Development and Evaluation of a Learning Analytics Dashboard for Moodle Learning Management System

Chapter *in* Lecture Notes in Computer Science · November 2022

DOI: 10.1007/978-3-031-22131-6_30

2 authors:

Ivan Peraić
University of Zadar
6 PUBLICATIONS **49** CITATIONS
SEE PROFILE

Ani Grubišić
University of Split
57 PUBLICATIONS **419** CITATIONS
SEE PROFILE

Development and Evaluation of a Learning Analytics Dashboard for Moodle Learning Management System

Ivan Peraić[1] and Ani Grubišić[2]

[1] Department of Information Sciences, University of Zadar, Croatia, iperaic@unizd.hr
[2] Faculty of Science, University of Split, Croatia, ani@pmfst.hr

Abstract. Learning analytics provides a potential for adapting learning, teaching and knowledge testing processes to individual needs. One of the ways of using learning analytics is a dashboard for providing feedback to students and teachers. This paper presents the development and evaluation of the learning analytics dashboard for students (LAD-S). The LAD-S displays three views: a look at student success, system activities and prediction based on machine learning algorithms. We have used LAD-S as a part of Moodle online courses, one during the second semester in the 2020/2021, and the other two during the first semester in the 2021/2022. A survey was designed to examine students' opinion about the LAD-S that included student's self-awareness, influence of the dashboard on learning effectiveness, satisfaction with the type of data collected, usefulness and ease-of-use, intention to use the learning analytics dashboard. Data from 33 undergraduate and graduate students were collected. The results have shown that students are satisfied with all examined aspects of the LAD-S above the average. Students express the greatest satisfaction for ease of use (M = 3.79), clarity of collected data (M = 3.6), usefulness (M = 3.6), SUS questionnaire (M=3.6), behavioral intention (M = 3.4) and satisfaction with individual functions of LAD-S (M = 3.4). Lower, yet above-average satisfaction was obtained for the impact of the LAD-S on more effective learning (M = 3.2); intention to use (M = 3.3) and satisfaction with the possibility of behavioral changes (M = 3.1). To verify the reliability of the measures used, the Cronbach's alpha reliability coefficient was calculated for each scale. Satisfactory reliability of all measures used was obtained, with alpha coefficients ranging from 0.704 for the SUS questionnaire to 0.942 for the ease-of-use measure.

Keywords: Learning analytics, learning analytics dashboard, evaluation

1 Introduction

Teaching is a dynamic activity that needs to be constantly monitored and adapted to changes in the social context and needs of students in order to ensure high quality learning and teaching process [1]. As the use of online learning continues to increase, there is a need for effective strategies and tools to help learners achieve success in

online environments [2]. During online learning, students leave a digital trail, which is appropriate for learning analytics. Learning analytics use the potential of increasing amounts of interaction, personal data, and achievement data [3]. According to the first international conference Learning Analytics and Knowledge (LAK), learning analytics (LA) is "measuring, collecting, analyzing and preparing reports on students and their context for the purpose of understanding and optimizing learning and the environment in which learning takes place" [4]. Suthers and Verbert [5] recognized the field of learning analytics as an "intermediate area" since it is at the intersection between technology and learning science. Moreover, the learning analytics should be seen as an educational approach guided by pedagogy rather than vice versa [6]. Online learning environments do not have the same support structure as traditional classrooms and many motivating social aspects are missing. One focus of research on learning analytics is empowering teachers and motivating students to make informed decisions about the learning process, mainly through visualizations of collected student data through dashboards [7]. Few [8] defines a learning analytics as an important information needed to achieve one or more objectives in one place. Teachers usually do not see how students communicate with the learning and teaching system; therefore, they need feedback to take appropriate actions. Feedback presented through Learning Analytics Dashboard (LAD) is used as a powerful metacognitive tool for students by encouraging them to think about learning activities and results [9] and enables teachers to create a real picture of students and teaching materials.

The following section analyses previous literature overviews regarding LADs. The third section describes development of a learning analytics dashboard for Moodle Learning Management System (LMS). The fourth section describes the methodology of the research. The fifth section presents the results of evaluation, the sixth chapter discuss the results and the seventh section gives future guidelines.

2 Research Background

2.1 Learning analytics

Learning analytics is an emerging trend, particularly in higher education. The development of big data technologies and the widespread use of digital tools allow us to build up important data collections on student behavior [10]. We can now measure, collect, analyze and process this data in order to better understand learners and improve their learning levels [11]. The dashboard concept was defined by Few [8], stating that a dashboard is "a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance". The definition of the LAD usually refers to displays in a single view, but due to the space limitation, the concept has evolved from a single view to multiple views and purposes, supporting viewers to interact with different components to gain necessary context [12]. Schwendimann et al. [13] say that learning analytics dashboards still follow the traditional paradigm in which the teacher monitors the students. Main purpose of dashboards is to give feedback to students, teachers in order to improve the learning and teaching process. Feedback aims to improve students' self-

awareness, which leads to improved academic performance as well as enhanced Self-Regulated Learning (SRL) [14]. Also, Matcha et al. [15] define SRL as an important role for achieving improved academic performance. LAD is undoubtedly an interesting tool because it visualizes a large number of information with which we can identify key problems in learning and teaching process. On the technical side, LAD is not a novelty, but it is still not completely clear how students accept online educational systems and how much these systems actually affect learning and teaching process. It has become a challenge for developers to design LAD that suits the needs in the educational domain to process the data generated by online learning activities [16]. Each analytics dashboard has features that do not necessarily fulfil every user's requirement [17].

A number of institutions developed systems for learning analytics and some of development objectives are monitoring and support [18], [19], [20], [21], visualization [22], [23], [24], [25] or prediction [26], [27], [28], [29].

