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New Functionality for Moodle E-Learning Platform: Files Communication by Chat Window

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Abstract: Moodle allows communication between students through the chat window, where you can send text messages and emoticons. A study carried out on 45 students identified which method they prefer to use to send attachments—which seems to them to be the most effective and easy to use. The challenges we started with in this implementation of the solution were the non-existence of this way of transmitting files within the Moodle platform and the need to introduce this new method, which has an impact on the communication process that is beneficial to users. When a requirement arises from users such as sending files through the chat window, a feature that does not exist now, the IT administrator has the possibility to create a new method by implementing a plugin that may be imported into the Moodle platform settings. By writing the necessary parameters, arguments, and command lines in the developed plugin, it was possible to create a new way to send files. This paper presents a new solution that contributes the possibility of transmitting files through the chat window, with various extensions such as .pdf, .zip, .docx, .jpg, .xls, .mp4, and other types and sizes of files that can be sent at any time and as many as desired, not limited by the number of uploads related to the transmission.

Keywords: moodle; e-learning; chat; plugin; attachment

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1. Introduction

Moodle is an e-learning platform created to provide students, teachers, and IT administrators with an easy-to-use system, the possibility to create personalized courses, and free open-source software [1]. Within the Moodle platform (Modular Object-Oriented Dynamic Learning Environment) [2], several communication methods are described as characteristic resources and activities for students [3]. Moodle is a platform designed for universal learning, both to support learning and teaching. It is an all-in-one learning platform; it has a simple and intuitive interface, copy functions, and continuous improvements in use. Moodle is licensed under the GNU (General Public License); it can be adapted, modified, and extended free of charge, without license fees, and has an online support community [4]. It is continuously improved and revised according to the needs of users; it can be customized, secured, and private. Being web-based, it can be accessed from anywhere in the world, and the interface is compatible with various browsers and operating systems [5]. The platform is available in different languages, as well as its documentation and a wide range of plugins. In recent years, several plugins or blocks have been developed to support communication between students or between students and teachers, most of them being created to integrate the platform with external programs such as Slack, Telegram, or TwinPush. Other plugins allow you to display teacher lists, and push notifications, or use the Moodle administrator to create automatic pop-up messages [6,7].

The challenges we started with in this implementation of the solution were created by the non-existence of this way of transmitting files within the Moodle platform and

the need to introduce this new method, with an impact on the communication process that would be beneficial for users. According to market research and analysis, existing programs had licensing costs or needed an additional client or program to be able to send files. Some sites are dedicated only to sending files, and others have shortcomings in terms of courses and exams. Moodle e-learning is an open-source platform; the source code is licensed in a way that allows anyone to make custom improvements and changes. In this work, we have developed a plugin that makes it possible to integrate the new file-sending function into the chat window [8]. The purpose of this solution was to find a free, easy-to-use, secure information protection method to integrate with the Moodle e-learning platform without incurring maintenance and administration costs. The advantages of integrating the file submission function into the existing platform include rapid exchange of information, interaction between learner and teacher at any time by viewing the links resulting from these operations, real-time transfer, ease of use, the possibility of sending different types of files, and an unlimited quantity and number of files; furthermore, the plugin has been developed without additional costs or the purchase of licenses. It does not require the existence of an internet connection if the platform was designed to be used on the intranet, substantially improves data security, and significantly decreases the likelihood of unauthorized access to information.

Disadvantages of file transfer sites or platforms versus integrating the file submission feature into the e-learning platform include the need for an internet connection, the costs arising from the existence of licensing or the installation of clients of other platforms, the use of another platform or website in addition to the e-learning platform, vulnerability in accessing information, and increasing the risk of virus attachments. Previous studies on file submission are difficult to compare due to the wide variety of work environments. Below are some evaluations of these studies. As outlined in the study by Jawdhari et al. [9], they set out to achieve many goals, such as reducing the processing time for transferring files to the other party and reducing overall expenses, as files are only transferred through the blockchain network without the need for files to be uploaded and downloaded to the drive. Maximum security is achieved by using an important algorithm that takes into account a critical part of the cryptography field to robustly encrypt files. The latter ensures that no individual, except the receiver, can access the files. Also, sufficient speed was achieved when transferring files, compared to other similar environments based on the manipulation of calculations with references. Another study by R. B. Madhumala & Chhetri et al. [10] set out to find a secure file transfer system to reliably protect and transfer their sensitive, business-critical data. Secure file transfer is a method of sharing data through a secure and reliable delivery method. Cryptography is a technique they used to secure information and communication in the presence of third parties. They used this technique to ensure that only those people to whom the intended information was addressed could read it. Thus, to improve the security process for storing and sharing data, they created a web application that uses a cryptographic approach to secure user data. They were also able to improve the proposed algorithm for encrypting and decrypting larger files. Push notifications and shareable links were also added that will expire after a set time. In addition, they were able to add other authentications, such as GitHub and Twitter. Another study by Maru et al. [11] aimed to reveal teachers' perceptions of online platforms such as Google Classroom and WhatsApp used during the COVID-19 pandemic. This research applies the qualitative descriptive method and involves English teachers from Bitung, a growing port and city in North Sulawesi in eastern Indonesia, as the research respondents. The data were obtained from semi-structured interviews. The data was then analyzed according to Miles and Huberman triangulation. They concluded that teachers perceive Google Classroom and the WhatsApp application from a positive perspective. They think that both platforms have made a good contribution to the learning process. Teachers need to be able to choose the best platforms for their virtual learning, as the types of digital platform are diverse. These are considered effective ways for teachers to keep in touch with students and conduct online teaching, including sending videos, conducting group chats,

and organizing video conferences. The fourth study, by Broadbent et al. [12] observed that in the online learning environment, much of the learning is self-directed and there are generally fewer opportunities to receive help in real time. Email and discussion forums are the most common ways to seek help in these environments. The study explored students' perceptions of the use of live chat technology for seeking academic help online in higher education, with a focus on comparing students' online and blended perspectives. The implications of this study are that it demonstrated the effectiveness of live chat as an online tool for seeking help in higher education between teacher and student. The tool has been well-received by both online and blended learners, especially for its ability to provide help instantly and conveniently, in real time. As an online, synchronous, private help-seeking tool between students and teachers, these findings provide a strong recommendation for the use of live chat in higher education. Collectively, these studies converge on the challenges of communication as well as the sending of documents between learners while maintaining a high level of security on e-learning platforms. They identify complex problems and propose innovative solutions to improve the learning process.

