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Understand the influence of learning analytics dashboards on learner self-regulation and academic success

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Abstract—Since the beginning of the COVID-19 pandemic, many countries have adopted online education as an alternative to face-to-face courses. This has increased awareness of the importance of analyzing learning data left by students to improve and evaluate the learning process. This article presents a new tool, named TaBAT, created to work with different LMSs in the form of dashboards accessible online and allowing teachers to monitor the progress of their learners and at the same time and allow teachers to track the progress of their learners, while allowing learners to develop self-regulation skills and visualize their learning process. The results of a study conducted show that TaBAT helped learners to increase their progress and spend more time in the online course.

Keywords—Learning analytics, Learning experience, Self-regulated dashboards

I. INTRODUCTION

Learning analytics (LA) is a discipline that aims at exploiting the hidden potential of interaction data generated by the use of learning management systems (LMS) [1]. Its main challenges are to collect learner interaction traces, to analyze them and to propose a display of the analysis results to different users [2]. According to Sclater, the goal of learning analytics is to analyze the digital traces left by learners in order to better understand them and optimize learning [3].

Learning analytics focuses on the detection, collection, analysis and exploitation of digital traces left by learners in their daily activities, in order to understand and optimize learning and environments in which it occurs [4]. However, the diversity of existing LMS complicates the task of analyzing this data, which is further amplified by the need to combine data from a variety of sources. The main challenge would be to have a system to analyze learning data in such a way that the precise meaning of the data is easily accessible and could be translated into an understandable format regardless of the LMS or technological environment used.

In this paper, we propose an interpretable visual communication tool, designed as a dashboard for teachers and learners that provides an analysis of learning data to facilitate the monitoring and control of the learning process, with the aim of improving the engagement and success rate of online learners.

In the rest of the paper, we present a literature review in the influence of self-regulated learning theory and learning analytics on online learners' success. Then we share the reports of our tool created in the form of learning trace analysis dashboards. The next section is dedicated to the methodology, data analysis of our tool usage and discussions of these results. Finally, we present a conclusion with some perspectives.

II. RELATED WORK

A. Self-regulated learning theory

Self-regulated learning theory (SRL) defines learning as a dynamic process in which the individual plans, monitors and evaluates his or her learning, applying appropriate strategies to achieve the goals [5]. It is a set of activities that individuals do by themselves in a proactive way [6]. Panadero published an article that presents a review of the six most popular self-regulated learning models [7], the article concludes that, most of these models are composed of three essential phases, namely, the preparation phase, the performance phase and the reflection phase. As presented in the model of phases and subprocesses of self-regulation by Zimmerman and Campillo [8], the preparation phase includes task analysis, planning, goal detection, and goal achievement; the performance phase involves the performance of the actual task completed while monitoring and controlling progress; and the final reflection phase, where the learner self-assesses, reacts, and adapts for future performance.

Many studies agree on the relevance of self-regulated learning as a predictor of academic success in online learning systems. Liaw and Huang investigated learner self-regulation to better understand learners' attitudes toward online learning [9]. The results show that the factors perceived satisfaction, perceived usefulness, and interactive learning environments were identified as predictors of perceived self-regulation in the online learning context. In a study on formal and informal learning using social media, the authors showed that the use of social media as pedagogical means, to encourage students to control their autonomies [10].

B. Learning analytics dashboards

One of the most common methods of learning analytics is the use of dashboards as a way to provide stakeholders (mainly teachers and learners) with visual interpretations to give them an overview of the learning process [11]. Schwendimann defined these tools as a set of single displays that aggregate many indicators about the learning process and/or context into one or more visualizations [12]. These dashboards are generally steering tools that summarize the company's activities and results by process; thus, allowing to supervise the achievement of any set objective [13].

Jivet and colleagues, proposed a literature review to better understand and describe the theoretical underpinnings behind the use of dashboards in educational settings. The study revealed that the most common foundation for the design of analytic dashboards is SRL. This theory is primarily used in the awareness and triggering of reflection, providing some support for the performance and self-reflection phases of the SRL cycle. In research conducted by Nicholas and colleagues to see how dashboards would be able to predict student

outcomes at different points in a course. The study shows that learner outcomes can be predicted with a supervised machine learning algorithm. These predictions were integrated into an instructor dashboard that facilitates decision making for learners classified as needing assistance [14].

In this paper we propose the development of a tool able to analyze learning data in a way that provides precise and meaningful dashboards for teachers and learners. We named it TaBAT (for Tableau de Bord d'Analyse des Traces d'apprentissage in French).

III. TABAT TOOL DESCRIPTION

LMS platforms provide a variety of integrated reports based on journal data but they are primarily descriptive. They tell participants what happened but not why and they do not predict outcomes or advise students on how to improve their academic performance. These tools are mostly programmed to work with a single platform.

Created to work with different online platforms, TaBAT is designed as a dashboard accessible online via the following link <https://safsouf.net/tabat>. It allows us to see what happened during the online course (descriptive aspect), to see which students will or will not succeed in the online course (predictive aspect), to know why students were declared as dropouts (diagnostic aspect) and finally to get information on the actions to be taken to improve students' progress and success in the online course (proactive aspect).

