

VULNERABILITIES OF MOBILE APPLICATIONS USED IN DISTANCE LEARNING ENVIRONMENT

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Abstract

E-Learning means learning through electronic resources. This is usually done on the Internet, where students can access materials online at any time.

Nowadays, more and more students are enrolling in online courses to learn, due to the comfort of their homes and the desire to learn at their own pace, turning to various platforms that provide educational materials.

Thus, mobile learning platforms, used in the university environment, bring benefits to students, although they cannot fully replace traditional education. The Internet presents many opportunities and beneficial ways of learning.

In this material, we present the concept of distance education and how it is used. We present different software tools intended for mobile devices used in the education environment, and especially in the distance education process, and we analyze the vulnerabilities that have appeared for these mobile applications from the point of view of the data managed by these applications. The vulnerabilities are searched in CVE MITRE - Common Vulnerabilities and Exposures.

For each mobile application, we centralize the vulnerabilities identified and we will create a statistical analysis using Common Vulnerability Scoring System – CVSS. In this way, we will create a ranking of the most vulnerable mobile applications used in distance learning.

We believe that such an analysis is important for a growing technology because this technology development must be linked to certain security standards. Existing vulnerabilities already identified for the solutions used must be provided and analyzed so that there is no danger that these vulnerabilities are present in the solutions used.

Keywords: *Distance education, mobile applications, learning, vulnerabilities, data.*

1. Introduction

A system's vulnerability can be thought of as a weakness or flaw that permits white-hat hackers to alert the public or the system's owners to the exposure or black-hat hackers to breach the system's security to express their destructive intent. In order to provide countermeasures against them, it is crucial to analyze these vulnerabilities and take appropriate action.

Mobile learning applications can be exposed to malware, data breaches, and unauthorized access, among other security risks. Malware can be used to steal private data, including passwords and financial information (Willson, 2022). When an application is not properly secured, data breaches can happen, giving attackers access to private data. When an application is not properly secured, unauthorized access might happen, giving attackers access to private data. Additionally, phishing attacks, which are designed to steal passwords or personal information, may target mobile applications used in education.

In (Syvyi et. al, 2022) mobile applications are presented as a great tool for distance learning, as they allow students to access course materials and resources from anywhere. Mobile applications can help to create a more interactive learning experience, as they allow students to communicate with their instructors and peers in real-time.

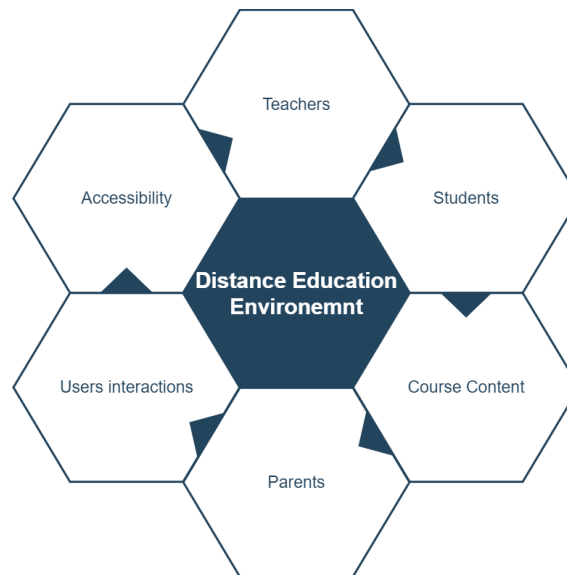
The purpose of the paper is to give a broad overview of the significance of analyzing CVEs (common vulnerabilities and exposures) for mobile applications used in distance learning environments so that more people, including non-specialists, will be aware of the dangers associated with the rising trend in vulnerability disclosures and take appropriate precautions.

2. Distance education environment

E-Learning and web-based applications have been and are very popular allowing users to access information via the Internet directly from their personal computers. M-Learning or Mobile E-Learning allows accessing information via the Internet via mobile devices. Within M-Learning, courses and the platform are customized for each user (Al-Jarf, 2022).

The principal elements and advantages of Distance education environment are presented in Figure 1.

Figure 1. Distance Education Environment.



In (da Silva, et. al, 2022) distance learning environments is presented as an effective and beneficial instrument for students, as long as they are properly designed and well implemented. Distance learning can provide students with the opportunity to learn at their own pace, in their own environment, and with the support of their peers. Distance learning can help to bridge the gap between traditional and non-traditional students, allowing them to access educational opportunities that may not have been available to them otherwise.

Mobile devices are cheaper than personal computers and thus are bought by more people. Users take these devices with them all the time because they are small, portable and easy to carry. Learning is facilitated by combining different types of resources and different ways of developing knowledge and skills. The Mobile Learning mode provides users with both a physical and a virtual world. The information in the courses is put in the form of games.

The distance education environment offers students the opportunity to learn in any place and at any time. This allows them to adapt to their schedule and manage their time effectively. Also, this environment offers students access to online educational materials, such as interactive courses, educational videos and other resources.

