Project-based Learning with Mattermost in Higher Education

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Abstract—This paper explores the use of Mattermost platform in project-based learning, examining how both teachers and students can use it and benefit from it. The aim of this research is to display implementation and setting up the platform and development of an application used to extract system and usage data that will be analyzed by professors. Mattermost is a proven tool for promoting effective communication and collaboration in project-based learning activities by improving students' critical thinking and problem-solving skills. Despite the potential benefits of the platform, currently there are no available analytics tools for the open-source version of Mattermost. The conclusion of this paper is that it is required to develop custom application that requires ETL procedures for data preparation before analysis can be conducted and certain actions based on it taken.

Keywords - project-based learning, e-education, information technologies, project management

I. INTRODUCTION

Fast paced society, intertwined with technology has created a demand for all people to become technically literate and to continually learn more. This presents a challenge for students of information technologies, software development, e-business, and many other fields. It also affects faculties and departments who need to adjust to these fast changes and modern trends. Traditional offline teaching is becoming outdated since the attention span of young adults becomes shorter, and it causes lack of motivation and will for engagement. The solution to overcome these difficulties is introduction of e-education. It can be adjusted to any specific course or group of students. Being more engaged with modern tools used in e-education enhances students' involvement and awareness. But increasing students' presence is just the first step in teaching improvement. The factors that lead to one's success are learning how to work in team, solve problems and find creative solutions for problems in a dynamic environment. By putting students in situations where they can learn these skills, their motivation will grow and with it their success in studies and the rest of career.

Project-based learning (PBL) is a learning approach that revolves around students, making them engage in real-world problems. It evokes students to develop knowledge and skills in a particular subject and makes them more involved in teaching. Buck Institute for Education, a leading organization in the field of project-based learning, defines PBL as "a teaching method in which students gain knowledge and skills by working for an extended period to investigate and respond to an authentic, engaging, and complex question, problem, or challenge" [1].

Integrating technology into teaching methodology serves to enhance student engagement. With technology tools like Mattermost, students promote critical thinking and problem-solving skills. E-education has the potential to transform higher education by providing personalized and flexible learning experiences [2].

This paper aims to provide an analysis of the benefits and drawbacks of using PBL with Mattermost. The analysis will explore how effective PBL is in improving students' practical skills as well as some people skills for working in the industry and its overall influence on students' motivation and involvement in class. Additionally, potential drawbacks or limitations will be identified, such as challenges to manage group projects and dynamics and if there is some need for guidance and support.

II. PROJECT-BASED LEARNING

PBL revolves around the assumption that it will lead to better outcomes for students, whether it is to pass the exam more efficiently or to find a job with more ease. Research has shown that PBL significantly improved students' programming, critical thinking, and problem-solving skills compared to traditional learning based on lectures and instructions. Students who were exposed to this learning method were more likely to be engaged and motivated. In the field of teaching information technologies, PBL can be an effective approach that can assist students to develop all necessary competencies required in the field of computer science [3].

Besides having an impact on providing a realistic experience of working in a project organization, PBL might not have a significant influence on improving students' theoretical knowledge [4]. The choice of the project has a significant role in both gaining theoretical knowledge and maintaining motivation. When students had felt motivation, they were more engaged in projects and showed

more interest, commitment, and satisfaction. When, on other hand, students lack motivation, their performance on projects is negative [5].

An important aspect of project-based learning is taking ownership of a project. By giving students autonomy to choose projects they want to work on, the level of responsibility for the outcome grows. Using Mattermost to support PBL, students can facilitate communication and follow the progress of their projects. It helps to engage students more and with them being active during classes and after them, their success level increases [6].

Using Mattermost can improve students' satisfaction and learning outcomes in PBL. This comes from the fact that students have learned how to work with a new tool and put their theoretical knowledge to practical use. However, a need for training on how to use the tool effectively and the potential for distractions due to the constant availability of communication is something that needs to be tackled. Implementing project-based learning with Mattermost requires careful planning and consideration. Students' learning outcomes are dependent on several factors, including the quality of the platform, the level of instructor involvement, and student motivation [7].

Utilizing online platforms like Mattermost can address some PBL associated challenges. Mattermost is a communication and collaboration platform designed for teams. It gives students the ability to experience teamwork and share ideas with various features such as direct messaging, group messaging, file sharing, and integrations with other tools commonly used in project-based learning [8]. Online platforms that allow students to discuss are a way to enhance student engagement and learning. This is specifically the case in PBL where communication among team members is crucial [9]. The collaborative learning model based on Mattermost promotes active learning and encourages student participation.