The purpose of the present study was to find a free, easy-to-use, secure method to protect information and integrate it with the e-learning platform without incurring maintenance and administration costs. Research and analysis of the market showed that existing programs had licensing costs or needed another client or program to be able to send files. Some sites are dedicated only to sending files, and others have shortcomings in terms of courses and exams. Moodle e-learning is an open-source platform; the source code is licensed in a way that allows anyone to make custom improvements and changes.

2. E-Learning Platforms and Chat Programs

Moodle internal messages do not support message attachments. There is a wide range of solutions on the market for online learning management software, offering a suitable choice for every educational structure or company. The criteria for choosing the platform are largely based on price and the facilities offered. Some offer more features at a higher price, and others are free, but the features are limited and cannot be improved because the client is not open-source. At the moment, there are live chat applications that can be integrated with Moodle, but they require payment, they need internet, the basic package is minimal, there are additional costs for functions such as sharing a file, and most of the time they are hosted in the cloud which prohibits local control of the content or security [13]. When these programs are updated, problems arise, and Moodle compatibility decreases most of the time. Some errors require time to resolve, and during this time, they cannot be used in chat; other, more serious problems require a new version of Moodle.

These solutions can cause security breaches or information leaks. There are several advantages to using chat, including the following [14,15]:

- Chat has an advantage over a forum in that it takes place in real-time.
- It is particularly beneficial when students do not have the opportunity to meet face-to-face.
- Students can read the discussions even if they did not attend the meeting.
- Students do not have to open a separate window to use this chat, while the Moodle activity chat needs another window to do so.
- The student can use it to collaborate with colleagues to ask questions of the teachers.
- The teacher can communicate with individual students.
- Students can navigate between pages, and their open conversations will always be there.

Chat features include:

- Sending text messages.
- Internet addresses written in the chat window are transformed directly into links.
- Emoticons.
- A warning to one or more students in the form of beeps or sounds.

We also made a comparative analysis of chat features, resources, and activities, with the identification or without identification of their existence, on each open-source e-learning platform (see Table 1). Following the analysis carried out, the existing chat features of the e-learning platforms that are the object of the comparison were identified. The proposed solution is the only one based on sending files through the chat window.

Table 1. Comparison between the created method and other platforms.

Chat-Features Resources and Activities	The Moodle Platform	ATutor Platform	The Ilias Platform	The Canvas Platform
Implemented solution-File attachments through the chat window	X	X	X	X
Sending and receiving messages	✔	✔	✔	✔
Previous conversation	✔	✔	✔	✔
View connected users, beep, and talk to	✔	✔	✔	✔
Different displays	✔	X	✔	X

3. Purpose of Sending Files through the Chat Window

This solution aims to develop a feature that allows the sending of files of different types (extensions) between users of the e-learning platform Moodle through the chat window.

Table 2 shows a comparison between Moodle LMS and the Moodle App, including whether the feature is supported offline in the Moodle app (last updated: March 2022) [8]. From Table 2, it can be seen that sending files is not supported; this feature does not exist. It is an option to upload files, but this is valid only for courses and, in no case, for chat, and only if they have received permission in this regard from the teacher or administrator. Sending files of different formats (.doc, .xls, .pdf, .txt, .mp3, .mp4, .zip, etc.) between users through the chat communication window is not possible. The solution is integrated into Moodle, and the chat window appears with a button with the "clip" icon from where you can select files from your computer and send them to another user to be viewed and downloaded from the user profile account. The e-learning interface is accessed from a browser such as Internet Explorer 11, Microsoft Edge, Mozilla, or Google Chrome. The Moodle e-learning platform (3.11 dev+ Build: 20210330, version for Windows operating system x64, PHP version 7.3.11, MySQL version: 5.5.5-10.4.8-MariaDB) is a standalone locally-hosted client and is installed on Windows Server 2022 × 64 [16]. The Moodle e-learning platform is installed and configured locally on the intranet; it cannot be accessed from the Internet. In Table 1, a comparison was made between the attachment transmission solutions offered by e-learning platforms that have similar services. From Table 1, it can be seen that the implemented solution for sending attachments through the chat window is an implementation that is not found on the other platforms that are the subject of the analysis. The implemented solution led to an improvement and simplification of the transmission method. Following the analysis carried out, the modalities and solutions used within the chosen platforms as an object of comparison were identified. The implemented solution is the only one that offers the possibility of sending an attachment through the chat window, thus no longer needing the use of other methods for sending this information. Thus, once the user has entered the chat, attachments may be transmitted through this interface without other mechanisms.

Table 2. Chat features.

