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Learning Analytics Dashboards for Online Collaboration Whiteboards: Feasibility Check of an Activity Dashboard to Support the Evaluation of Student Activity within Miro

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Purpose: Current developments due to ongoing socioeconomic transformations have increasingly boosted the digitalisation process and thus, have shifted the work domain closer to the internet. This includes the education sector, which results in the rising demand for suitable online learning opportunities. In the university context, students are frequently challenged with test performances based on collaborative work in joint research projects. The paradigm shift also affects the tutor turning him into an e-tutor. In the scope of e-tutoring, tracking and assessment of group-specific or individual-based work performance can be guaranteed by a suitable social analytics solution.

Study design/methodology/approach: In this work, the design and implementation of a learning analytics dashboard tool for Online Collaborative Whiteboards, especially Miro, is presented.

Findings: The requirements were derived from focus group interviews with key users.

Originality/value: The tool features real-time tracking and quantitative evaluation of group and individual user actions

Introduction

Since the beginning of the Covid-19 pandemic, internet traffic has substantially increased, and so did the volume of collaborations that take place online (Favale et al., 2020). Consequently, in the context of collaborative work within institutions like universities, there is a rising demand for online collaboration solutions that may support or replace conventional, on-site teaching methods. Effective and efficient support of learners in online scenarios is enabled by the opportunity to monitor group activities in real-time to intervene quickly if issues arise and to objectively evaluate the performance of the group and the individual members. However, the multitude of interactions is difficult to record and interpret manually (Rietze, 2016). Focusing on online collaboration whiteboards, this study aims to evaluate the feasibility of a collaborative analysis in the online collaboration tool Miro, i.e., a proof of concept. Specifically, this can be achieved with the help of a prototype that extracts user data from group work on an online whiteboard in Miro, processes it and visualises it in a graphical user interface. Supported by this user interface, educators can evaluate group performance, group interactions and the behaviour of individual group members when working on the online whiteboard (Mailles-Viard Metz et al., 2015). The following research questions will be evaluated:

1. Which key indicators or parameters are relevant for tracking and evaluating collaborative group work on an online whiteboard in the Miro environment?

2. Which software architecture is suitable for extracting and processing Miro board data, calculating relevant key indicators, and visually displaying the results?

The third and last research issue is to evaluate a proof of concept in terms of technical feasibility and practical relevance for members of institutions in the education sector.

This research work is structured as follows: At first, the theory section will define the most important definitions and terms in online collaboration and learning analytics. After that, the methodology part describes the research process and the methods selected for realising the proof of concept. Next, the results of the research process are explained. Afterwards, the prototype is evaluated based on the findings from the focus group interviews. Finally, we reason the research questions and discuss the implications of this work.

Concepts of Online Collaborative Learning Analytics

Collaborative learning is a situation in which a group of human beings interact with learning (Mailles-Viard Metz et al., 2015). The team members influence not only their own learning outcome but also the learning process of the other group members (Dillenbourg, 1999). Online collaborative learning is defined by groups of learners engaged in collaborative learning via an online collaboration platform. It turned out that potential issues may arise differ from the problems emerging from collaborative work performed offline (Swan, 2019).

An online tool based on Social Learning Analytics can be used to track and quantify the work progress of the collaboration group and its individual members. In the educational context, Social Learning Analytics are suitable for retrieving information that might be hidden in large amounts of data records otherwise (Aguilar et al., 2019).

A suitable way to realise an effective online collaboration environment is by a shared virtual whiteboard. In a shared whiteboard, usually, the screen is divided into different parts, which can differ from one whiteboard to another. However, the important point is that all whiteboards have one commonality: a shared design area for all users from the same group. In that area, the group members can perform collaborative work and design (Mailles-Viard Metz et al., 2015).

Miro is an online collaborative whiteboard platform that enables distributed teams to work effectively together, with useful tools for activities such as brainstorming with digital sticky notes or visually planning and managing agile workflows. There are various possibilities to implement the platform into an already existing learning platform. Further, it also offers its own video-conferencing approach and functions to present whiteboards as presentation slides (RealtimeBoard Inc., 2021).

To reduce the task load of educators, it is important to limit the flow of information by categorising the data stream in which the students' work progress is constantly monitored. This can be implemented by defining and using so-called key performance indicators.

For the definition of key performance indicators, it can be stated that these quantities are used to control and evaluate the development of the activity and work efficiency to help the collaboration groups successfully accomplish their pre-defined goals. Hence, an appropriate selection of activity detection indicators is highly important (Velimirović et al., 2011).

Methodology

Prototyping with the ACDM Method

A prototyping method is helpful for developing new applications, especially in domains with little experience (Broy & Kuhrmann, 2021). Therefore, we created a vertical prototype to demonstrate the feasibility of the technical implementation. Here, a part of a system is completely realised across all layers of the architecture: from the user interface to data management (Balzert, 2009). For the systematic creation of the prototype, we followed the ACDM method by Lattanze (2012).