2.2 Support for Learning Analytics in Moodle

Moodle LMS (www.moodle.org) is a web-based system specifically developed to complement traditional learning methods. Moodle LMS is an open-source LMS developed using PHP programming language and was first released in 2002. With the increasing demand and usage of online learning, Moodle is one of the most used LMS [30]. Moodle LMS has a simple interface with drag-and-drop features and well-documented resources along with ongoing usability improvements. Moodle LMS has very high flexibility and scalability that can be customized to support the needs of both small classes and large organizations [31].

Moodle and other LMS systems collect extensive data on how staff and students are using the systems. The ability to track and store vast amount of data on students and instructional design is very helpful for educational institutions. Such tracking in Moodle is conducted through various tracking tools and reports and through different analytic graphs and dashboards. Moodle has a wide list of analytical tools and graphs such as Engagement Analytics, GISMO, Analytics Graphs, Heatmap, Analytics [32]. On the other hand, many authors are developing Moodle plug-ins to integrate analytics. Plug-ins give an overview of relevant metrics such as student engagement time and student interaction with specified activities. The most popular Moodle plug-ins are IntelliBoard, SmartKlass, My Feedback, Piwik Analytics , etc.

InteliBoard is a complete commercial implementation of the e-learning analysis frameworks in LMS [33]. In addition to the visual analysis through customizable dashboards, it defines a set of informed decision rules together with an Artificial Intelligence (AI) assistant called LISA. On the one hand, it integrates LMSs through web services and, on the other hand, an open-source plugin maintained by the company [34]. Admin reports, notifications, learner access rate, etc. are supplied from the analysis. The learner can use this for self-assessment by comparing their progress against course completion. Teachers and admins can track the course activities and acceptance among learners [35].

A free plug-in, SmartKLass is a dashboard for Learning Analytics that could be incorporated into the Moodle virtual learning platform to allow teachers monitor their

students' behavior [36]. The technology analyzes the statements using machine learning algorithms and builds dashboard analysis with consolidated user information. It enables students to view their performances, see the evolution of the course, and receive or send alert messages [35].

My Feedback plug-in allows students to see an overview of all their grades and feedback on assignments [37] . It provides their visible grades and a link to their submission and any feedback that has been released to them. The report is intended to help students understand the variety of feedback they receive. Piwik Analytics provides reporting in the form of a comparative table. Data such as page views, bounce rate, and average generation time are recording to provide an overview for the user to understand their contents hit rate [31].

3 Learning Analytics Dashboard for students (LAD-s)

The design specification of the analytics dashboard is influenced by the objective and the current design trend. Our Learning Analytics Dashboard (LAD-s) is created as a Moodle Block which may be added to any course in Moodle. Students access the LAD-s from the Moodle course page. There are three components (Activity Component, Success Component and Prediction Component) in the LAD-s system which generate feedback presented furthermore to the student in the Dashboard component. All the components are programmed in the PHP programming language. Prediction Component also use Python for integrated Machine Learning algorithms for prediction of student's success. In addition, HTML, CSS, and JavaScript are used for front-end development. The architecture of LAD-s is illustrated in **Fig. 1**.

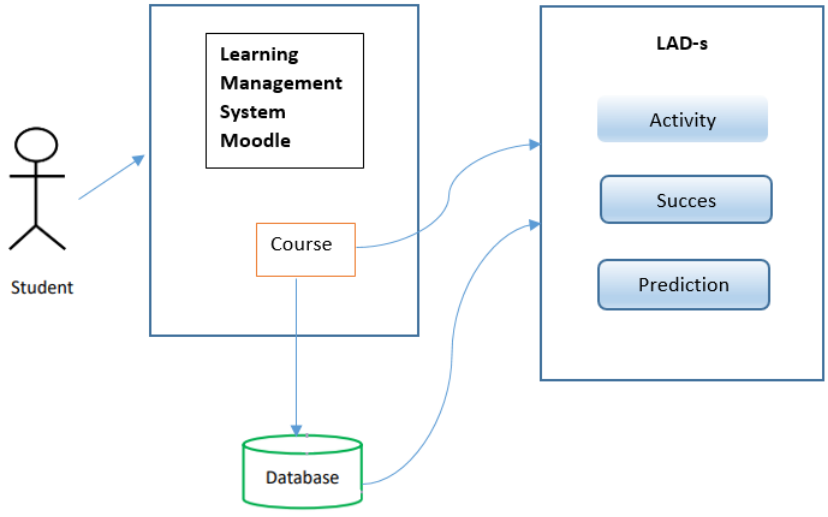

Fig. 1. LAD-s Architecture

The LAD-s report for the student gives an overall view of each student's progress in the course.

3.1 Activity Component

Activity Component highlights student engagement levels based on students' logs. Activity Component has three different panels. The first panel shows the number of total logins and logins in last seven days (**Fig. 2**). This panel contains only descriptive analytics components and compares the learner's engagement versus that of the groups average, median, minimum and maximum.

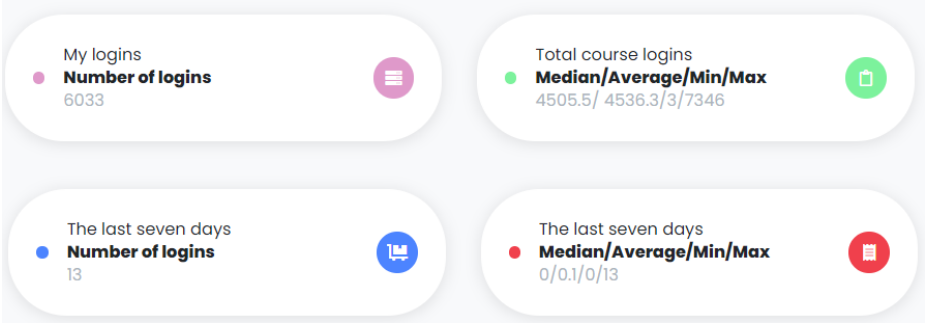

Fig. 2. Number of total logins and logins in last seven days

The other data visualization available in the Activity Component dashboard includes the bar chart. The bar charts show the individual logs of each student in terms of weeks. **Fig. 3** show the bar charts that are shown in the Activity Component.