Chat	Moodle LMS (Web)	Moodle App
Send and receive messages	✔	✔
See connected users, beep and talk to	✔	✔
View previous conversations	✔	✔
Different displays	✔	X
Send and receive files	X	X

3.1. Threats Addressed by Sending Files through the Chat Window

Document control: the e-learning platform is accessed in a closed environment, and without an internet connection, the transfer of files is done only through the intranet. Document security: by sending documents only through your platform, their confidentiality is preserved. There is no longer the risk of attachments being transmitted through different channels and the content being read or monitored. Protection against viruses: in this way, you avoid phishing attacks, spam, or viruses that encrypt documents, and can only be removed if a ransom is paid. Even so, there is no guarantee that the decryption solution will be sent. A common method of infecting computers is by sending emails with malicious attachments. The main cause of computer viruses and data breaches is the use of untrusted websites or a poor-quality antivirus solution. The largest percentage of financial losses is due to cloud data breaches, according to a 2022 cost of data breach report by IBM and the Ponemon Institute. The five biggest mechanisms of loss ranked according to the data breach attack method in 2021 were phishing (USD 4.91 million (compared to USD 4.65 million in 2021)), business email compromise (USD 4.89 million (compared to USD 5.01 million in 2021)), vulnerabilities in third-party software (USD 4.55 million (compared to USD 4.33 million in 2021)), malicious intruders (USD 4.18 million (compared to USD 4.61 million in 2021)), and criminal social engineering attacks (USD 4.10 million (compared to USD 4.47 million in 2021)). The average cost of a data breach has reached a record of USD 4.35 million, according to a 2022 cost of data breach report by IBM and the Ponemon Institute. The above data can be found on the company's website [17].

3.2. Analyzing the Impact of the Developed Method

Following the implementation of the proposed solution, the following aspects were discovered:

- The speed of information communication between students;
- Minimizing attachment transmission via other methods, such as email or online file transfer sites;
- Eliminating viruses from computers without using the internet.

The proposed solution was implemented within the institution where one of the authors is employed, and the study presented in this paper was conducted on 45 users. Data collection was done through questionnaires with different questions sent and received by email and/or phone call. Data gathering was carried out over 30 days. Each participant received the questionnaires and had the responsibility to fill them in and send them on day 10, day 20, and day 30. After receiving the questionnaires in those intervals, the data were collected and centralized in a table. The 45 people from the chosen institution who participated in this study are aged between 22 and 30 years. The participants' level of knowledge and use of e-learning platforms, chat sites, and videoconferencing programs are as follows: eight beginner level, 24 intermediate level, and 23 advanced level. Every person is familiar with sending messages via chat, email, and attachments through file transfer sites. All of them accessed an e-learning platform where they participated in tests, quizzes, and conferences on different topics. The e-learning platform is usually used for posting or sending information on the main page as well as the chat window. The study carried out

on the 45 students was to identify which method they prefer to use to send attachments, and which seems to be the most effective and easy to use, as can be seen in Figure 1.

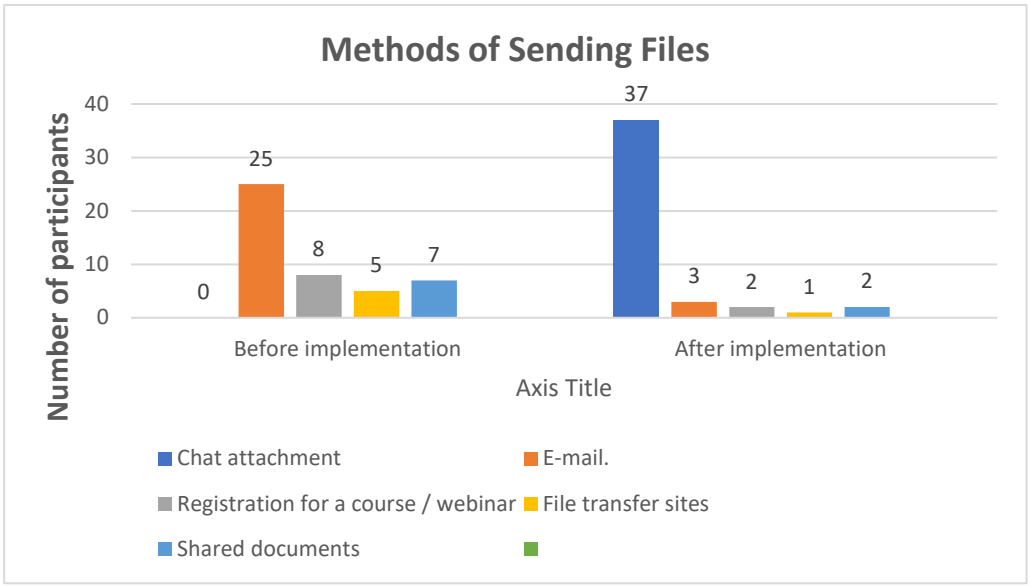

Figure 1. Comparison of the implemented method before and after sending the files.

From the analysis of the obtained results, the following conclusions can be drawn: The number of users who sent attachments via chat is quite large; 37 of the 45 learners used the new method without reservations, thus proving the interest, usefulness, and efficiency of this implementation. The number of users who sent attachments via email decreased significantly, from 25 to three. The number of users who have sent attachments when registering for a course or webinar decreased significantly, from eight to two. The number of users who sent attachments via file transfer sites dropped significantly, from five to one. The number of users who sent attachments via document sharing dropped significantly, from seven to two. When attachments were sent through the chat solution, the number of viruses transmitted through attachments decreased from three to zero. Thus, a decrease in interest and the number of those using the old solutions was observed in favor of the newly implemented solution. The evaluation aimed to determine user satisfaction with the new solution implemented on a sample of 45 users for 30 days. In addition, in parallel with these actions, a controlled work environment was created, with about 400 users who used the new method for 3 months. During this time, integration of the new solution into the Moodle platform was monitored, as well as the operating and loading parameters and the technical and functional parameters of the components in the system architecture. The platform's IT administrators in a Windows Server 2022 operating system environment on which the deployed client is installed executed the test parameters. Access to it was offered from workstations configured with Windows 8, 8.1, 10, and 11 operating systems. The browsers used were Internet Explorer, Microsoft Edge, Mozilla, and Google Chrome, the latest versions, thus aiming to test the compatibility of the solution with these browsers. During this testing, no performance degradations of the systems were identified, and no side effects occurred, such as increased network traffic or performance degradation at the level of the servers hosting the IT solution. The amount of secondary storage and the security of file storage did not undergo adaptations or adjustments; the same solution and logic already provided by the IT platform was employed. The file-sending and storage modes were kept as in the previous solution. Saving them is done locally on the user's station; they are not stored in hardware spaces related to the server. Thus, the technical characteristics related to memory, processor, and storage space are not affected by the implementation of this solution. The server is provided with SSD storage. The backup is performed at the platform component level. The server is configured to

