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Desarrollo de un sistema operativo orientado a la educación para la enseñanza en línea durante la pandemia de COVID-19

Development of an education-oriented operating system for online teaching during the COVID-19 pandemic

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Resumen
La situación provocada por la pandemia mundial del COVID-19 ha supuesto un desafío sin precedentes para el sector educativo. La necesidad de mantener el distanciamiento social y las restricciones impuestas para controlar la propagación del virus han obligado a impulsar de forma inmediata la enseñanza online, transformando radicalmente el panorama educati-vo. Ante esta realidad, se ha vuelto imperativo buscar soluciones innovadoras y accesibles para garantizar la continuidad del proceso de enseñanza-aprendizaje. En este contexto, se ha desarrollado un sistema operativo gratuito basado en software libre, como una iniciativa clave para contribuir a las estrategias globales orientadas a amortiguar el impacto del coro-navirus en la comunidad educativa. Este sistema operativo se presenta como una herramien-ta de gran valor, no solo por su accesibilidad y bajo costo, sino también por su adaptabilidad a diferentes contextos educativos. Cuenta con un conjunto de aplicaciones preinstaladas, diseñadas específicamente para facilitar la labor docente en un entorno virtual. Estas aplica-ciones permiten mantener un canal de comunicación efectivo a distancia con los alumnos, además de ayudar en la organización y gestión del trabajo, tanto para docentes como para estudiantes. Para asegurar que este sistema operativo respondiera efectivamente a las nece-sidades reales de los educadores y alumnos en tiempos de pandemia, se llevó a cabo un estu-dio de investigación exhaustivo. Este estudio incluyó encuestas, entrevistas y grupos focales con docentes de diversos niveles y disciplinas, así como con expertos en tecnología educati-va. Los resultados obtenidos proporcionaron información importante sobre las necesidades, retos y expectativas del profesorado en relación con la enseñanza en línea. A partir de estos hallazgos, se diseñó un sistema operativo que integró estas necesidades, ofreciendo solucio-nes prácticas y efectivas para la educación a distancia. Finalmente, la versión de prueba de este sistema operativo fue sometida a una rigurosa evaluación. Se invitó a un grupo diverso de docentes y expertos en tecnología educativa a utilizar el sistema en un entorno real de enseñanza. Sus comentarios y observaciones fueron fundamentales para realizar ajustes y mejoras, garantizando así que la versión final del sistema operativo fuera una herramienta robusta, intuitiva y eficaz, que respondiera a los desafíos educativos planteados por la pan-demia del COVID-19.

Palabras clave: COVID-19, sistema operativo, enseñanza online, software educativo, software libre.

Abstract
The situation caused by the global COVID-19 pandemic has posed an unprecedented chal-lenge for the educational sector. The need to maintain social distancing and the restrictions imposed to control the spread of the virus have necessitated the immediate implementation of online teaching, radically transforming the educational landscape. In light of this reality, it has become imperative to seek innovative and accessible solutions to ensure the continuity of the teaching-learning process. In this context, a free operating system based on open-source software has been developed as a key initiative to contribute to global strategies aimed at mitigating the impact of the coronavirus on the educational community. This oper-ating system is presented as a tool of great value, not only for its accessibility and low cost but also for its adaptability to different educational contexts. It includes a set of pre-installed applications, specifically designed to facilitate teaching work in a virtual environment. These applications allow for maintaining an effective distance communication channel with students, as well as assisting in

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the organization and management of work, for both teachers and students. To ensure that this operating system effectively met the real needs of educa-tors and students during the pandemic, an exhaustive research study was conducted. This study involved surveys, interviews, and focus groups with teachers from various levels and disciplines, as well as with experts in educational technology. The results provided im-portant information about the needs, challenges, and expectations of teachers in relation to online teaching. Based on these findings, an operating system was designed that integrated these needs, offering practical and effective solutions for distance education. Finally, the trial version of this operating system was subjected to rigorous evaluation. A diverse group of teachers and educational technology experts were invited to use the system in a real teaching environment. Their feedback and observations were crucial for making adjustments and improvements, thus ensuring that the final version of the operating system was a robust, intuitive, and effective tool that met the educational challenges posed by the COVID-19 pandemic.