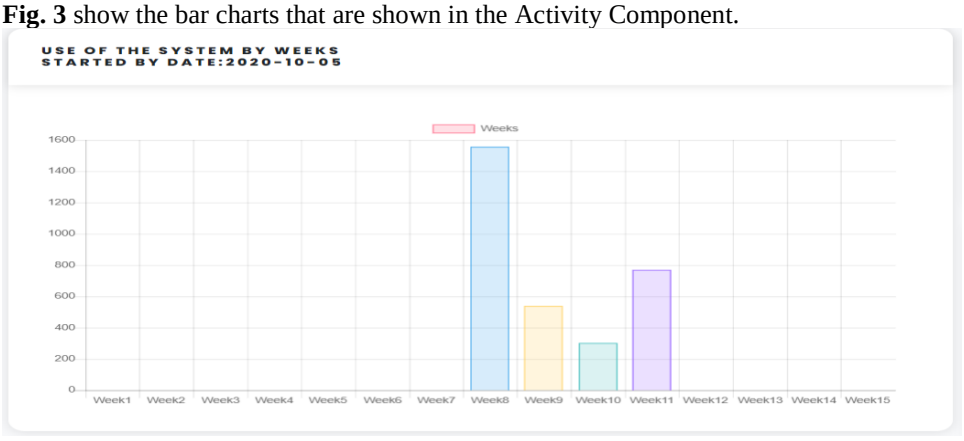

Fig. 3. Student's use of system

Besides data visualization, Activity Component also returns a message (**Fig. 4**). The message is visible to students as a system notification. The notifications are as follows:

1. " Your effort on the course is very low. Please try harder! "
2. "Your effort in college is low. Try harder please!"
3. "Your effort in college is average. Do your best please!"
4. "Your effort in college is high. Keep it up!"
5. "Your hard work in college is exceptional. Keep it up and you will surely succeed!"

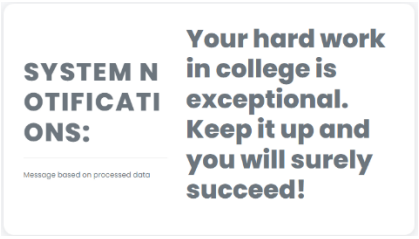

Fig. 4. Notification based on student's logs

The aim of the Activity Component is to encourage students to see their engagement and, if they are not satisfied with their use of the system, which they can see from the previously described data, to approach the work more maturely and responsibly.

3.2 Success Component

Success Component gets information about their success and compare it with all colleagues keeping in mind the student's score, minimum grade, maximum grade, average grade and median grade. This Component has four panels. First panel (**Fig. 5**) displays the grades the student has achieved. Using this visualization student can compare his performance level with the class's best performance level, class's worst performance level, class's average performance level and class's median performance level by selecting Details. Student can create his/her own personalized learning environment to increase his performance level to the class best level. This visualization supports increasing the grades of the student.

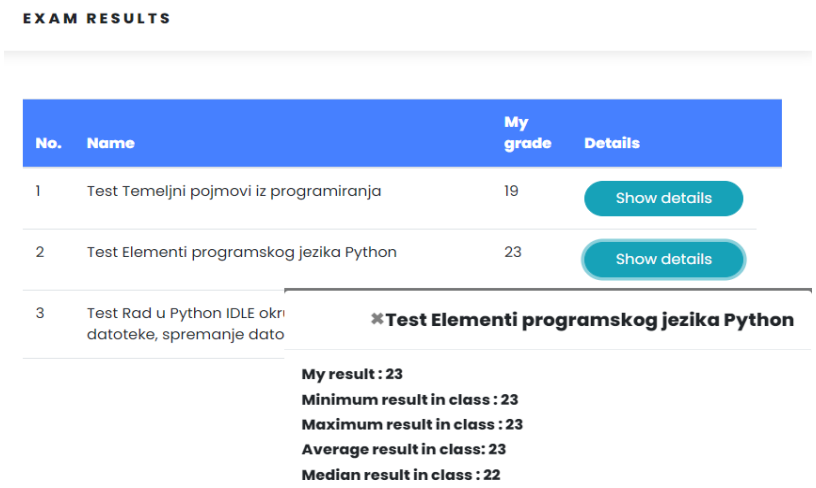

Fig. 5. Exam results with Details

The following overview (**Fig. 6**) allows the student an insight into the upcoming exams. Students can see how many exams they have till the end of semester, so they can do their best to make their performance better.

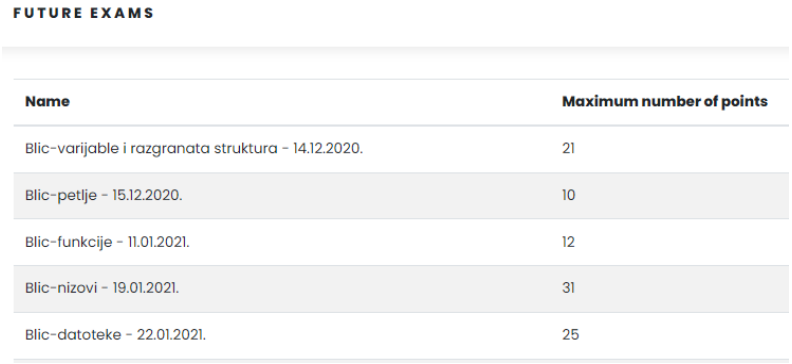

Fig. 6. Future exams

In order to show to students the activities they perform, students are shown a line graph. The graph shows the number of submitted materials, the number of resource views and the number of completed quizzes (**Fig. 7**). We believe that feedback on the student's success in the group is very important, because it can act as a trigger for the student to improve his results, so in the following graph we show the student his success. We singled out the success on all exams for student and compared it with average student success of all colleagues (**Fig. 8**).