perform incremental backups every day, an operation that is scheduled to be performed every night through a job that launches a script created for this purpose. On weekends, a full backup is performed every Sunday, an operation that is scheduled to be performed at night, through a job that launches a script created for this purpose. There is a backup configured at the storage level. Incremental backup is performed every day, an operation that is scheduled to be performed every night through a job that launches a script created for this purpose. The server on which the e-learning platform is installed is large enough to cope with over 2500 users and to support at least 1500 simultaneous logins. The way files are transmitted and stored does not affect or bring any degradation to the platform because this operation of transmitting and opening files has a minimal cost in terms of processing on the server. From the point of view of system security analysis, on each workstation from which the platform was accessed, there are installed antivirus programs (BitDefender, Windows Defender) and anti-spyware programs (Spybot, Search&Destroy), as well as a management console (ManageEngine). Security information was collected from Windows logs, system logs, and application-specific logs, as well as other related programs, to see if there were errors, security breaches, vulnerabilities, and cyberattacks. The simulations were run over 30 days, and the logs were checked every 24 h. Logs reported multiple phishing attacks and antivirus programs were able to block these attempts, leaving the platform and workstations unaffected.

The value in the Table 3 represents the average of three scans performed during one day. From the actions taken regarding the scans that were done three times a day (at 09.00, 12.00, and 15.00) for 30 days and the results obtained, as shown in Table 3, the following can be observed: Only two spam attacks and no viruses were discovered as a result of the antivirus program's three daily scans. As a result of scans performed by the antivirus program for a week, only nine spam attacks, and no viruses, were found. After thirty days of anti-virus scanning, only seventeen spam messages and no viruses were found. As a result of three LAN/WAN monitoring sessions per day, a total of 8 Kbps/s was sent and 252 Kbps/s was received. As a result of weeklong monitoring at the LAN/WAN level, 17 Kbps/s was sent and 296 Kbps/s was received. As a result of thirty-day monitoring at the LAN/WAN level, 24 Kbps/s was sent and 273 Kbps/s was received. Following the monitoring performed three times a day at the Windows system information/manage engine level, 6 warnings were received, 2 incidents were identified, and no problem was reported. Following the monitoring carried out for one week at the Windows system information/ManageEngine level, 14 warnings were received, five incidents were identified, and no problem was reported. As a result of thirty-day monitoring at the Windows system information/ManageEngine level, 43 warnings were received, 16 incidents were identified, and no problem was reported. After three days of monitoring at the CPU usage level, 7% CPU usage and a speed of 3.86 GHz per 60 s were observed. Following weekly CPU usage monitoring, CPU usage of 12% and a speed of 3.22 GHz per 60 s were identified. As a result of thirty-day CPU usage monitoring, CPU usage of 19% and a speed of 3.47 GHz per 60 s were identified. Following the monitoring performed three times a day at the server memory level, a memory usage of 24.5 GB was identified, with the free memory being 104 GB. Following the monitoring performed for one week at the server memory level, memory usage of 26.3 GB was identified, with the free memory being 101 GB. After thirty days of server memory monitoring, a memory usage of 25.6 GB was discovered, with 102 GB of available memory. Following the monitoring performed three times a day at the HDD hard disk server level for one day, a response time of 0.6 ms, a write speed of 64.9 KB/s, and a free space of 86% were identified. Following weekly monitoring of the HDD hard disk server, a response time of 0.5 ms, a write speed of 72.8 KB/s, and 77% free space were identified. Following 30-day monitoring of the HDD hard disk server, a response time of 0.7 ms, a write speed of 70.4 KB/s, and 81% free space were identified. According to reports provided by network monitoring, there was an increase in data traffic on the days of and before exams and tests. Even if the hits increased, the server was not overloaded and was working within normal parameters. Also

in the same days, there were increases in processor and memory, but performance was not affected, operating within normal parameters. The processor and memory did not undergo increases that would lead to the degradation of operating parameters. No problems were reported, and the number of incidents and warnings were within normal parameters, not registering a significant increase compared to the period and number of users. No viruses were identified, but the number of spam messages increased, according to reports provided by the antivirus program. Throughout this period, users' workstations were monitored 24 h a day for 30 days. Throughout the development and use of the implemented solution, a series of actions were carried out at the user level aimed at obtaining feedback on the new solution.

Table 3. Data parameters, functionality, E-Learning platform.

Period / Program	3 Scans per Day/1 Day	1 Week	30 Days
Antivirus Windows Defender, BitDefender, Spybot, Search&Destroy	2 spam/0 viruses	9 spam/0 viruses	17 spam/0 viruses
Network LAN/WAN Broadcom Netxtreme® Ethernet Adapters	Send 8 Kbps/s Receive 252 Kbps/s	Send 17 Kbps/Receive 296 Kbps	Send 24 Kbps/Receive 273 Kbps
Windows system information/ManageEngine reports	6 Warnings/2 incidents/0 problems	14 Warnings/5 incidents/0 problems	43 Warnings/16 incidents/0 problems
Server processor CPU Intel® Xeno® Silver 4314 CPU @2.40 GHz	Utilization 7% Speed 3.86 GHz/60 s	Utilization 12% Speed 3.22 GHz/60 s	Utilization 19% Speed/3.47 GHz/60 s
Server memory 128 GB	In use 24.5 GB/Available 104 GB	In use 26.3 GB/Available 101 GB	In use 25.6 GB/Available 102 GB
Server hard disk HDD 1 TB	Average response time 0.6 ms/Write Speed 64.9 KB/s/Free space 86%	Average response time 0.5 ms/Write Speed 72.8 KB/s/Free space 77%	Average response time 0.7 ms/Write Speed 70.4 KB/s/Free space 81%

These actions consisted of the following:

- Questionnaires sent by email;
- Receiving submitted questionnaires;
- Sample phone calling of users;
- Interpreting/analyzing the answers received.