ADCM is a design method for software-intensive systems and focuses on the software architecture in all project phases. The method involves creating a notional architecture as soon as the initial requirements' elicitation is completed. The architecture was developed early and refined iteratively as the project's central point. Moreover, it is refined until the development team is confident that the system can be implemented and meets the stakeholders' demands. In ACDM, the architecture is the starting point for defining all subsequent processes, planning, activities, and artefacts (Lattanze, 2012).

Additionally, we added an initial analysis phase, in which all information about the prototype should be collected. Since Miro offers developer documentation with existing interfaces and available data, this is analysed in this phase. In addition, an evaluation phase was added to the process in which a focus group interview was conducted with education staff to define and rate the importance of the relevant metrics that would assist an educator in evaluating and supervising group work in Miro. Subsequently, the prototype was revised, and the feasibility of displaying and calculating the relevant metrics was verified, concluding the evaluation and validating the research method (Wilde & Hess, 2006).

Evaluation via a focus group discussion method

According to Flick (2010), focus groups are "simulations of everyday discourse and conversation" (p. 261), while Lamnek (2010) defines them as a “conversation of a group of research subjects on a specific topic under laboratory conditions” (p. 413). Methodological guidance for conducting focus group interviews is quite varied. A fact that Morgan and Bottorf (2010) summarise in the journal Qualitative Health Research with the phrase “There is no single right way to do focus groups” (Morgan & Bottorff, p.579, 2010).

We followed the methodological focus recommendations by Tausch & Menold (2015) for the preparation, conduct, and evaluation of the focus group interview. This paper summarises the most important aspects that should be considered for this scientific method and applied to this research project because of its topicality and general approach.

The basis concerning the sample is precisely a selection of participants that is not random but intentional (Schreier, 2011). The selection strategy for the focus group interview was a top-down procedure, which means that the relevant characteristics of the participants were determined beforehand. In addition, a homogeneous selection of participants was made based on the pertinent characteristics of the composition of the focus group, as recommended by Côté-Arsenault & Morrison-Beedy (2005). In addition, a focus group interview guide was created and used to guide the questions and methods for the metrics generation.

For the evaluation of the focus group interviews, the results of the discussion were used. This approach from Colucci (2007) is a common method for evaluating focus group interviews.

Solution Approach

Within Phase 0, existing documentation regarding available Interfaces was identified and analysed. The next step in Phase 1 was defining the user and functional system requirements shown in Table 1. For the user requirements, the scientific literature was searched for relevant metrics for evaluating group work in Miro for educators. A total of three statements were found based on which three metrics were defined for the prototype and set as requirements.

Table 1: User requirements and functional requirements of the prototype

User requirements	Specification of system requirements - Functional requirements
R1: The educator would like to receive information on how much content each team member has contributed to the online whiteboard	Operations to be carried out by the system: Extract the necessary data using request/response communication from Miro's REST API interface.
R2: The educator would like to receive the information on whether the group work on the whiteboard is asynchronous (based on the output data of the individual users).	Operations to be carried out by the system: Storage of the imported data of the REST API interface in the database system
R3: The educator would like to receive the information on whether all team members have actively participated in the editing of the online whiteboard or not.	Operations to be carried out by the system: Calculation of the required key indicators using the extracted data and storage of the newly calculated variables in the database model
R4: The educator wants to know how large the online whiteboard is and how much content has been created by the team.	Operations to be carried out by the system: visualisation of the calculated variables in a, for the educator, understandable form in an HTML template
R5: The educator would like to receive the information on which period the individual learners and the whole group were active.	System interaction provided to the user: Reading the output board that gathers valuable information for an educator from the Online Whiteboard collaboration

The first two user requirements (R1 and R2) were derived from Clauss et al. (2019). The third defined metric (R3) was derived from the question "Is the participant also asynchronously active?" from Rietze (2016). Finally, two additional requirements (R4 and R5) were added based on discussions with educators currently using learning analytics within related use cases.

In Phase 2, the user requirements were also divided into three different categories (low, medium, and high) in terms of the degree of complexity of their implementation and possible restrictions regarding data availability from existing interfaces.