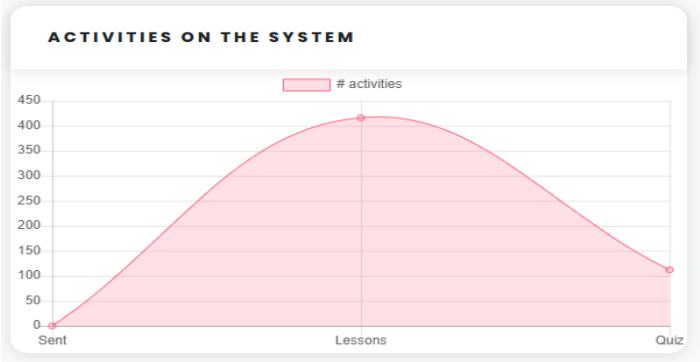

Fig. 7. Activities on the system

Fig. 8. Comparison of success

3.3 Prediction Component

Data mining for educational purposes and learning analytics can be used to predict the success and possible giving up of students based on an assessment of their achievements, participation, engagement, assessment in the learning process, teaching and knowledge testing [38]. Data mining is used to define student behaviour and create learning patterns in order to create different profiles of students [39]. Based on our descriptive-analytic results, LAD-s generate predictive analytics. We wanted to predict a student's final results, our model will predict whether a given learner will be Poor, Average, or Good. Prediction Component use Decision Tree Algorithm, performance prediction is based on student's logs, score on first exam, activities on Moodle (number of submitted materials, the number of resource views and the number of completed quizzes) and time spent on exam. In this case, idea is to see what student's think about

Prediction Component, so the information is presented to students in the form of visualization (**Fig. 9**).

Fig. 9. Prediction Component

We decided to use colors, so we associated red with Poor performance, yellow with Average success, and green with Good success.

4 Research Methodology

The objective of this research is to introduce the LAD-s to the student's and to see how students evaluate it. We present here a study based on a quantitative approach, with the aim to present the results obtained after feedback on the use of the LAD-s tool, and then to collect the impressions and opinions of the participants. Based on this we have three research questions:
RQ1: *What is the relationship between students perception of the usefulness of LAD-s, improvement suggestions, and comments on the use of LAD-s?*
RQ2: *How students accept LAD-s and their perception of the use in the future?*
RQ3: *Can the use of LAD-s affecct bihevioral changes during learning process?*

This study is conducted on a population of 228 student's (175 first year undergraduate students and 53 first year graduate students) all taking courses organized in a blended learning modality, which takes advantage of both face-to-face and online learning. Some course sections are done face-to-face, with some sections online on the Moodle 3.8 platform. Undergraduate students took a course entitled "Programming 1" over a 15-week period, during the first semester in the 2021/2022. Graduate students took two courses entitled "E-learning systems" (42 students) and "E-learning systems design" (11 students) over a 15-week period. Students could use LAD-s during the whole semester whenever they wanted to.

A survey was submitted at the end of the previously mentioned courses to the students who used LAD-s, in order to evaluate the presented tool. A survey was designed to examine students' opinion about the LAD-s, that included student's self-awareness, influence of the dashboard on learning effectiveness, satisfaction with the type of data collected, usefulness and ease-of-use, intention to use the learning analytics dashboard. The survey was adopted from recent work on the use of learning analytics dashboards as a decision support tool. Scheffel [40] presents evaluation framework for Learning

Analytics. This framework has four dimensions (Data, Awareness, Reflection and Impact). Learning Analytics should stimulate the self-regulating skills of the learners [41] and foster awareness and reflection processes for learners and teachers. We adopted Self-awareness, Influence and Data from [40]. Kim, Jo and Park [21] indicate that students were not able to connect the dashboard information to their behavioral changes. We adopted Behavioral changes from [21] to see if LAD-s could have a better impact on changes during learning process.

Perceived usability affects greatly students learning effectiveness and overall learning experience. The System Usability Scale (SUS) is a well-researched and widely used questionnaire for perceived usability evaluation [42]. In order to research degree of learner's opinion on usability of LAD-s, SUS questionnaire was adopted from [43].

Using the principles of technology acceptance model (TAM) we explored students' acceptance of LAD-s. TAM model consist of four items Usefulness, Ease-of-use, Behavioral intention and Intention to use [44].

Participant's opinion and suggestions on LAD-s include questions to research what students thinks generally about LAD-s. Two open-ended questions are set to students to have the opportunity to offer something to add without currently being on the LAD-s and to give their suggestions for improvement in future.

The questions were translated to Croatian and adapted minimally to reflect the topic of the dashboard. As shown in Table 1, the survey consisted of 45 questions (43 questions using a five-point Likert scale and 2 open-ended questions). Thirty-three students completed a questionnaire, 6 of them enrolled in course "E-learning systems design", 8 in course "E-learning systems" and 19 in course "Programming 1".

Table 1. Summary of Survey Questionnaire

Part	Contents	Example	No. of questions
Student's self-awareness	Degree of conformity between learner's perceived online activity and real data	This dashboard makes me more aware of my current study situation.	4
Influence	Degree of learner's influence of the dashboard on learning effectiveness	This dashboard stimulates me to study more effectively (as in: making sure to reach the target, in any way).	2
Data	Degree of learner's satisfaction with type of collected data	It is clear to me which data are being collected to assemble this dashboard.	2
Usefulness	Degree of learner's usefulness with the LAD-s	LAD-s contains the feedback I want to know.	3
Ease-of-use	Degree of learner's opinion on ease-of-use	The interaction with the LAD-s is clear and understandable.	4
Bihevioral intention	Degree of learner's bihevioral intention to use LAD-s in future courses	It is important to use LAD-s during online teaching	3

Intention to use	Degree of learner's intention to use LAD-s in future	I will adopt the use the LAD-s system in the next semesters.	2
Bihevioral changes	Degree of learner's bihevioral changes during use of LAD-s	I reflected on my learning behavior based on the info in LAD-s	6
SUS questionnaire	Degree of learner's opinion on usability of LAD-s	I would imagine that most people would learn to use this dashboard very quickly	10
Participant's opinion and suggestions on LAD-s	Participant's opinion and suggestions on LAD-s	LAD-s shows your success over your peers. This feedback is of great importance for creating a sense of succss in course.	9

5 Evaluation Results

The results will be given according to previously described parts.