III. APPLICATION OF PROJECT-BASED LEARNING WITH MATTERMOST

In this chapter, the implementation of Mattermost in higher education will be described. The way to configure the system and set up this tool will have a role in how the teams will function and if it will have benefits for students in an educational or professional sense.

A. Features of Mattermost tool

Mattermost is open-source software. This means that all users have access to the entire source code of the platform and that it is possible to change, modify and improve it according to needs. The source code of the platform is written in Go and JavaScript languages [10].

Mattermost offers two options for connecting to the server: connecting to the Mattermost server or the users'

own. Connecting to their server provides users with unlimited data control, privacy, and compliance with legal regulations.

At the outset, a secure local installation of Mattermost in the customer's data center is provided, with layered security options such as SSL, VPN, and DMZ. Mattermost provides the ability to encrypt data in motion and at rest. Encryption is not necessary for the platform to be compliant with the GDPR (General Data Protection Regulation), but it represents additional protection against the misuse of data [11].

B. Installation and configuration of Mattermost

Once the system is installed, it offers the possibility of personalization at the level the user needs. In addition to the fact that it is a free software, which is open source, it provides the possibility of wide use in environments where the budget is limited, and the staff is competent to implement it and is familiar with some of the systems or databases that are supported.

In Mattermost, there are six types of user roles with different levels of permission:

- system administrator - the first user added to a newly installed system of this tool, usually a member of the IT staff, is assigned the role of system administrator;
- team administrator - when a team is first created, the person who set it up becomes the team administrator. It's a team-specific role, meaning someone can be a team admin for one team, but only a member of another team;
- channel administrator - the person who creates the channel assumes the role of channel administrator for that channel;
- members - this is the initial role given to users when they join a team;
- guests - this is a role with limited permissions, which allows organizations to collaborate with users outside their organization, so-called external users, and to control which channels they are on and with whom they can collaborate
- inactive accounts.

When the first user is created, they will not be added to any team, because there are no teams yet and it is required to create some team.

The main features of Mattermost are having teams, channels, messages, notifications, and search. During the search, the results are searched in all channels that the user is a part of. Notifications are used to inform the user that there are unread messages and mentions. Further elaboration will be provided on other features.

C. Teams

The team at Mattermost is a digital workspace where collaboration between members is possible. One person

can be a member of one or more teams depending on the settings in the organization using Mattermost. If the system administrator has enabled the user to create teams, the user who creates a team will automatically be assigned the role of administrator of that team. Single-team deployment is currently recommended for the following reasons:

- single team applications improve communication throughout the organization. When more teams are added, groups can become isolated;
- cross-team or channel search is not supported yet, which may affect the team-user experience;
- integrations are persistent only in single-team applications.

However, some Mattermost users prefer multiple team deployments for the following reasons:

- teams are useful when there is a purpose for each team. For example, one team is used for staff members, i.e. internal users of the organization, and another team for external users;
- performance is better when users are spread across multiple teams instead of all in the same one. With multiple teams, there is less content to load per team and database queries are faster as it is also partially based;
- creating a shared team for all users and using advanced permissions to control who can create channels and add members to a shared team improves multi-team collaboration when using multiple teams.

D. Channels

Channels are used to organize conversations on different topics. he channels in the system can be categorized into three types: public channels, private channels, and direct messages.

All team members have access to public channels. When new team members are added, they are automatically added to public communication channels.

Private channels are used to discuss sensitive topics and are only visible to specific team members who have been added to them. All members of a private channel can add new members to it. A team member can leave a channel at any time, but cannot kick out other channel members; only the team admin has that option.

Direct messages refer to direct communication between two people. There are also group messages, which are direct messages between three to seven people. Both types of messages are only visible to people who are involved in the conversation. If users want to communicate in a group of more than seven people, it is necessary to create a private channel on which to do so.

Channels and teams can have an unlimited number of members, which is possible because it is possible to modify the source code and the base used.

E. Messaging

Good and active team communication is necessary for productive teamwork, which is made possible by sending and receiving messages. It is possible to modify or delete each sent message, as well as refer to it.