Keywords: COVID-19, operating system, online teaching, educational software, free software.

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Introduction

The outbreak of the coronavirus pandemic in early 2020 had a profound impact on the global education system (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2021). By May 2020, it was estimated that over 1.2 billion students from various educational levels across the world were compelled to halt their regular face-to-face classroom learning (Economic Commission for Latin America and the Caribbean [ECLAC] & UNESCO, 2020). This sudden shift brought forth an immense challenge in the educational sector. The era of COVID-19 marked a pivotal moment where online teaching and learning emerged as the primary, if not the only, mode of education. This transformation, as highlighted in studies such as those by Mishra et al. (2020), necessitated a rapid and effective response to adapt to the new normal of digital learning (Guo, 2020). Along the same lines, it has been pointed out that due to the Covid-19 pandemic, a change in the educational paradigm is required to facilitate the transition from face-to-face to online teaching (Seo & Chul, 2022).

In response to these unprecedented circumstances, and with the goal of supporting and enhancing the educational process during these challenging times, a dedicated research study was initiated. This study aimed to develop a computer operating system specifically tailored for educational purposes. The objective was to make this system as universally accessible as possible to the entire educational community, especially in the context of the surge in online teaching due to the pandemic. The research employed a mixed-method approach, integrating both quantitative and qualitative methodologies. This comprehensive approach was chosen to thoroughly understand and address the diverse educational needs of students engaged in online learning.

The development process of this operating system was meticulous, with a strong emphasis on incorporating a variety of educational tools as default features. These tools were designed to facilitate and enhance the online learning experience for students and educators alike. Following the development phase, the operating system was subjected to critical evaluation. Teachers, who are key stakeholders in the educational ecosystem, were invited to test this new system. Their feedback and insights were of paramount importance. The teachers' opinions regarding the testing version of the operating system were actively sought and

carefully considered, ensuring that the final product was well-aligned with the practical needs and expectations of the educational community during these challenging times.

Recommendations for efficient online teaching include recording online lectures and providing self-study material (Mahmood, 2021); teachers must create a discussion section in order for students to interact and exchange their knowledge (Bao, 2020). Inclusive access to new technologies is a crucial element in order to meet the Sustainable Development Goals. Only by ensuring the full and equal participation of girls and boys, women and men in digital learning opportunities will all people be able to exercise their human rights (UNESCO, 2021).

In countries of the developed world, information and communication technologies (ICT) policies are being promoted in order to achieve the digital literacy of citizens. One of the target areas of these policies is education, for which the aim is to promote the use of ICT in educational centres (Colás Bravo et al., 2015). The importance of training future teachers in basic technological skills is discussed, whether in undergraduate or graduate studies (Roblizo Colmenero & Cózar Gutiérrez, 2015). Over 70% of the teachers consulted in all grades were favourable or very favourable about the importance and benefits of ICT on the different learning processes of students (cooperative work, autonomously, practices, etc.) and objectives (such as higher-order thinking and motivation) (Wastiau et al., 2013). Inclusion and information and communication technologies (ICT) arouse high scientific interest in society. The use of ICT in classrooms enables feedback for students (Fernández Batanero & Colmenero Ruíz, 2016). The impact of ICT on education translates into the promotion of five educational dimensions: active, collaborative and cooperative, creative, integrative and evaluative learning (Raja & Nagasubramani, 2018). New technologies make it possible to keep abreast of the latest advances with the help of their own tools: e-learning, chat discussion groups, e-modules (accessible, digitised and stored documents), audio, video and web-based teleconferencing as well as open and distance education (Ratheeswari, 2018). Infocommunication tools are becoming increasingly important in the transformation of teaching methodologies. This can be seen in the substitution of printed books for digital learning materials, the increase in interactive materials and also the new e-communication channels between teachers and students, etc. (Basak et al., 2018). Besides, several authors have pointed out the benefits of using free software in different areas of education, such as artistic education (Mahakul, 2018), electrical

engineering (Horvatić et al., 2020) and computational chemistry education (Lehtola & Karttunen, 2021). It has been reported that there are no differences between face-to-face and online teaching, as long as they are based on a well-designed, prepared, organized and applied teaching and learning process (Kardum & Vukelic, 2021).