5.1 Student's self-awareness

The satisfaction with the way the LAD-s helps them raise their self-awareness and the way it encourages them to think about their own learning is generally above average among students. Regarding questions related to self-awareness and thinking in general, students express somewhat greater satisfaction with survey items such as "LAD-s helps me create awareness of my current learning situation" (M = 3.39, SD =1.27), item "LAD-s encourages me to think about my learning behavior " (M = 3.30, SD =1.42), and item „LAD-s stimulates me to change learning behavior or the way I study." (M = 3.24, SD =1.37) and slightly lower satisfaction with the item " With the help of the LAD-s, I predict my possible learning situation" (M = 3.09, SD =1.33). Individual differences were noted among students in terms of answering these questions, and individual answers ranged from 1 to 5.

5.2 Influence

The average satisfaction of the students with the way the LAD-s encourages them to learn more effectively (such as: „ensuring the achievement of the goal, in any way") is M = 3.36, SD =1.39, while the average satisfaction with the way the learning analytics dashboard encourages them to learn more effectively (such as: „make sure you work the right way") M = 3.12, SD =1.34.

5.3 Data

When considering the clarity for the students regarding the type of data to be collected and the clarity of the reasons for collecting the data presented on the LAD-s, medium to higher satisfaction was obtained. The average satisfaction with the item "I understand what data is collected for compiling and displaying the learning analytics dashboard" is M = 3.52, SD =1.35 with about 2/3 of students giving a score of four or five. Satisfaction with the item "I understand why the data presented on the dashboard of learning analytics is collected" is M = 3.7, SD =1.29 while again about 2/3 of students gave a score of four or five. There are individual differences among students.

5.4 Usefulness

Students thinks that the LAD-s contains useful feedback. Average satisfaction with the item “LAD-s contains useful feedback for me” is M = 3.55, SD =1.27 with just over half of the students giving a score of four or five. Satisfaction with the item “LAD-s contains feedback I want to know” is also high M = 3.52, SD =1.35 with more than half of the students rating this aspect at four or five. Satisfaction with the item “LAD-s improves online teaching system in the form of displaying feedback” is M = 3.64, SD =1.17 with almost two thirds of students evaluating this aspect with a score of four or five.

5.5 Ease-of-use

Students are very satisfied with the ease of use of the LAD-s, and almost two thirds of students rate this aspect with a score of four or five. The average satisfaction with the item „LAD-s is easy to use” is M = 3.85, SD =1.18. „Using the LAD-s does not create difficulties” is M = 3.7, SD =1.13; the item “Data presented by the LAD-s is clearly presented.” M = 3.67, SD =1.16 and the item “Interaction with the Learning Analytics Dashboard is clear and understandable” M = 3.94, SD =1.06. It can be concluded that students perceive the LAD-s as easy to use, which does not create difficulties with clearly presented data and clear and understandable interaction.

5.6 Bihevioral Intention

Students would like to have the opportunity to use the LAD-s in the following semesters during online learning (M = 3.48, SD =1.12) with almost half of them grading this aspect with a score of four or five. It is important for students to be able to use the LAD-s during online learning (M = 3.27, SD =1.33), also about half of them rate this aspect with four or five. In addition, they would like to have access to the LAD-s in online courses at all times (M = 3.58, SD =1.17).

5.7 Intention to use

Item "LAD-s becomes a tool that I will add to every online course in the Moodle environment" has an average grade of M = 3.12, SD =1.19 with almost half of respondents (42%) undecided whether to use this tool in each course, grading this aspect 3. In the question "I will use the dashboard of learning analytics in the next online courses", an average grade of M = 3.55, SD =1.12 was obtained, indicating, a somewhat stronger intention to use, with about half (54%) of students rating this aspect 4 or 5.

5.8 Bihevioral changes

In this research, we are also interested in the possible behavioral consequences of using this tool, e.g., whether there is a change in behavior in students. The answers obtained are quite widely scattered around the core values and it is difficult to draw any general conclusion as to whether the use of the tool has influenced behavioral changes. The average answers range mainly around the mean value, ranging from M = 2.82, SD =1.33 for the benefit of the LAD-s in creating a learning plan to M = 3.33, SD =1.38 for the positive impact of LAD-s on learning motivation.

5.9 SUS questionnaire

The SUS questionnaire was used to measure the usability of this tool. The greatest satisfaction was obtained for the ease of use of the tool, as described by the item "I think this dashboard is easy to use" (M = 3.7, SD = 1. 07), and the item "I guess most people would learn to use this dashboard very quickly" (M = 3.9, SD = 1,01). Approximately 2/3 of the students rate these aspects 4 or 5. On the other hand, approximately 2/3 of the students rate (grades 1 and 2) that they did not have to learn many things before they could start with this dashboard. An equal number of them estimate that they do not need help to be able to use LAD-s, nor do they think that LAD-s is too complex or inconvenient to use.

5.10 Participant's opinion and suggestions on LAD-s

When considering satisfaction with specific aspects of this tool, it is evident that students show the highest average satisfaction (M = 3.91, SD = 1.16) with a Success Component, among other things, upcoming exams give students a sense of course complexity by the end of the semester. Approximately 2/3 of students give this feature a score of 4 or 5. Students are also relatively satisfied (M = 3.55, SD = 1.33) with features such as minimum grade, maximum grade, grade point average and Median success on the exam that allow them to compare performance level with the class's performance. Slightly more than half of the students (60%) give this panel a score of 4 or 5. The average high grade (with about half of the respondents giving a grade of 4 or 5) was obtained, in addition, for the item "Minimum grade, maximum grade, average grade and Median success on the test allow me to create a vision of my knowledge in relation to colleagues".