Also, the distance education environment offers students the opportunity to interact with their teachers and colleagues through online platforms. This allows them to participate in discussions and collaborate with other students. Also, this environment offers students the opportunity to receive feedback and support from their teachers.

In addition, the distance education environment offers students the opportunity to learn in a more interactive and intuitive way. This allows them to better focus on the educational materials and better understand the concepts presented. Also, this environment offers students the opportunity to connect with other people from all over the world who share the same educational interests.

3. Mobile applications used in distance education

Mobile applications, like any other software product, to be accepted and used by users must meet the quality requirements imposed by them. Mobile apps represent investments made by the developer and after launch, he has to recover his investment. Failure to adapt the mobile application to user requirements leads to its non-use and automatic removal from the market, similar to removing a product from the

market. In our opinion the most used mobile applications in Mobile Learning are (Best Educational Apps, 2022):

- a. **Duolingo** is a free online language learning app. It is designed to help users learn a new language through interactive lessons, games, and quizzes. The app is available for mobile devices and computers and can be used to learn more than 30 different languages (Duolingo, 2023).
- b. **Teams** is a collaboration and communication application that provides a platform for work teams to connect and collaborate. The application offers communication tools, such as chats, video and audio calls, file sharing and other collaboration tools. It also offers integration with other Microsoft applications, such as SharePoint, OneDrive and Outlook (Teams, 2023).
- c. **MoodleMobile** is a mobile application that allows users to access the Moodle platform from mobile devices. This app gives users access to course content and activities, as well as received messages and notifications. It also gives users the ability to participate in discussions and upload files (Makruf, 2022), (Moodle Mobile, 2023).
- d. **Blackboard learn** is an online learning application that provides tools and resources to help teachers create and manage online courses. The app offers collaboration, communication and assessment tools, as well as course management tools such as the calendar, discussion list and material library. It also provides tools to create multimedia content such as videos and presentations. Blackboard Learn can be used to create complete online courses with all the resources you need to learn (Blackboard learn, 2023).

There are more mobile applications used in distance learning but for our analysis, we will use these four mobile applications.

4. Data vulnerabilities of mobile applications

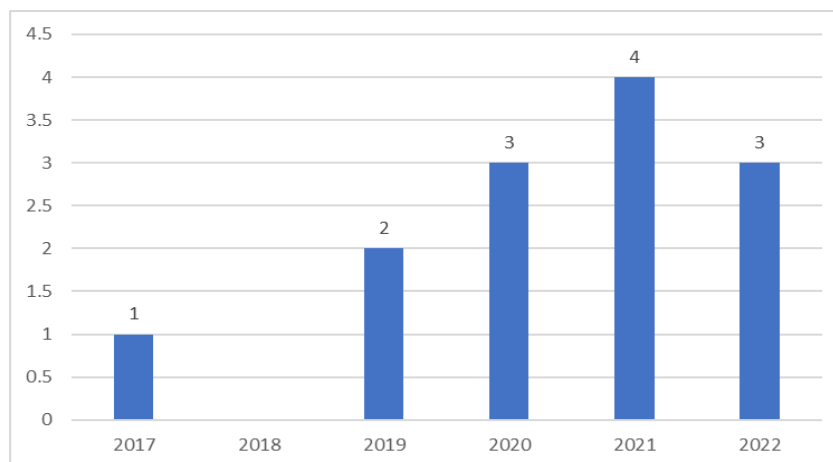
For this study, we searched for the vulnerabilities reported on the platform (CVE, 2023) for these main solutions used in distance learning. Search results are shown in Table 1. For each solution, there is also a period in years in which these CVEs have been identified.

Table 1. Identified CVEs for solutions used in distance learning.

No.	Solution	CVEs
1	Duolingo	CVE-2017-16905
2	Teams	CVE-2022-21965, CVE-2021-24114 CVE-2020-17091, CVE-2020-10146 CVE-2019-5922
3	MoodleMobile	CVE-2022-35652, CVE-2021-32477 CVE-2019-14830
4	Blackboard learn	CVE-2022-39196, CVE-2021-36747 CVE-2021-36746, CVE-2020-9008

The identified vulnerabilities cover a period of 2017-2022. For most of the solutions, the latest vulnerabilities were identified in 2022. This information is shown in Figure 2.

Figure 2. CVEs per years.



The Common Vulnerability Scoring System (CVSS calculator, 2023) is very used to calculate the score for each common vulnerability. The current version, and also the used version for our analysis is v3.1. We used this calculator to calculate the scores for the identified vulnerabilities. The results are presented in Table 2.

Table 2. Scores for identified vulnerabilities.

