user rights access and helps to avoid data entry errors in terms of patient identity. Thanks to this link, users can directly launch and access patients' EDRs from ECHO without extra navigation. Thus, data entry can be performed on ECHO and then in patients' EDRs in a streamlined workflow.

ECHO was launched in 2018/02 and evaluated in late 2018/03 by 102 dental students (40% of all students in the department). Among the respondents, 96% stated that ECHO is easy to use, 86% that it saves time, and 81% that it gives them a better

overview of their activity. Moreover, 79% of respondents declared that ECHO is fairer and more equitable than the internship booklets because it is better at preventing fraud. While many respondents (56%) had mixed or bad opinions about ECHO before it was launched, their perceptions were very positive or positive (98%) by the time of the study. Regarding the difficulties encountered with ECHO, respondents expressed the need for: 1) a tool that facilitates the search for procedure codes in the dropdown list and 2) a tool that reminds faculty members to validate the care session.

4. Discussion

To our knowledge, ECHO is the first information system dedicated to the monitoring and evaluation of dental student activity in a pre-doctoral clinic in France. In our dental department, ECHO has helped to overcome the limitations of the pre-existing health information system which did not account for educational aspects. It has also solved many of the difficulties related to the use of internship paper booklets for student evaluation. Students can now monitor their progress towards their objectives in real time, as can their teachers (figure 2). Those in difficulty can be identified early on and can be offered more sustained support by faculty members. ECHO also makes it possible to track students' skill acquisition throughout their preclinical training.

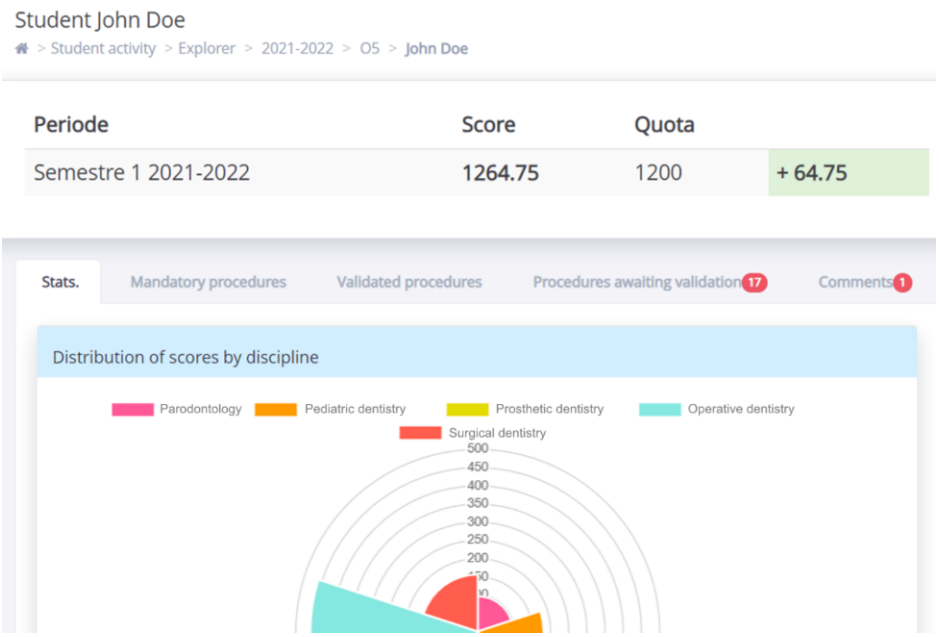

Figure 2 – Example, translated into English, of an available view of student's activity

When building ECHO, we paid special attention to the needs to improve user interface and to facilitate a streamlined workflow, which were identified as a major concern in the literature [9–12]. As regards user interface, we opted for the popular front-end framework Bootstrap because it enables an intuitive usage that reduces student training time. Since Bootstrap is a responsive framework, students started on their own

initiative to use ECHO directly from their smartphone when connected to the hospital's local Wi-Fi network. As regards workflow, we applied the "collect once, use many" principle [13], which allowed to unify administrative and educational data entry in one single process.

The local development and management of ECHO also has advantages in terms of availability and reuse of data. Local practitioners/teachers can reuse the student activity data stored in ECHO for management and research purposes. The inclusion of non-billable educational procedures makes it possible to enter information that is needed for student evaluation, while indirectly enabling better descriptions of patients. In this regard, ECHO may be more useful for clinical research than a registry based on national procedure codes alone.

5. Conclusion

After several years of use, ECHO has fulfilled its educational mission, while also providing a documentary database of the activities of our dental department. The student activity data stored in ECHO are not only directly accessible by faculty members, but can be reused to facilitate departmental management and research and to improve patient follow-up. Future studies are needed to validate the suitability of using non-billable educational procedures to improve the quality of reused data.

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