Lower than the previously mentioned functions, but satisfactory average grades were also obtained for the remaining functions of the tool “LAD-s displays your login data compared to your colleagues. This presentation allows us to create a sense of effort and work on the course. ”M = 3.3, SD = 1.41; “LAD-s provides feedback in the form of a message that can be positive or negative. Example of a positive message: Your work is exceptional, Keep it up and you will surely succeed!” (M = 3.3, SD = 1.47); “The LAD-s uses a prediction algorithm to predict student success at the end of a course. I think that the presentation of the predicted situation in the course is very important" (M = 3.3, SD = 1.41) and "Mode, Median, Minimum and Maximum are functions that allow me to clearly compare my log data with my class logins" (M = 3.06, SD = 1.20).

Students also answered a question about three different views of the LAD-s. Students were able to choose from the three different views (Activity Component, Success Component and Predict Component) the one that they think is most important. The answer was offered by 25 students and 68% (17) think that the Success Component is the most important, 16% of them (4) think that the Activity Component is the most important, while the same number (16%) think that the Prediction Component is most important.

Students had the opportunity to offer something to add without currently being on the LAD-s. Four students gave their suggestions for improvement. One student's proposal is to add a part for independent enrollment, e.g. hours dedicated to the course (e-learning, memory), so that this is included in the amount of effort, because according to the student he personally learns more independently using the material than online with quizzes. He does not, however, see any need for the whole dashboard idea, for someone who is organized. He believes that this is a surplus of information that anyone can access on their own. Another student would not add anything, but he thinks that it would be good if the interface was not graphically simple, but that it was a little more graphically interesting to the eye. The third student suggests that it would be good to have more options, e.g. suggests a settings page where students can turn on or off whether they want to compare their data with others and that they can filter which data they compare (first test, total only...).

Another suggestion for improvement is to reduce the emphasis on certain activities, e.g. the number of logins to the system. This student feels that this does not reflect the real situation (e.g. some students have studied through the system so they have more logins compared to others who have downloaded materials to the computer).

6 Discussion

If we compare student’s perception of the usefulness of LADs, improvement suggestions, and comments on the use of LADs, we come to the conclusion that LAD-s is dashboard that students are globally satisfied with. The guidelines in the more detailed report include more comparisons with their class, allowing for comparisons that students desire. Here we must be careful to define what and in what way it can be compared. Students acceptance level is also above average satisfaction. LAD-s is a tool that students would like to use in the future learning process. LAD-s is a tool that needs to be adapted to the needs of students. Teaching methods are changing, so we must always

keep in mind a new ways to improve the learning process. Once LAD-s becomes a "must have" tool with online teaching, it will certainly need to adapt to the needs of students. Finally, behavioral changes is the most difficult to achieve. In this study, students expressed how LAD-s has a positive impact on learning motivation. However, the answers obtained are quite widely scattered around the core values and it is difficult to draw any general conclusion as to whether the use of the tool has influenced behavioral changes.

In order to compare individual dimensions that examined student satisfaction with LAD-s, the overall average results for each examined general aspect were formed. Based on individual questions within each appropriate measure from the survey, the overall results were formed. The total score on a particular measure was formed as the average score of each student on individual issues related to a particular measure. Before that, by calculating the Pearson correlation coefficient between individual items (questions), it was checked if all items within the same measure really belong to the same characteristic. If they refer to the same measure, it is expected to have a medium to high correlation between individual items. Medium to high correlations between items were obtained and it can be concluded that it is justified to construct total average results for each measure. When forming the total results, negative items were taken into account, which were recoded in the direction that the higher result on the particle represents the higher total result (4 items in total).

Table 2. Descriptive data of summary measures.

Part	M	C	D	Min	Max	SD
Student's self-awareness	3,26	3,25	3,00[a]	1,00	5,00	1,25
Influence	3,24	3,50	3,50	1,00	5,00	1,30
Data	3,61	3,50	5,00	1,00	5,00	1,22
Usefulness	3,57	3,67	4,00[a]	1,00	5,00	1,16
Ease-of-use	3,79	3,75	5,00	1,00	5,00	1,05
Behavioral intention	3,44	3,33	3,00	1,00	5,00	1,11
Intention to use	3,33	3,50	3,50	1,00	5,00	1,11
Behavioral changes	3,08	3,00	2,33[a]	1,00	5,00	1,09
SUS questionnaire	3,60	3,60	3,00	1,00	5,00	0,66
Participant's opinion and suggestions on LAD-s	3,42	3,71	3,71	1,00	5,00	1,02

From the summary results (Table 2), we conclude that students are above average satisfied with all examined aspects of the LAD-s. Students express the greatest satisfaction for Ease-of-use (M = 3.79, SD = 1.05), Data (M = 3.6, SD = 1.22), Usefulness (M = 3.6, SD = 1.16), Sus questionnaire (M = 3.6, SD = 0.66), Behavioral intention (M = 3.4, SD = 1.11) and satisfaction with individual functions of this tool (M = 3.4, SD = 1.02). Lower, yet above-average satisfaction was obtained for the Influence of the LAD-s on more effective learning (M = 3.2, SD = 1.30); Intention to use (M = 3.3, SD = 1.11) and satisfaction with the possibility of Behavioral changes (M = 3.1, SD = 1.09).

Table 3. Reliability of measures

Part	α	No. of items
Student's self-awareness	0,941	4
Influence	0,898	2
Data	0,826	2
Usefulness	0,908	3
Ease-of-use	0,942	4
Bihevioral intention	0,902	3
Intention to use	0,911	2
Bihevioral changes	0,918	6
SUS questionnaire	0,889	10
Participant's opinion and suggestions on LAD-s	0,704	9

To verify the reliability of the measures used, the Cronbach's alpha reliability coefficient was calculated for each scale. The number of items by which each aspect of satisfaction is measured varies from at least 2 items to up to 10 items (Sus questionnaire). Satisfactory reliability of all measures used was obtained, with alpha coefficients ranging from 0.704 for the SUS questionnaire to 0.942 for the Ease-of-use measure. Despite the small number of items in some measures, all measures are considered reliable and appropriate.