In addition, the logs from the components related to the implemented solution were analyzed as follows:

- System logs on the station;
- Antivirus logs (BitDefender);
- Logs from network station scanning programs (ManageEngine);
- Logs from scanning data traffic (Wireshark);
- Application specific logs, as well as from other related programs.

Following the positive results from users and the analysis of the systems in the logs mentioned above, the decision was made to go into production. Currently, over 550 people use the presented solution, and the target is to be used by all employees, namely a total of 2500. Every month, 300 accounts are activated. The challenges we started with in this implementation of the solution were the non-existence of this way of transmitting files within the Moodle platform and the need to introduce this new method, which has an impact on the communication process that is beneficial to users. During the implementation process, we tried to go beyond how communication through the chat window exists and works on the Moodle platform. Starting from the idea of introducing this new solution and analyzing and comparing other communication methods within the well-known e-learning systems existing on the market, we had an ongoing challenge to overcome this impediment and to achieve and implement in optimal conditions this solution that offers great advantages to users and brings added value and security to the Moodle system. Thus, we learned that a thorough analysis, a good knowledge of the requirements for

implementing the new solution, and adequate testing are the keys to success in such an implementation, as well as using good practices in the IT field.

3.3. The Methodology of the Study, the Statistical Analysis of the Results, and the Scientific Discussion

Laboratory studies on configuration, use, and evaluation by users.

The tests were completed by 60 people over the course of a month. Data collection was carried out using questionnaires sent and received by email and phone call. The results obtained can be seen in the Table 4.

Table 4. Platforms used by users for communication and sending files.

Questionnaire Questions on Sending Files through the Chat Window	1 Day	10 Days	20 Days	30 Days
Platforms used after deployment	Cisco Webex 5, HCL Verse 4, Zoom 4, Microsoft Teams 9, Lifesize 7, Moodle 31.	Cisco Webex 3, HCL Verse 2, Zoom 2, Microsoft Teams 6, Lifesize 4, Moodle 43.	Cisco Webex 3, HCL Verse 2, Zoom 1, Microsoft Teams 4, Lifesize 2, Moodle 48.	Cisco Webex 2, HCL Verse 2, Zoom 1, Microsoft Teams 1, Lifesize 0, Moodle 54.
Separate or integrated client preference	29/31	17/43	11/49	6/54
Degree of usefulness	82%	91%	97%	100%
Complexity of use	Advanced Level 12, Medium Level 14, Low Level or Easy to Use 34	Advanced Level 9, Medium Level 10, Low Level or Easy to Use 41.	Advanced Level 5, Medium Level 7, Low Level or Easy to Use 48.	Advanced Level 2, Medium Level 3, Low Level or Easy to Use 55.
Transmitting files after deployment	Email 26, file transfer sites 15, shared file folder 7, Chat 12.	Email 19, file transfer sites 8, shared file folder 5, Chat 28.	Email 9, file transfer sites 3, shared file folder 2, Chat 46.	Email 1, file transfer sites 1, shared file folder 0, Chat 58.
Keeping this solution	37 yes/23 no	46 yes/14 no	52 yes/8 no	59 yes/1 no

As a conclusion, the surveyed users have opened up to the use of the new solution, given its advantages. Thus, the transmission of files through the chat window, in the opinion of users, is useful, easy to use, does not require complex knowledge, and remains in their preference for further use, even after the end of the test.

3.4. Case Study on How Users Perceive Using the New Method of Sending Files

Data collection was done through questionnaires sent and received by email and/or phone call. The results obtained can be seen in Table 5.

Table 5. Analysis of the users' perceptions of the usefulness of the new method of sending files.

Questionnaire Questions on Sending Files through the Chat Window	1 Day	10 Days	20 Days	30 Days
Ease of use	40	50	52	60
Level of understanding	30	35	42	55
Send and receive error rate	0%	0%	0%	0%
Degree of satisfaction	45	49	55	60
Degree of complexity	10	8	6	5
File submission time	40	50	52	60
Degree of diversification of the files sent	51	53	58	60
Easy way to send files	50	54	58	60
Efficiency of the solution	55	57	60	60
Inefficiency of the solution	5	3	0	0

The evaluation carried out followed what was the intention of the users when they chose to use the new method of sending files and what was the experience, the degree of satisfaction, and the results obtained as a result of using it within the established sample. The following patterns of behavior were derived from the use and intention to use this solution in the next period, as can be seen in Table 6.

Table 6. Patterns of behavior in using chat to send files.

Perceived comfort	They can access the file transfer icon in the chat window at any time. They can send any type of file and size to any user who has an account with the e-learning platform. Executing file sending is fast, efficient, and simple.
Attitude	It would be very desirable to use the chat for sending documents. Using chat is better than using other methods of sending files.

Chat file attachment plays an important role in reducing costs, optimizing resources, and automating services. The conclusion of this study results in the openness of the surveyed users to sending documents through the chat window, which is declared efficient, easy, and easy to use, which brings added value both in terms of use and time and the diversity of files that can be sent within it. All this has made this solution useful, easy to use, efficient, and offers a high degree of satisfaction to the people who use it, thus making it a new and accessible way of using chat for such problems.

