Overview of learning analytics dashboards usage in educational systems
(Огляд використання навчальних аналітичних панелей в освітніх системах)[1]

Actuality. In the wake of the Covid-19 pandemic, many teachers have had to radically change the way they conduct their classes, adapting to the forms of distance education[2]. Teachers who mix regular and distance learning activities on the Internet face many challenges in monitoring students' online activities. One way to improve this process is to use learning dashboards to help teachers track students' progress as they use the learning system.

There are several features of the use of learning analytics dashboards[3]. Usage context: dashboards contain information on learning outcomes specific to the chosen learning platform. Panels can make it much easier for teachers to identify students who need a special approach. Thus, learning strategies can be more quickly and efficiently adapted for individual students.

Learning progress: in the dashboards, students' progress can be shown using indicators such as achieved levels, number of completed modules, regularity or time of classes, test results, etc. These indicators reflect the progress of students over time, and not only provide information about the current state of the course, such as a course or module. They can be used not only by teachers but also by students themselves to improve their planning skills and adjust their plans for further study.

Informed Interventions: teachers often conduct interventions in-class to congratulate, encourage, remind, or alert learners. They highlighted the complexity of using the existing reporting table to keep track of learners' online activity and to pinpoint gaps in learners' progression, which hindered engaging in informed interventions with learners, e.g., acquiring arguments for debriefs and feedback.

Informing the student's progress and problems can allow teachers to pay more attention to students who need it, and students – to receive relevant reminders. Positive messages in this case can also increase the motivation to learn from students.

Educational dashboards provide an opportunity to quickly learn about students' academic performance, patterns of their behavior during studies and social connections in groups, the ability to predict successes or failures during courses and the ability to influence student behavior and actions, motivating them to continue learning . The use of dashboards can greatly facilitate online learning for both teachers and students, and will increase the effectiveness of learning. However, the construction of an effective training dashboard remains a significant challenge and requires analysis and search for optimal solutions given the pedagogical, psychological, analytical and interface features of its implementation.

The purpose of the article. This paper provides an overview of existing solutions for learning dashboards and possibilities, provided by such applications,

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[1] **Автори Furman V.D., Tarelkina M.O., Tytenko S.V. (Фурман В.Д., Тарелкіна М.О., Титенко С.В.)**

[2] Identifying Student Engagement and Performance from Reading Behaviors in Open eBook Assessment. URL: https://www.researchgate.net/publication/337745936_Identifying_Reading_Styles_from_E-book_Log_Data

[3] Verbert, K., Govaerts, S., Duval, E. et al. Learning dashboards: an overview and future research opportunities. Pers Ubiquit Comput 18, 1499–1514 (2014). https://doi.org/10.1007/s00779-013-0751-2

formulated requirements requirements to be considered during the development of such components, and prospects for further improvement.

Main part. Learning dashboard is an application which is used to display data of a learning system about systems' users and their activity.

The main features[4] of a good dashboard are:
1) defined target users;
2) defined data, which are required (and useful) for an analysis, their sources and volume;
3) apposite, understandable visualization, which clearly demonstrates gathered and processed data in optimal form for subsequent analysis;
4) correct analysis of the gathered and visualized data.

Learning dashboards that have been deployed in recent years can be broadly categorized in three groups:
1) dashboards that support traditional face-to-face lectures;
2) dashboards that support face-to-face group work;
3) dashboards that support awareness, reflection, sensemaking, and behavior change in online or blended learning.

dashboards could be designed to be used by both students and teachers as well as administrators of the learning system. The role of the target users has a direct impact on data that has to be gathered, and the visualization of that data.

For instance, teachers could have a possibility to monitor the activity of a group of students or students of a certain course. In this case, data about students' success or failure could be used to create a better program for a new course (or correct the existing one), or apply an individual approach for students who need it.

In most of the cases, students do not have a possibility to monitor the activity of their study group, but they could explore the history of their own activity to get information about the results of tasks completion and courses attended, or to improve their learning strategies.

The three key questions you need to answer when you're designing learning dashboards[5]. Who is the audience for dashboards? What is the purpose of the dashboard? Where is your dashboard going to be accessed? You need to have a clear understanding of who the audience of your dashboard is going to be e.g. what a front line manager needs will be different to what a senior manager needs, to what a learning designer needs.

Main goals and purposes:
1) using dashboards for tracking learning activity;
2) using dashboards to measure the impact of learning;
3) using dashboards to gain insights.

You need to plan how your audience accesses your dashboard. Three potential options are:
1) in your learning management system, it's the most common approach;

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[4] Yeonjeong Park, Il-Hyun Jo. "Development of the Learning Analytics Dashboard to Support Students' Learning Performance" (2015).

[5] The power of learning dashboards and how to design an effective learning dashboard. URL: http://www.sproutlabs.com.au/blog/the-power-of-learning-dashboards/

2) embedded somewhere else such as your Intranet;
3) it's a part of your wider business reporting systems.