7 Conclusion

Learning analytics dashboards are becoming increasingly commonplace within the educational sector with the aims of improving the quality of the learning process. This study presents the development and evaluation process of our LAD-s dashboard. The LAD-s report for the student gives an overall view of each students progress in the course. This study found that students overall satisfaction on LAD-s is above average satisfied with all examined aspects. The greatest satisfaction is found for Ease-of-use. Data, Usefulness, Sus questionnaire, Behavioral intention and Satisfaction with individual functions of this tool. Lower, yet above-average satisfaction was obtained for the Influence of the LAD-s on more effective learning, Intention to use and satisfaction with the possibility of Behavioral changes. The impression remains that students will use LAD-s for the purpose of making better progress.

Comments from open-ended questions provided the direction for another point of view. For example, a student mentioned, "reduce the emphasis on certain activities, eg. the number of logins to the system". This student feels that this does not reflect the real situation. Another students mentioned, "it would be good to have more options, suggesting a settings page where students can turn on or off whether they want to compare their data with others and that they can filter which data they compare (first test, total only...)". These facts coincide with the choice of the Success Component as the most

important view of the LAD-s. Students want different possibilities of comparison, but the question arises, where to draw the line.

As a further study, it is necessary to examine the impact of the LAD-s empirically in different contexts to prove its usefulness more precisely. The impact of LAD-s could be very different between a full online class and a blended learning class. LAD-s use a prediction of student success. As a further study it is important to research and implement the best prediction model. We believe that students would pay more attention to prediction if they are shown the way it works. Limitations of this study are working conditions due to the Covid-19 pandemic. On the one hand, it allowed students to track their successes and activities on the system, on the other hand, we feel that too many courses have moved unprepared to online learning, thus leaving negative consequences on online learning.

8 Acknowledgment

This work was supported by the Office of Naval Research grant, **N00014-20-1-2066** „Enhancing Adaptive Courseware based on Natural Language Processing“**.**

9 References

[1] A. L. Dyckhoff, V. Lukarov, A. Muslim, M. A. Chatti and U. Schroeder, "Supporting Action Research with Learning Analytics," in *LAK'13, April 08–12* , Leuven, Belgium, 2013.

[2] R. Bodily, T. K. Ikahihif, B. Mackley and C. R. Graham, "The design, development, and implementation of studentfacing learning analytics dashboards," *Journal of Computing in Higher Education*, 14 June 2018.

[3] R. Ferguson, "Learning analytics: drivers,developments and challenges," *International Journal of Technology Enhanced Learning 4, 5-6*, pp. 304-317, 2012.

[4] G. Siemens, "Learning Analytics & Knowledge," in *LAK 2011*, Banff, Alberta, 2011.

[5] D. Suthers and K. Verbert, "Learning analytics as a middle space," in *Proceedings of the Third International Conference on Learning Analytics and Knowledge*, 2013.

[6] W. Greller and H. Drachsler, "Translating Learning into Numbers: A Generic Framework for Learning Analytics," *Educational Technology & Society 15 (3),* pp. 42-57, 2012.

[7] E. Durall and B. Gros, "Learning Analytics as a Metacognitive Tool," in *6th International Conference on Computer Supported Education*, Barcelona, Spain, 2014.

[8] S. Few, "Information dashboard design: Displaying data for at-a-glance monitoring," in *Analytics Press*, Burlingame, CA, 2013.

[9] S. Charleer, J. Klerkx, E. Duval, T. De Laet and K. Verbert, "Creating Effective Learning Analytics Dashboards: Lessons Learnt," in *European Conference on Technology Enhanced Learning*, 2016.

[10] Y. Safsouf, K. Mansouri and F. Poirier, "TABAT: DESIGN AND EXPERIMENTATION OF A," *Journal of information technology education: Research, Volume 20, ,* 2021.

[11] G. Siemens and R. S. J. d. Baker, "Learning analytics and educational data mining: towards communication and collaboration," *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, pp. 252-254, April 2012.

[12] A. Sarikaya, M. Correll and L. B. Mela, "What do we talk about when we talk about dashboards?," *IEEE transactions on visualization and computer graphics, 25(1),* p. 682–692, 2018.

[13] B. A. Schwendimann, M. J. Rodrıguez-Triana, A. Vozniuk, L. P. Prieto, M. S. Boroujen, A. Holzer, D. Gillet and P. Dillenbourg, "Perceiving Learning at a Glance: A Systematic Literature Review of Learning Dashboard Research," *IEEE TRANSACTIONS ON LEARNING TECHNOLOGIES, VOL. 10, NO. 1*, Siječanj-ožujak 2017.

[14] B. J. Zimmerman and A. R. Moylan, "Self-regulation: Where metacognition and motivation intersect.," in *D. J. Hacker, J. Dunlosky & A. C. Graesser (Eds.), Handbook of metacognition in education*, 2009, pp. 299-315.

[15] W. Matcha, D. Gasevic, N. Ahmad Uzir and A. Pardo, "A Systematic Review of Empirical Studies on Learning Analytics Dashboards: A Self-Regulated Learning Perspective," *Transactions on Learning Technologies,* Svibanj 2019.

[16] H. Aldowah, H. Al-Samarraie and W. M. Fauzy, "Educational data mining and learning analytics for 21st century higher education: A review and synthesis," *Telematics and Informatics vol. 37,* p. pp. 13–49, April 2019.

[17] D. Gasevic, S. Dawson, T. Rogers and D. Gasevic, "Learning analytics should not promote one size fits all: The effects of instructional conditions in predicting academic success," *The Internet and Higher Education 28:68–84 · January 2016 with 2,096 Reads* , January 2016.

[18] D. M. Naranjo, J. R. Prieto, G. Moltó and A. Calatrava, "A Visual Dashboard to Track Learning Analytics for Educational Cloud Computing," *Advanced Sensors Technology in Education),* 4 July 2019.