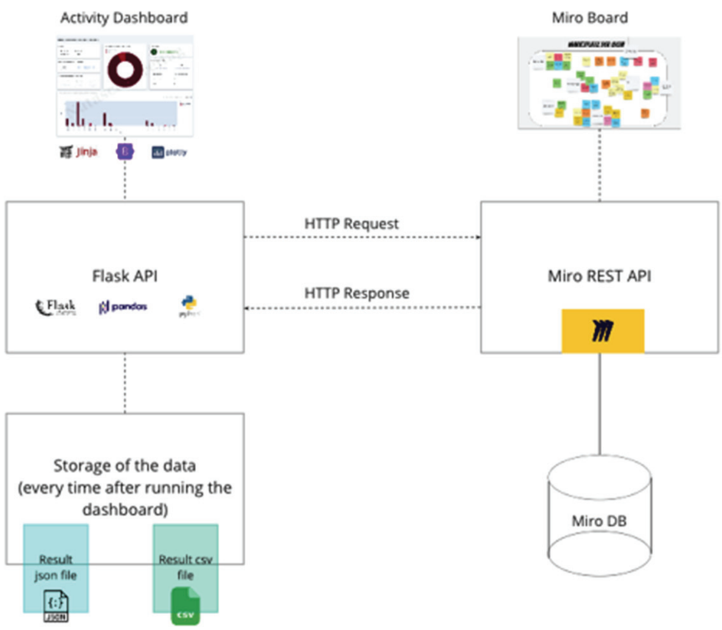

Figure 1: Software architecture of the prototype

In Phase 3, a possible system architecture was developed based on the requirements. Fig. 1 shows the basic software architecture, built out as follows: On the right side is the external tool Miro, where groups of learners are registered and work together on a specific online whiteboard.

Further, the exposed interface (Miro REST API) is shown as an API for Miro's internal data flows and an access point for data extraction. On the left side, the architecture of the developed prototype is shown, relying on a Python-based web server and interface system and standard file formats to cache the extracted data from the Miro interface. In Phase 4, the architectural analysis was performed. The user and system requirements, as well as the constraints of the prototype, were presented and again considered step by step whether the architecture can fulfil or influence them. Since no risks or problems were found in this architectural design, the architecture was refined in Phase 5.

For the implementation, it was determined in Phase 6 that the API-Request should come first for the data extraction of a Miro board. Then, iteratively, all metrics were calculated one by one, and if required, a graph was created from certain variables. After the application logic of the script was implemented and working, the activity dashboard template was realised. Finally, the data storage of the metrics was implemented. In Phase 7, the implementation of the Activity Dashboard prototype took place. The result is a working prototype with a user interface. An excerpt is shown in Fig. 2.