IV. MATTERMOST TOOL IN TEACHING

Department for e-business in the Faculty of organizational sciences implemented Mattermost to enhance students' learning experience. In this model of project-based learning, students from three courses were given different roles within a team and each team chose one project to work on (development or analysis of various applications). During these courses, students had the opportunity to gain theoretical and practical knowledge about both PBL and scrum methodology. During the courses, it was obligatory for team members to record all necessary information within channels where they were members. Those were messages to other team members or facilitators to inform them on the progress of their part of work. To track progress more visually, Mattermost Boards feature was used. It is a tool for recording and assigning tickets to team members, setting deadlines, and prioritizing them [12].
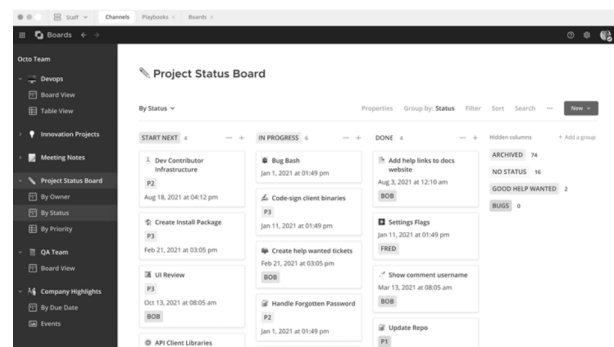

Fig 1: Mattermost Board

If Mattermost is implemented and used by various student teams, the next step would be to analyze statistics, e.g. number of students on the platform, number of messages, time of activity, and others. The system administrator role is the only role with access to System Console. There, the team size can be modified, notification settings can be set as well as many other configurations regarding security, day-to-day use, and overall functioning of the system.

In the reporting section of the system console, the system administrator can track the number of users and their activity. Administrators can see which users were most recently active and who posted the most in the team. In terms of teaching, this means that professors will be able to regularly monitor students' work and adapt their lessons to the state of the report.
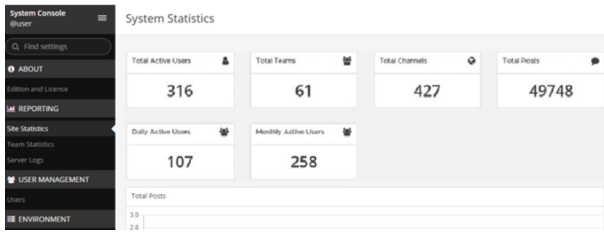
Fig 2: Statistics from the system

Another way to get usage data is via Mattermost API. The Mattermost REST API is a web service that employs JSON to enable communication between servers and third-party applications, as well as Mattermost clients. The server is currently on API version 4.. All API access is via HTTP(S) requests to your-mattermost-url.com/api/v4. Mattermost offers approximately forty API groups, each with multiple different APIs. The ability to call any method depends on the user's role. JavaScript and Golang drivers are available to connect to the APIs. Device drivers are different for each operating system and depend on the hardware.

To extract data from the system using APIs, it is needed to create an app that calls them and saves results. A couple of APIs that will be implemented are: get teams, get user's sessions, get channel's pinned posts, and many others.

Extracted data will be analyzed using VOSviewer – a software tool for constructing and visualizing bibliometric networks. These networks may, for example, include journals, researchers, or individual publications, and may be constructed based on citations, bibliographic linkages, co-citations, or co-authorship relationships. In addition, VOSviewer provides capabilities for text mining, allowing for the creation and visualization of co-occurrence networks that highlight significant terms extracted from scientific literature [13].

An application that calls Mattermost APIs must allow the user to view a selection of fields that call different APIs via the computer. Clicking on the field triggers the call. Some APIs need to send some parameter: user, team, or channel ID. All methods are GET and the goal of the application is to save the obtained data from Mattermost in corresponding JSON documents (responseTeamMembers.json responseTeams.json, etc.).

Fig 3: Java application for data extraction

VOSviewer is storing configuration for visualizing the network and the JSON files imported in it must be in a specific format. For example, attributes network, config and info of type object are mandatory and each of them contains list of mandatory and non-mandatory attributes [14]. JSON files retrieved by using Mattermost API have predefined structures and the response format cannot be modified during API call, i.e. there are no parameters that can influence the outcome. Since these response files do not contain all attributes required by VOSviewer, they need to be transformed into desired format.