4. Approaching the Solution by Implementing the Newly Developed Plugin

The working method to add new features to Moodle is to create a new standard plugin [18,19]. Plugins are for things that do not match standard plugins; examples include the following:

- Custom administrator settings
- New database tables used in the core
- Applications that extend Moodle to the server system level
- Custom definitions of web services and external functions
- New definitions of capabilities used in the core
- Extension of the navigation block with personalized menus

The minimum and mandatory requirements for the operation of Moodle are the following: 200 MB hard disk, 512 MB of memory, and 1 GHz CPU [20]. The tests were performed on a Windows Server 2022 x64 operating system, Intel Xeon-Silver 4208 8C, CPU @ 2.1 GHz processor, 32 GB of 2933 MHz installed memory, 2 TB of hard disk, and controller disk RAID 0/1/10/5/50/6/60 with RAID 930-8i 2 GB Flash. The Moodle package for the installed Windows operating system was version 3.11, which contains all the other programs needed to run it on Windows. The working method used to create and edit the plugin was PHP (Hypertext Preprocessor, Web Scripting Language) technology and the WAMP (Windows, Apache, MySQL, PHP) server on Windows systems. WAMP was used as a secure space to work on the platform without having to host it online. Apache is the server software used to display web pages [21,22]. When a user requests a page for viewing, Apache approves the request via HTTP and displays the site. MySQL is a relational database management system and is an integrated component of the WAMP platform. A PHP interpreter implemented as a module processed the PHP code on a server. PHP is a general-purpose writing language, especially suitable for web application development.

Detailed technical description of the plugin implementation. Functional flow. When the clip icon is clicked, basic file upload options are available. Once a file is uploaded, the link to the file will be shared as a message to another user. The user who receives the message will click on that link and view the attachment. Since the implementation of this functionality is customized, it will also depend on the theme because the theme can override the appearance of the message. While this required a custom base change, to make

it compatible and take into account future release updates for Moodle, the preference was to provide a standalone plugin so that it would be easy to implement from the front-end only. Considering the development of a standalone plugin, the Moodle standard was taken into account. In addition to functional domain coverage, a site administration screen is also added to control the size of the site. A built-in scheduler, according to the Moodle standard, is added and can be found from "Site Administration > Server > Tasks > Schedule Tasks", to clean up orphaned files. The message screen will be displayed as follows: the images are displayed inline, and the rest will be displayed as a link. Keeping the provisions for future improvements, a database table is added, which contains the records of the uploaded files and their path, and the associated message ID. This helps to list records that contain the original file name and the unique file name generated by the system. Module structure. Under the DB folder, the database table structure is mentioned, which will create a table during installation. Under Classes/Task, it mentions the scheduling task that is scheduled by default to run hourly; however, it can be configured from the site administration. Below is shown llib.php, the code that is injected on the message screen, to provide the loading functionality. The code for adding the multimedia message setting to site administration is described below in Algorithm 1.

Algorithm 1: File upload process, managing upload size and allowed file extensions

```
<?php
defined('MOODLE_INTERNAL') || die();
if ($ADMIN->fulltree) {
}
$settings = new admin_settingpage('local_mutiplefiles, 'MultiMedia Message Settings');
$settings->add(new admin_setting_configtextarea(
'local_mimemessage/extension',
'Allowed Extensions',
' comma separated extensiion',
'.jpg,.jpeg,.png',
PARAM_RAW
));
$currentmaxbytes = get_config('local_mutiplefiles, 'maxbytes');
if (isset($CFG->maxbytes)) {
$choices = get_max_upload_sizes($CFG->maxbytes, 0, 0, $currentmaxbytes);
} else {
$choices = get_max_upload_sizes(0, 0, 0, $currentmaxbytes);
}
$settings->add(new admin_setting_configselect(
'local_mimemessage/maxbytes',
new lang_string('maximumupload'),
'',
key($choices),
$choices
));
//'Email Footer', PARAM_RAW));
$ADMIN->add('root', $settings);
```

Below is the method and command line for the attached "clip" icon. Under lib.php, the following code is used for this and is described below in Algorithm 2.

Algorithm 2: Displaying the loading button (clip) and setting its shape

```
$(' <a href="#mutiplefilesmodal" class="mutiplefileslink btn btn-link btn-icon icon-size-3"
data-toggle="modal" data-target="#mutiplefilesmodal"><i class="fa fa-paperclip fa-2x"
aria-hidden="true"></i></a>').insertBefore('button[data-action="send-message"]','[data-
region="content-messages-footer-container"]');
```

The developed plugin must be imported into the Moodle database [23,24]. The setting of the new solution for the site was done as follows: From site administration, plugins were selected, followed by installing plugins. In the Install plugin from the ZIP file, select the file in question from your computer and upload it. Then, a plugin check is done to see if it meets the criteria of the database, and if everything is fine, a confirmation message appears, and the user moves on to the next step of upgrading the Moodle database. Here, it is confirmed that upgrading to the new version is in progress. The 'confirm' button is clicked, and after a few seconds, the successful completion message appears. The installation is done like any other plugin; it connects to the platform with the administrator account, after which it is selected from Site Administration, Plugin, plugin installation, the zip file is searched, the zip plugin installation command is given, and the database is updated with the new plugin, as can be seen in the image below, Figure 2 [25,26].

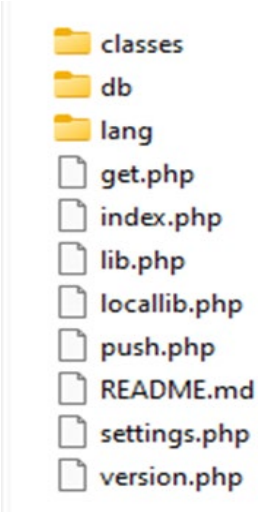

Figure 2. Component of the plugin created.

The following lines describe what php and zip files contain and their role: classes, db, lang, get, Php, and others.