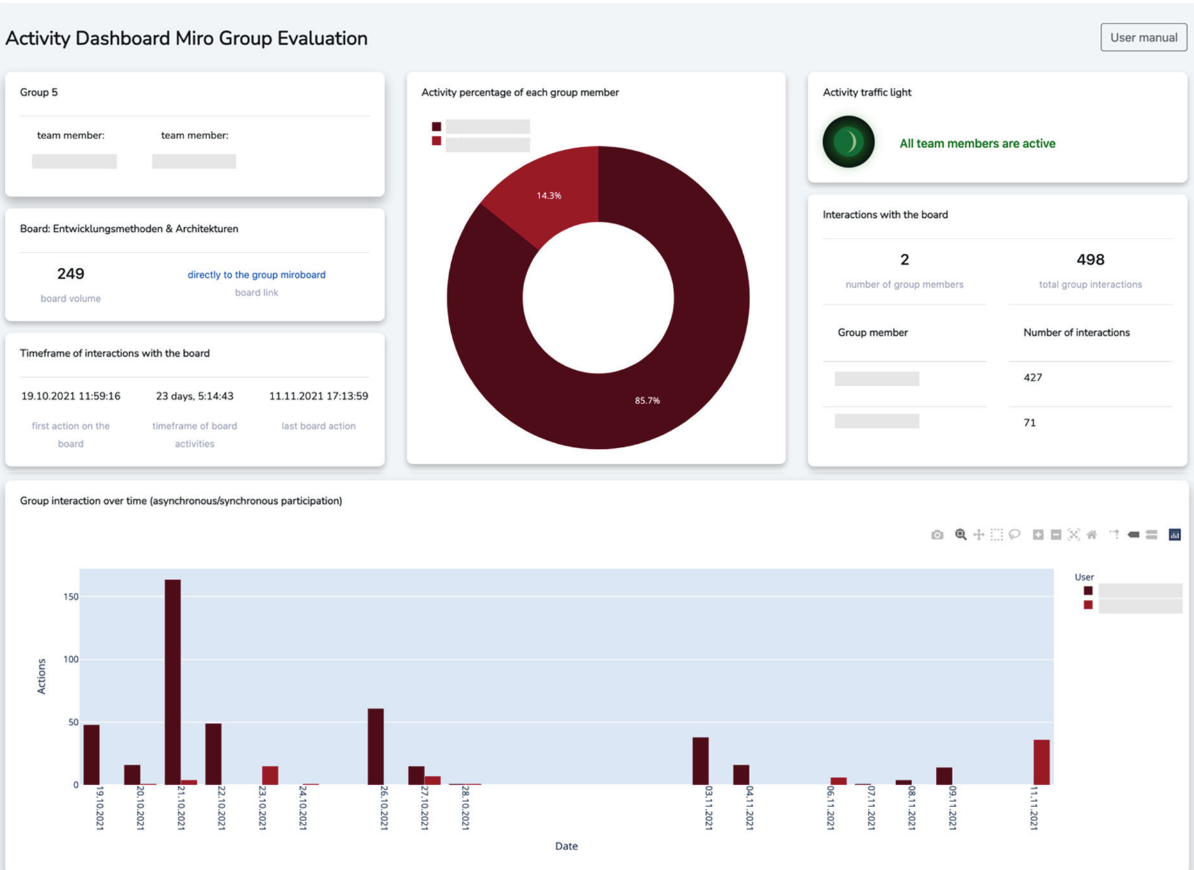

Figure 2: User interface design of the first prototype

Evaluation

In Phase 8, the prototype was evaluated with the help of two focus group interviews with four educators.

First, the educators were asked about what metrics, information, or parameters would assist them in evaluating group performance as well as the performance of individual participants when evaluating an online whiteboard of group work on Miro. After each participant wrote down their metrics on virtual post-it notes, they presented them and explained them to the group. Then, each participant rated his or her own metric based on its relevance to the importance of that metric on a scale of 1-10. 1 for the metric that is not relevant to the evaluation, and 10 for the most relevant metric. All participant ratings were then averaged and stapled to each metric (see Table 2).

Table 2: Result of focus group interviews

KPI		DESCRIPTION	RATING (1-10)	FEASIBILITY
1	Activity history	Period mapping when did who work	10	Yes
2	Activity on participants	View of participants and their activity on the board	10	Yes
3	Last edit	When was the last edit on the board?	9	Yes
4	Overview types of activities	View - differentiation of interactions, and if possible, assignment (visual adjustment, content addition)	8	Yes
5	Interactions with content from others	Number of actions that would not be done by the creator from the widget	8	No
6	Board comparison between groups	Possibility to compare the performance of the groups	7	Yes
7	Collaboration tool	Information with which collaboration tool would be used in addition to the board (MS Teams, Zoom, asynchronous)	7	No
8	Editing time	How long would it take to write a post? Would content be copied in?	6	No
9	Number of edits	How many actions would be performed on the board	6	Yes
10	Comments	Evaluate comments; how much would be commented	5	No
11	Board creator	Information about the creator of the board, or who has what roles in the team?	5	Yes
12	Note in case of missing activity	A live ticker that indicates the lack of activity	5	Yes
13	Visual adjustments	Information about interactions that were only meant to be aesthetic	5	No

Finally, the prototype was extended to include the key figures. Unfortunately, due to the limited data insight provided by the Miro REST API, the creation of 5 out of 13 metrics was technically impossible. After revising the original dashboard and adding the collected parameters from the focus group interviews, the user interface design was reworked.

Discussion

Relevant key indicators used to track and evaluate a collaborative group effort on an online whiteboard in the Miro environment

Since the work with a collaborative platform like Miro can be of asynchronous and synchronous nature, educators need to be able to monitor activities in real-time. However, it is important to note that a proper qualification of the educators is required to fully enable them to interpret the metrics collected from online environments and to determine the limitations of each calculation and parameter. Furthermore, in the area of learning analytics, many qualitative indicators are not fully implementable within the designed solution. Nevertheless, they should not be disregarded in such group supervision or evaluation.

Software architecture for data extraction, processing, and visual representation of group work in Miro

The software architecture of this prototype was designed to prove technical feasibility and thus does not implement all necessary functions to be used in practice. Furthermore, for a more mature deployment, the storage system, scalability, hosting, and overall software architecture should be improved if it is necessary to evaluate several boards simultaneously.

Evaluation of proof of concept in terms of technical feasibility and practical relevance

From a purely technical point of view, extracting, processing, storing, and visually displaying Miro board data is possible. The prototype proved this by meeting all functional requirements defined in the requirement analysis. However, after collecting relevant metrics directly from the target group of educators, there were already some metrics that could not be easily implemented due to the restrictions of the Miro API.

Conclusion

This research aimed to provide educators with a software solution to quickly collect group activity data using important key parameters and present it in an easy-to-interpret user interface. A demand analysis was conducted using the focus group discussion method, which revealed that there are some metrics to support the evaluation and assessment of an online collaboration group effort that could be mapped with the software solution.

However, the results of relevant information from the focus group discussion also reveal some key parameters that are not implementable with these prototypes due to technical restrictions of the Miro API.

Furthermore, the results show a high need for objective parameters or even information about group performance in a partially asynchronous virtual platform to be able to support groups and evaluate group performance.

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