Often how your dashboards are going to be accessed is defined by the technology you use to build them.

Data gathering. The usage of the log data is one of the most popular direction of existing research[6]. The other methods of data mining, that are used, are analysis of the user content, analysis of the data from the databases of the educational establishments and third-party APIs, conducting surveys and tracking of the physical activity of the users. For example, research of usage of the recorded user's gaze-movements while viewing the page was conducted in the AdeLE (Adaptive e-Learning with Eye-Tracking)[7] project. Obviously, the data could be gathered from several sources, but in such case it is possible to meet the problem of integration of the data in different formats or in different granularity.

For tracking users' activity could be used both ready learning content management systems, such as Moodle, and tracking systems developed especially for the learning system. It was stated[8], that the former variant is more secure, as well as scalable. However, it should be noted that development of the special tracking system will allow to determine data to be gathered more precisely, and gather it in the most optimal way in the context of the existing system.

A tracking system data gathering is based on a usage of so-called indicators[9]. Indicators could be based on various types of data. Firstly, it could be data about the user, provided by the user itself. It includes both personal profile data and user's content. User content includes published articles, created courses, blog posts, uploaded files, provided feedback and comments, etc.

Second, it is information about user actions. You can conditionally divide the following information into four categories:
— resource use;
— time spent;
— user achievement information;
— information about the social activity of a user or group of users, etc.

Most dashboards track resource use as a basis to provide awareness for teachers. Resource use has been used in examples of adaptive hypermedia and recommender systems to estimate knowledge levels of the learner as well[10].

Dashboards visualize time spent so that teachers can identify potential students at risk. In addition, time spent is sometimes visualized for students, so that they can compare their efforts with those of their peers.

[6] Yeonjeong Park, Il-Hyun Jo. "Development of the Learning Analytics Dashboard to Support Students' Learning Performance" (2015).

[7] Christoph Fr ¨oschl. "User Modeling and User Profiling in Adaptive E-learning Systems" (2005)

[8] Yeonjeong Park, Il-Hyun Jo. "Development of the Learning Analytics Dashboard to Support Students' Learning Performance" (2015).

[9] B. A. Schwendimann et al., "Perceiving Learning at a Glance: A Systematic Literature Review of Learning Dashboard Research," in IEEE Transactions on Learning Technologies, vol. 10, no. 1, pp. 30-41, 1 Jan.-March 2017, doi: 10.1109/TLT.2016.2599522.

[10] Ez-zaouia, Mohamed, A. Tabard and É. Lavoué. "PROGDASH: Lessons Learned from a Learning Dashboard In-the-wild." CSEDU (2020).

The information obtained from the achievements can include test results. This type of information is a more objective assessment of knowledge than the amount of time spent on the course.

Social activity is a second commonly tracked and visualized element[11]. Examples include analysis of the amount of speech by the learner in face-to-face group work or interactions and ratings of tweets, comments on blog and forum posts or chat messages between learners.

Information could be gathered both for individual users and, for instance, study groups, or students of a certain course, or for all users of the system. In the case of data gathered for a group of users it is most likely that it would be very hard, or even impossible to divide such data to data about individual users, and this nuance must be taken into account when gathering aggregated data.

Display information. Gathered data could be used for a simple visualisation for further analysis by a user (a student, a teacher, an administrator, an analyst, etc.), as well as for development of certain predictions based on the data. For example, it could be possible to predict students' success or failure, lectures attendance, average marks or topics of materials for future learning.

In order to make information displayed on the dashboard really useful for end users it is not enough to just gather data and display it on screen. Instead some basic principles could be followed:

1) after determining the needs of the end users while using the dashboard, it would be better to devote more screen space to the more important to user details of the panel;
2) usage of the different visualisation techniques will allow to make information more descriptive;
3) the arrangement of the elements of the page should correspond to users' needs and intentions.

The great example of a dashboard is LAPA Dashboard (Figure 1):
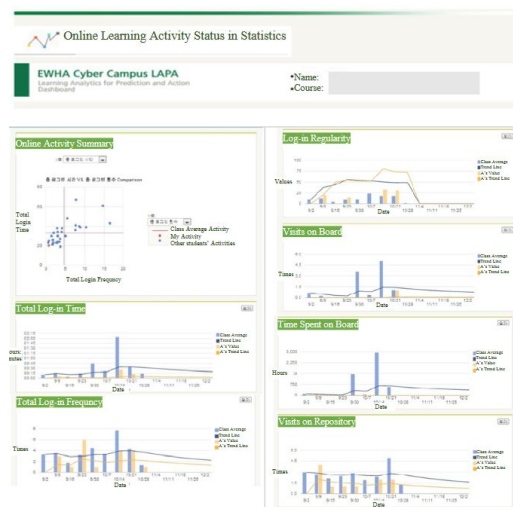
Figure 1. The first version of LAPA Dashboard[12]

[11] Ez-zaouia, Mohamed, A. Tabard and É. Lavoué. "PROGDASH: Lessons Learned from a Learning Dashboard In-the-wild." CSEDU (2020).