TaBAT presents reports in various diagrams (based on the learning traces generated from the LMS platform in JSON files to ensure interoperability). Two independent views are presented: the student report and the teacher report.

A. Report for the Teacher

The report for the teacher (showed in Figure 1) presents statistical data during the online course. The first page (1) includes the number of students enrolled, the number of sections, activities and resources in the course, the number of students who actively participate in the course, statistics on monthly connections for the current year, as well as statistics on the number of times students consult the activities and resources.

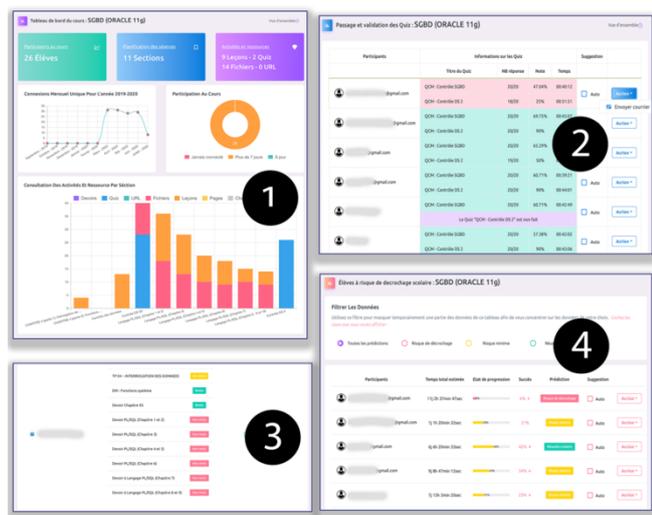


Fig. 1. Dashboards summarizing the report for the teacher.

The quiz analysis page (2) provides a table that shows, for each student, the list of quizzes taken or not taken, the number

of questions answered, the total number of questions, the final score obtained as a percentage, and the time recorded for taking the test.

The assignment analysis page (3) provides a summary of the assignments that may (on time or late) or may not be returned by students.

The dropout page (4) presents a table that displays the list of students with an estimation of the overall time spent on the course, an indicator representing the level of success (based on the results of our theoretical model called e-LSAM (for e-learner Success Assessment Model) [15], [16]) and finally a prediction status. This status indicates the result of the prediction either: risk of dropping out, minimal risk or success. A color coding allows to visually differentiate if the assignment is submitted or not, if the quizzes are done or not and the risk of dropping out or not.

B. Report for the Student

The report for the student gives an overall view of each student's progress in the course. The three available interfaces are shown in Figure 2.

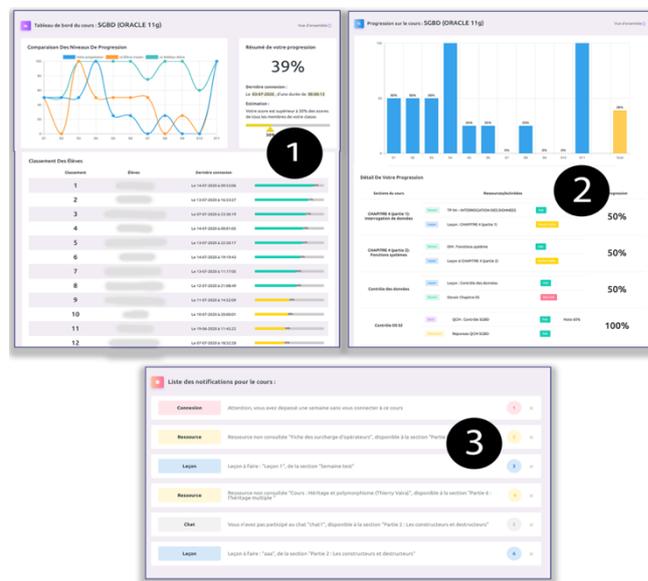


Fig. 2. Dashboards summarizing the report for the student.

The first interface (1) gives a positioning of the student's progression level for each section of the course with two other levels: the level of progression of the best student and the level of the average student in the class. It also displays a ranking table of all learners in the class. This interface aims to motivate and support students' metacognition and self-regulation processes.

For the second interface (2), the student can see the details of his/her progress in the course. A chart presented in the form of a vertical progress bar summarizes the student's progress for each section of the course. This interface displays the details of the student's progress in each section.

The last interface (3) is the notification interface. Here the student can view the list of notifications (marked as unread) sent automatically by the system. Notifications are displayed by type, with a message indicating the actions to be taken. A script is scheduled to send notifications automatically twice a day; at 08:00 in the morning and again at 08:00 in the evening.

If the same notification has already been sent and has not been read yet, the sending is not done.

IV. METHODOLOGY AND DATA ANALYSIS

This study aims to test TaBAT and evaluate its impact on self-regulation and prediction of success of two classes of the Higher Institute of Engineering and Business in Morocco. We present here a study based on a quantitative approach, with the aim to present the results obtained after a feedback on the use of the TaBAT tool. The methodology and the results analysis are presented below.