- .php file contains PHP code,
- /local/mutiplefiles/version.php-version of the script,
- /local/mutiplefiles/db/install.xml-executed during installation,
- /local/mutiplefiles/lang/en/local_pluginname.php-language file,
- /local/mutiplefiles/lib.php-function library, automatically included with config.php.
- /local/mutiplefiles/settings.php-configuration options.

These are added to the Admin menu. Returning to the default method was also considered, a situation in which the plugin will be uninstalled without affecting the database or reinstalling the platform, which is a reversible process [26].

Below, the way of working and how the created solution was put into practice is presented. There have been several improvements to the file submission.

- Control the size of the file, which can be reduced or enlarged as needed.
- Managing file extensions that can be uploaded by adding or removing them.
- Inline viewing of images directly in the chat to facilitate communication, but also the possibility that the link is also available for download.
- Only one file is attached, as each file has its download link.
- Works on Moodle regardless of the type of installation, as it is on the intranet or internet, and as soon as the user has access to the platform, it can download all incoming messages.
- File extensions are managed through a window created for this purpose, as shown in Figure 3.

- The files sent are available to both communicating parties.
- Any main core dependency has been removed so that the plugin is not deleted when switching to a new version.
- The files in the plugin created in zip format to be imported into site administration contain the codes that execute this functionality.

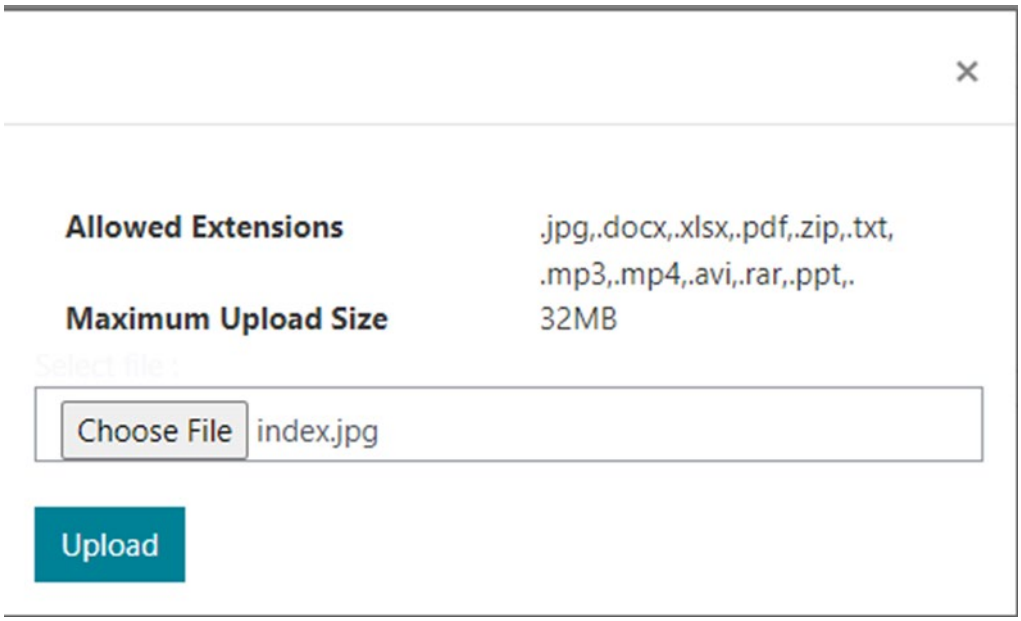

Figure 3. Uploading files using the newly created method.

A new Site Administration section has been added under the Advanced feature called MultiMedia Message Settings, as shown in Figure 4.

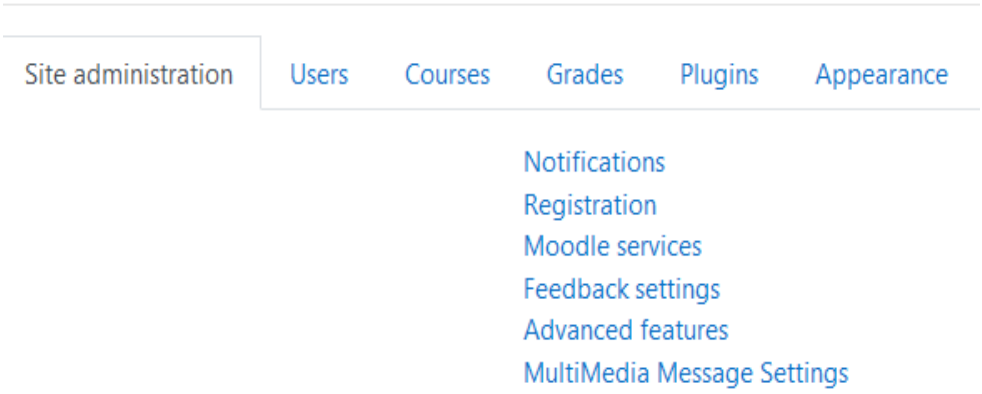

Figure 4. A new Site Administration section.

This settings page allows administrators to control or enter file types and maximum upload size for students in the chat window, as shown in Figure 5.