ETL (Extract, Transform, Load) is a data integration process that involves the data being extracted of data from diverse sources, transformed to suit a specific target format, and then loaded into a target database or data warehouse [15]. The diagram bellow displays how is ETL process applied to get data from Mattermost in adequate VOSviewer format.
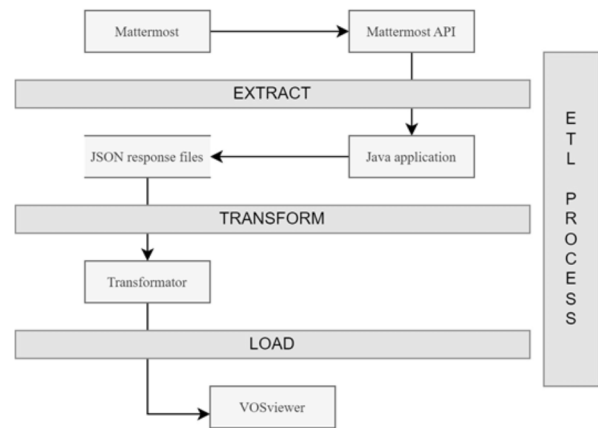

Fig 4: Mattermost-VOSviewer workflow

With this data, combined with student success and satisfaction scores, success of the implementation of project-based learning can be displayed.

Two years after the Department for e-business implemented Mattermost at Faculty of Organizational Sciences, around 40 projects were completed, with over 100 students involved. It was used as a channel for communication within the projects and between students and teaching staff. It was also used for official announcements by professors [16].

An important integration that was put in place was an integration of BigBlueButton with Mattermost. BigBlueButton is an open-source system that enables video conferencing, screen sharing, whiteboarding and recording. It is designed specifically for online learning. It is shown that this system increases flexibility for students to follow lectures and encourages interactive learning followed with discussion and collaboration [17].

With integration of these two tools, it was ensured that communication on project is transparent and available to all interested students.

The use of agile project management tools facilitated better communication and coordination among team members, ensuring that everyone was working towards the same goals and objectives. Project-based learning provided students with the opportuinity to develop important soft skills such as collaboration and time-management [4].

Students of Faculty of Organizational Sciences have demonstrated high adaptivity skills to this new tool that became part of their education. The innovative method in teaching was recognized and very well received.

All students were successful in regards to completing all activities for the subjects and passing the exams. As the greatest benefit of this method of learning, students singled out the opportunity to experience real teamwork and management, and the opportunity to get an insight into what their future work on projects looks like. What increased students' motivation the most was the interest to participate in practical exams and projects [18].

V. CONCLUSION

Project-based learning is an innovative approach to teaching. It carries many benefits for students, such as increasing motivation, awakening curiosity, and the will to follow the lessons. Project organizations are the majority of IT companies nowadays and gaining experience in such an environment can be crucial in the early stages of career-making. Students in this method are working in a team, follow a specific timeline, and are responsible for delivering their product.

On the other hand, the implementation of PBL can face many challenges. Adjusting from classical theoretical knowledge transfer to more hands-on lessons, especially in a virtual environment, leaves space for professors and departments to be creative to overcome that.

Mattermost as a collaboration tool has been demonstrated to be a platform that is easy to accommodate. It is user-friendly and resembles in looks and features many applications that are in everyday use by students. By providing space for teams to collaborate and members to open as many discussions on however many channels and groups, Mattermost offers versatility for students and professors to their projects and needs.

Implementation of Mattermost, as in installation and configuration, can be a challenge itself. So far, Mattermost has become a popular tool in the IT industry and with its popularity, documentation, and instructions on installation and use are available online.

Implementation of project-based learning with Mattermost has shown that with dedicated department members and students who are willing to explore new teaching methods, it is possible to improve students' success. By following metrics and analysis of data from Mattermost usage, professors can adjust some parameters or give students additional training or directions.

The goal of future work is to introduce functions that fully automate the ETL process. This implementation should considerably ease the job of teachers in data analysis and enable them to concentrate on the decision-making process based on the analysis results. The planned features should support the automatic collection, cleansing, and conversion of data into desired formats, with the integration of different data sources.

As education continues to evolve, the hope is that in the future more departments and faculties will implement tools like Mattermost to support project-based learning. In doing so, it is crucial to listen to students and analyze their progress in every step of the project.

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