CVE	Overall	Impact subscore	Exploitability subscore
CVE-2017-16905	8.1	5.9	2.2
CVE-2022-21965	7.5	3.6	3.9
CVE-2021-24114	5.7	3.6	2.1
CVE-2020-17091	7.8	5.9	1.8
CVE-2020-10146	5.4	2.7	2.3
CVE-2019-5922	7.8	5.9	1.8
CVE-2022-35652	6.1	2.7	2.8
CVE-2021-32477	4.3	1.4	2.8
CVE-2019-14830	6.1	2.7	2.8
CVE-2022-39196	6.5	3.6	2.8
CVE-2021-36747	5.4	2.7	2.3
CVE-2021-36746	5.4	2.7	2.3
CVE-2020-9008	5.4	2.7	2.3

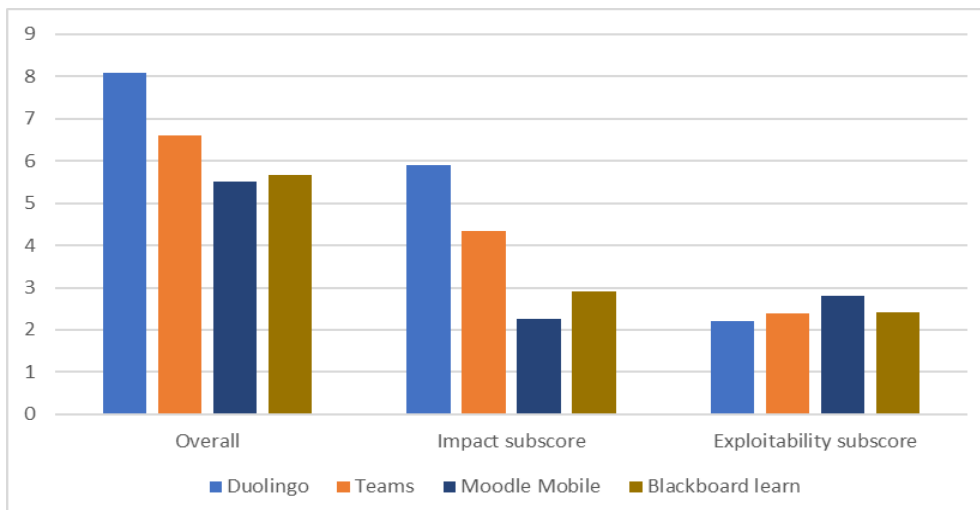
Also, we have calculated the averages for each mobile solution. The averages are presented in Table 3.

Table 3. Average scores for mobile applications used in distance learning.

	Overall	Impact subscore	Exploitability subscore
Duolingo	8.1	5.9	2.2
Teams	6.6	4.34	2.38
Moodle Mobile	5.5	2.26	2.8
Blackboard learn	5.67	2.92	2.42

These data are represented in the Figure 3 for a better interpretation.

Figure 3. Average scores for mobile applications used in distance learning.



For Duolingo solution the average represents actually the score obtained by the single CVE identified for this solution. For the rest three solutions, we can see that the maximum overall score is obtained by the Teams solution.

5. Conclusions

In this paper, we analyze the identified vulnerabilities for the mobile applications used in the Distance Learning Environment and the impact of the number of identified vulnerabilities per year for these solutions.

Our future work will concentrate to identify new vulnerabilities and to make again the calculation of the new scores with the new data. Also, we want to create an automated tool that will identify automatically the number of common vulnerabilities and the overall score CVSS and to present reports monthly regarding to impact of each solution or other new solution that will be analyzed.

Acknowledgments

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References

- Al-Jarf, R. (2022). Specialized dictionary mobile apps for students learning English for engineering, business and computer science. *Journal of Humanities and Education Development (JHED)*, 4(1), 1-9.
- Best Educational Apps, Online: <https://www.educationalappstore.com/app-lists/apps-for-education>, Accessed: November 2022.
- CVE Mitre, Online: https://cve.mitre.org/cve/search_cve_list.html, Accessed: January 2023.
- CVSS Calculator, Online: <https://nvd.nist.gov/Vulnerability-Metrics/Calculator-Product-Integration>, Accessed: January 2023.
- da Silva, L. M., Dias, L. P., Barbosa, J. L., Rigo, S. J., dos Anjos, J., Geyer, C. F., & Leithardt, V. R. (2022). Learning analytics and collaborative groups of learners in distance education: a systematic mapping study. *Informatics in Education*, 21(1), 113-146.
- Duolingo, Online: <https://www.duolingo.com/>, Accessed: January 2023
- Makruf, I., Rifa'i, A. A., & Triana, Y. (2022). Moodle-Based Online Learning Management in Higher Education. *International Journal of Instruction*, 15(1), 135-152.
- MoodleMobile, Online: <https://download.moodle.org/mobile>, Accessed: January 2023. Blackboard learn, Online: https://help.blackboard.com/Learn/Instructor/Ultra/Getting_Started/What_Is_Blackboard_Learn, Accessed: January 2023.
- Syvyi, M., Mazbayev, O., Varakuta, O., Panteleeva, N., & Bondarenko, O. (2022). *Distance learning as innovation technology of school geographical education*. arXiv preprint arXiv:2202.08697.
- Teams, Online: <https://www.microsoft.com/en-us/microsoft-teams/group-chat-software>, Accessed: January 2023.
- Wilson, S. V. (2022). *Cybersecurity and Higher Education: A Review of Cyber Vulnerabilities and Their Impact on Colleges and Universities*. [Master's Thesis, Utica University]. Utica University ProQuest Dissertations Publishing.