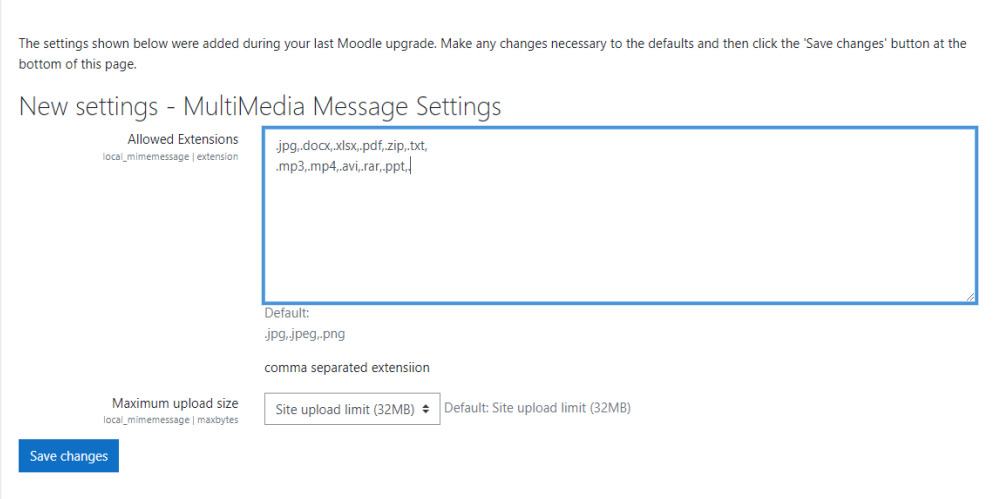

Figure 5. Manage file types and size.

After all the settings have been made in the administration section, the platform will be restarted, and the new changes will be checked. If all changes have been made successfully, it will go to the chat window, where the file attachment icon will appear. To attach files, click on the icon, then select the desired document and execute the send command. Immediately in the chat window of student 1 who sent the document, the name of the file and its extension will appear, and student 2 will receive a warning message, as shown in Figure 6.

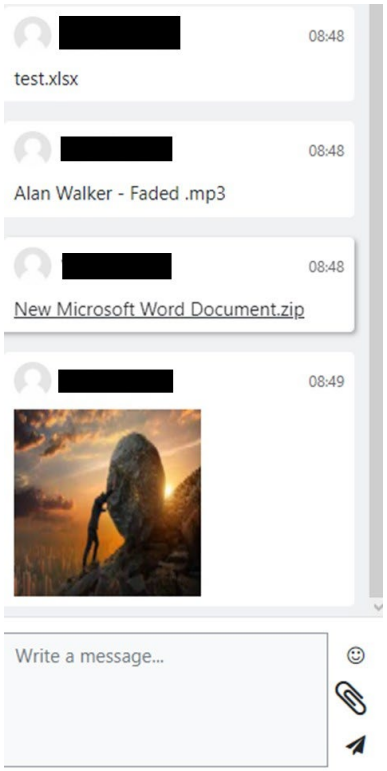

Figure 6. Attachments with different file types in the chat window.

5. Actual Outcomes

This project aimed to increase the degree of communication, the rapid exchange of information, a better administration of accounts, the protection of the information uploaded

on the site, and the access and easy identification of the people connected to the platform. All these aspects have been achieved with the help of the newly created plugin. Another important point of file transfer is that it can always go back to the original form of the chat and vice versa without affecting the database or the configuration of the student profile. In addition, the value offered by this paper is indicated by the advantages and benefits obtained through its implementation:

- The possibility of transmitting files through the chat window is created.
- Users can thus communicate easier and faster.
- Can send files of different extensions (.pdf, .zip, .docx, .jpg, .xls, .mp3, .mp4, etc.) and sizes.
- Can send as many files as they want at any time (one file for each upload), not being limited by the number of uploads related to the transmission.
- The transmitted files reach the private space of the platform user.
- The uploaded file is made available to users via a link.
- Keeping in the interface both the user who uploaded and the users who received the file, the links related to all the files that were communicated through the chat window.
- The possibility to access at any time any file available to be read after uploading to the platform by various users.
- The possibility to delete the uploaded file through the chat window at any time desired by users.
- The possibility to download the uploaded files using the link formed after the file upload.
- Obtaining error messages in case the upload was not performed or the required validations were not observed.
- The files can be uploaded both from the platform's intranet and from the internet.
- The files are uploaded after the users are authenticated in the system.
- The files are transmitted to the users of the platform as follows:
  - the individual,
  - one or more groups,
  - to all users.
- Files can only be downloaded after user authentication.

The connection to the platform can be made from any device, whether it is a mobile phone, tablet, laptop, or computer, based on the access link. Using this implementation guarantees that the transmission of files is done inside the network through its platform, without the need for another program, application, site, or company that offers such services in the cloud. This way, there is no possibility of security breaches, files being read by unauthorized persons, or reaching another location. From a security point of view, the proposed solution does not present any risk in this regard. The implementation of the plugin does not affect the structure or data of the Moodle platform, and there is the possibility of returning to the previous working method. Good practices were taken into account when developing the plugin. Logging in for users is done in the same way as before installing the plugin. There is no change in this regard. The new solution can be installed on any operating system, and access to the site can be achieved from any browser; there are no restrictions or conditions. A stress test was performed, and no performance degradations of the systems were identified, and no side effects occurred, such as increased network traffic or performance degradation at the level of the servers hosting the IT solution. The amount of secondary storage and the security of file storage have not undergone adaptations or adjustments; they work on the same solution and logic provided by the IT platform. Their saving is done locally, on the user's station, not on the server, which is not affected. Thus, the technical characteristics related to memory, processor, and storage space have no problems and are not affected by the implementation of this solution. The study carried out shows the importance of the continuous improvement of the resources and facilities of the e-learning platform, with the aim of increasing the satisfaction of the students and their

learning outcomes. This research contributes to the understanding of effective e-learning strategies and their implementation in education.

6. Conclusions

Moodle allows communication between students through the chat window, where you can send only text messages and emoticons. There is also the possibility for the IT administrator, when necessary, to create a new method using the plugin function found in the site administration. This plugin is used for a new solution that contributes to the possibility of transmitting files through the chat window with various extensions such as .pdf, .zip, .docx, .jpg, .xls, .mp4, and other types and sizes. Files can be sent at any time and as many as desired, not limited by the number of uploads related to the transmission. This new method was intended to increase the degree of communication, the rapid exchange of information, better management of accounts, protection of information uploaded to the site, access to resources, and easy identification of people connected to the platform.

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