[12] Yeonjeong Park, Il-Hyun Jo. "Development of the Learning Analytics Dashboard to Support Students' Learning Performance" (2015).

Another good example would be a design of the web-dashboard by Aga Ciurysek for 10Clouds (Figure 2).
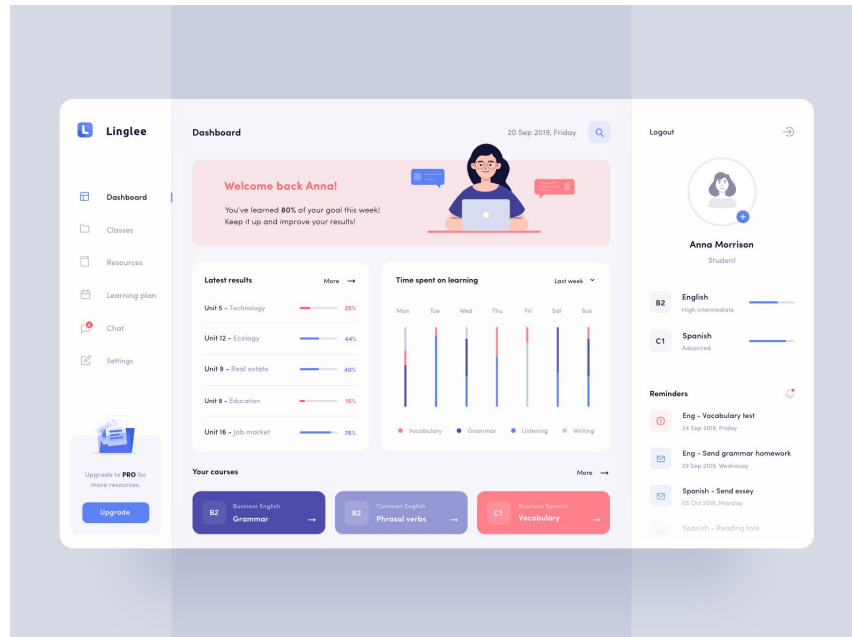
Figure 2. Web-dashboard by Aga Ciurysek for 10Clouds[13]

Existing solutions. Existing reviews of learning dashboards lack systematic, also they in most cases are conducted on small thematic researches[14]. Existing learning dashboards mostly were studied in a formal approach. Their target users are teachers, and information is retrieved mostly from log data.

Part or the existing solutions for learning dashboards has some disadvantages, which could be relatively divided into the two categories: data issues and data visualisation issues. The first category includes usage of generalized data. Such data have to complete enough to be useful. Also it is hard to (or impossible) integrate with more detailed data. The second category includes, for instance, lack of data visualization techniques for presenting the information regarding activity of users of the learning system. Also presented information and a dashboard on the whole could be not practical and usable enough and together with previously said, this could undoubtedly affect users' ability to make correct conclusions based on gathered data.

However, such disadvantages demonstrate possibilities for further improvements. For instance, dashboards designed for students could be created, which will allow to increase engagement of students into the learning process, increase students' motivation and at the same time improve quality of the received while learning knowledge.

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[13] Aga Ciurysek for 10Clouds. "Linglee – Languages learning platform". URL: https://dribbble.com/shots/7052720-Linglee-Languages-learning-platform.

[14] B. A. Schwendimann et al., "Perceiving Learning at a Glance: A Systematic Literature Review of Learning Dashboard Research," in IEEE Transactions on Learning Technologies, vol. 10, no. 1, pp. 30-41, 1 Jan.-March 2017, doi: 10.1109/TLT.2016.2599522.

Regardless of who exactly will be the target audience of the dashboard, it is important to devote significant attention to which data (and with which aim) will be gathered. In order to receive more comprehensive information it is possible to combine data from several resources, or gathered in differ ways. No matter how useful the received information is, for its proper analysis it is necessary that information is appositely visualised. In order to achieve this, the research the particular qualities of user experience and user interface is required, as well as, possibly, determination of certain visualisation for certain data types.

Conclusions. This work provides an overview of learning through the use of dashboards designed to support awareness, reflection, reasoning, and impact on learning. We have outlined several research questions for the development and evaluation of dashboards for learning based on this analysis. Many promising prototypes illustrate the potential and capabilities that these programs can provide. Further research is needed to assess the usefulness of different types of data for dashboards of analytical training. The choice of types of indicators and information to collect has major implications for the completeness and usefulness of the data. Surveying potential users, such as faculty and students, about their actual problems can help better understand needs and is key to better targeting dashboards to improve learning effectiveness.