A. Methodology of Study

This study is conducted on a population of 25 students all enrolled in the first year, all of whom take a course entitled "Object Oriented design" over a period of 14 weeks, organized in a blended learning modality on the Moodle 3.8 platform. The course is finalized by a supervised face-to-face exam. In order to respect the sanitary protocol, put in place during the COVID-19 pandemic, the institute has limited the number of students from 10 to 14 per group.

The class is divided into two homogeneous groups, composed of 13 and 12 students randomly. The first group was informed about the experiment to use TaBAT to analyze learning traces (called exposed group), while the second group did not have access (called control group). Table I summarizes the demographic profile of participants.

TABLE I. DEMOGRAPHIC PROFILE OF PARTICIPANTS

		Exposed group	Control group
Gender	Male	9	10
	Female	4	2
Age	18 – 25	12	9
	26 – 35	1	3
Learner initial computer skills	Novice	0	2
	Intermediate	4	2
	Advanced	8	6
	Expert	1	2
Computer usage time	2 to 5 hours per day	1	2
	5 to 10 hours per day	12	10

B. Data Analysis and Results

The online part of course is composed of 9 sections, with 7 lessons, 3 files to download, 5 URL links to visit, and 2 assignments due on scheduled dates. The analysis of the activity of the TaBAT tool dashboards via the teacher report. Table 2 describes the result of study.

We first note that all students in the first class groups logged into the online course. The second observation concerns the total time spent doing the online course activities. This time is represented in Table 2, cumulated for each group. Students in the exposed group spent more than twice as much time as those in the control group doing the online course. The third observation concerns the performance of both groups, which is represented by the average progress score in the online course. The average obtained of the exposed group is significantly higher than that of the control group.

The fourth observation concerns the analysis of assignment completion. The exposed group had a 100% assignment return rate (returned on time with those returned late), while for the control group, the same rate was 45.83%. The final point concerns student success. In this study, the level of success calculated by the TaBAT is compared to the level of success obtained after the terminal exam. Table 2 shows that TaBAT was able to predict the totality of the success of the learners in the exposed and control groups. This result demonstrates the effectiveness of the success algorithm, based on our theoretical e-LSAM model to predict learners' success early before the end of the online course.

TABLE II. TABAT USAGE STATISTICS

	Exposed group	Control group
Number of active users	13/13	12/12
Cumulative time to complete the course	74 h 05	34 h 45
Average percentage progress score	70.69%	43.08%
% of assignments returned on time	96.15%	45.83%
% of assignments returned late	3.85%	0%
% of assignments not returned	0%	54.17%
Prediction of success (online success)	13/13	9/12
Effective success (validation of the face-to-face exam)	13/13	9/12

C. Discussion of Study Results

The strong increase in participation of the exposed group in our study gives positive feedback to the TaBAT tool, reflecting the contribution of this tool in helping learners resist distractions, regulate their learning, and monitor their performance. The increase in participation is mainly explained by the proactive actions carried out manually by the teacher or sent automatically by the TaBAT tool, in order to remind learners (through notifications) if they have resources not to consult (file to download or URL to visit) or activities not to carry out (lesson, homework, quiz to do). Not to mention the important role of the learner's report that allows them to self-evaluate and follow meta-cognitive strategies to improve their online performance.

In addition to increased participation and progress in the online course, the number of assignments submitted also increased for the group exposed to the use of the TaBAT tool. This increase is primarily due to the notifications sent automatically by the tool when an assignment is due. These proactive actions allowed learners to remember the due date and have a higher submission rate than the control group.

For predicting learner success, the TaBAT tool was found to be very effective for this role. The results of the study demonstrate the tool's ability to predict learner success online for both groups, compared to their actual success in a classroom situation (after face-to-face testing). These results also show that student performance and success is due in part to their ability to provide effective work at home, better preparing them for in-class exams.

The teacher reported that TaBAT helped him track the participation and progress of students participating in the

experiment. Indeed, the dashboards provide the teacher with a comprehensive view of learner activities that allows him/her to monitor learners' progress, consult homework and quiz results, view predictive states (academic success, low or high risk of failure), as well as contact learners directly or schedule automatic reminder notifications to alert them when needed.

V. CONCLUSION AND PERSPECTIVES

The design, development and implementation of the TaBAT learning outcomes analysis tool represents the completion of our modeling work, which would identify factors in an attempt to reduce the dropout rate of learners, and at the same time to improve their success in online courses. We proposed in this paper a study to test the effectiveness of the tool in the analysis of learning traces in online courses planned by an engineering school in Morocco. The results of this study confirmed that the use of TaBAT increased the learners' performance, improved their autonomy, and finally improved their academic success.

In our future work we would like to extend the use of TaBAT to other online courses (of different fields and specialties), in order to generalize our experience and to see the impact of the tool on the performance and the real success of learners.

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