[19] J. A. Ruiperez-Valiente, P. J. Munoz-Merino, J. A. Gascon-Pinedo and C. D. Kloss, "Scaling to Massiveness With ANALYSE: A Learning Analytics Tool for Open edX," *IEEE TRANSACTIONS ON HUMAN-MACHINE SYSTEMS,* 22 October 2016.

[20] M. Hussain, S. Hussain and W. Zhang, "Mining Moodle Data to Detect the Inactive and Low performance Students during the Moodle Course," *ICBDR,* 27-29 October 2018.

[21] Y. Park and I.-H. Jo , "Development of the Learning Analytics Dashboard to Support Students' Learning Performance," *Journal of Universal Computer Science, vol. 21, no. 1,* 2015.

[22] V. Podgorelec and S. Kuhar , "Taking Advantage of Education Data: Advanced Data Analysis and Reporting in Virtual Learning Environments," *ELECTRONICS AND ELECTRICAL ENGINEERING ISSN 1392 – 1215; No. 8(114)*, 2011.

[23] N. R. Aljohani, A. Daud, R. A. Abbasi, J. S. Alowibd, M. Basheri and M. A. Aslam, "An Integrated Framework for Course Adapted Student Learning Analytics Dashboard," *Computers in Human Behaviour,* March 2018.

[24] D. Azcona, I.-H. Hsiao and A. F. Smeaton, "Personalizing Computer Science Education by Leveraging Multimodal Learning Analytics," *IEEE,* 2018.

[25] C. Shi, S. Fu, Q. Chen and H. Qu, "VisMOOC: Visualizing Video Clickstream Data from Massive Open Online Courses," *IEEE Pacific Visualization Symposium,* 14-17 April 2015.

[26] G. AKÇAPINAR and A. BAYAZIT, "MoodleMiner: Data Mining Analysis Tool for Moodle Learning Management System," *Elementary Education Online,* pp. 406-415 , 2019.

[27] A. Tervakari, K. Kuosa, J. Koro, J. Paukkeri and M. Kailanto, "Teachers' learning analytics tools in a social media enhanced learning environment," *International Conference on Interactive Collaborative Learning (ICL),* 03-06 December 2014.

[28] L. Corrin, A. Bakharia, D. Williams, G. Kennedy, L. Lockyer, S. Dawson, P. De Barba, D. Gasevic and S. Copeland, "Loop: A learning analytics tool to provide teachers with useful data visualisations," in *Ascilite*, Perth, Australia, 2015.

[29] R. Martinez-Maldonado, A. Pardo, N. Mirriahi and K. Yacef, "The LATUX Workflow : Designing and Deploying Awareness Tools in Technology-Enabled Learning Settings," in *International Conference on Learning Analytics and Knowledge*, At Poughkeepsie, NY, USA, 2015.

[30] S. H. P. W. Gamage, J. R. Ayres and M. B. Behrend , "A systematic review on trends in using Moodle for teaching and learning," *International Journal of STEM Education: Article number: 9,* 2022.

[31] O. K. Xin and D. Singh, "Development of Learning Analytics Dashboard based on Moodle Learning Management System," *International Journal of Advanced Computer Science and Applications, Vol. 12, No. 7,* 2021.

[32] "Moodle docs," Moodle, [Online]. Available: https://docs.moodle.org/400/en/Analytics_plugins. [Accessed 15 April 2022].

[33] "Create better learning experiences," [Online]. Available: https://intelliboard.net/.

[34] R. Marticorena-Sánchez , C. López-Nozal , Y. P. Ji , C. Pardo-Aguilar and Á. Arnaiz-González , "UBUMonitor: An Open-Source Desktop Application for Visual E-Learning Analysis with Moodle," *Open Source Software in Learning Environments,* 19 March 2022.

[35] R. Krishnan , S. Nair , B. S. Saamuel, S. Justin , C. Iwendi, C. Biamba and E. Ibeke, "Smart Analysis of Learners Performance Using Learning Analytics for Improving Academic Progression: A Case Study Model," *Entrepreneurship and Sustainability of Higher Education,* 14 March 2022.

[36] "SmartKlass™ Learning Analytics Moodle," https://moodle.org/plugins/local_smart_klass. [Online].

[37] "My Feedback," [Online]. Available: https://moodle.org/plugins/report_myfeedback. [Accessed 15 April 2022].

[38] S. Parack , Z. Zahid and F. Merchant, "Application of data mining in educational databases for predicting academic trends and patterns," *IEEE International Conference on Technology Enhanced Education (ICTEE), Kerala, 2012, ,* pp. 1-4, 2012.

[39] D. T. Tempelaar, B. Rienties and B. Giesbers, "In search for the most informative data for feedback generation: learning analytics in a data-rich context," *Computers in Human Behavior, 47 pp.,* p. 157–167, 2015.

[40] M. Scheffel, H. Drachsler, C. Toisoul, S. Ternier and M. Specht, "The Proof of the Pudding: Examining Validity and Reliability of the Evaluation Framework for Learning Analytics," in *Data Driven Approaches in Digital Education. EC-TEL 2017. Lecture Notes in Computer Science(), vol 10474. Springer, Cham*, 2017, pp. 194-208.

[41] D. Persico and F. Pozzi, "Informing learning design with learning analytics to improve teacher inquiry," *British Journal of Educational Technology 46(2),* p. 230–248, 2014.

[42] K. Orfanou, N. Tselios and C. Katsanos, "Perceived Usability Evaluation of Learning Management Systems: Empirical Evaluation of the System Usability Scale," *International Review of Research in Open and Distance Learning 16(2),* pp. :227-246, 2015.

[43] E. Celi, "Application of Dashboards and Scorecards for Learning Models IT Risk Management: A User Experience," in *International Conference of Design, User Experience, and Usability*, 2015.

[44] R. Ramirez-Anormaliza and F. Sabate, "Evaluating student acceptance level of e-learning systems," in *8th International Conference of Education, Research and InnovationAt: SevillaVolume: ICERI2015 Proceedings*, 2015.