The aim of this paper is to explore the specific needs of teachers when teaching in an online format, as was the case during the time of the coronavirus pandemic. Accordingly, it is desired to carry out the development of an operating system adapted to this situation.

Method and procedure

The present work consists of an applied development and evaluation research, structured in a mixed methodology that combines qualitative (exploratory phase and needs analysis) and quantitative (evaluation of the final product through a questionnaire) aspects. For evaluating educational software, the mixed methodology that combines both a quantitative and qualitative approach is fundamental to guarantee effectiveness and usability, as well as a global framework for these cases (Ngadiman et al., 2021).

Needs Exploration Phase: Comprehensive Overview

The primary objective of this initial phase was to meticulously assess and understand the specific requirements and needs of teachers. This understanding was essential to inform the tailored design of the operating system, ensuring it met the end-users' expectations and demands. Due to the challenges and limitations imposed by the COVID-19 pandemic, all data collection was conducted through electronic means.

A series of sixteen remote interviews were conducted targeting educators across a broad spectrum of educational levels, including early childhood, primary, secondary, and university. In addition, three further interviews were held with technical experts specializing in the information technology sector. These interviews were diverse in terms of the gender of the interviewees. The interviews with teachers were structured around a series of key questions aimed at uncovering the essential features and functionalities that would make an educational operating system both effective and appealing. The questions posed to the teachers were as follows:

• What specific design elements and applications would make an educational operating system appealing and engaging for students, including aspects such as motivation, accessibility, and ease of use?

• What types of applications should be pre-installed in an educational operating system to enhance and support student learning?

• What kinds of applications should be pre-installed for organizational purposes to aid in the management of students' work?

• What design features should an educational operating system incorporate to be effectively used for teaching?

• What design aspects should be included to assist teachers with their organizational tasks?

• What inclusive design features should be considered to accommodate students with specific learning needs, such as disabilities or learning difficulties?

Furthermore, the technical interviews were structured to gain insights into the more technical aspects of the operating system's design. The questions for these interviews focused on:

• Essential features for simplifying the installation process, especially for inexperienced users.

• Hardware requirements necessary for the operating system to be compatible with most computers.

• Recommendations on the type of licenses best suited for the operating system and basic applications (e.g., office suites, browsers, multimedia players), considering options like free software, proprietary software, freeware, shareware, etc.

• Characteristics that would facilitate maintenance, updates, patches, and upgrades for inexperienced users.

• Key features that should be included in the user manual.

• Security-related features essential for the operating system, including pre-installed applications, installation/configuration permissions, firewalls, containers, encryption, etc.

Development phase

The goal of this stage was the design and creation of the Aula operating system. For the configuration of the operating system, the needs detected in the previous phase of this study were taken into account. Aula is based on a Linux-like operating system and is therefore under a free software license. Among the Linux variants, the Ubuntu distribution was chosen because it is usually the most compatible with greatest number of hardware devices.

Next, the system was customised by incorporating the largest number of educational applications according to technical, pedagogical and organisational criteria, which were defined based on the results of the previous interviews. To carry out this process, the researchers had to study the fundamentals of Linux systems, including package management or customisation of available desktop environments. The authors also had to learn to use the virtual machine manager "VirtualBox" to test the new operating system. Finally, when the beta version was ready, the corresponding file was exported as an operating system image (.ISO) for AMD architecture, ready to be installed on most computers.

Operating System Assessment Phase: Detailed Process

This critical phase of the operating system evaluation was structured into two distinct parts, each designed to gather comprehensive insights about the system's performance and user experience.

The initial segment of the assessment adopted a qualitative methodology approach. Its primary aim was to conduct a thorough test of the beta version of the operating system, with a specific focus on gathering initial reactions and feedback from the teachers who participated in the testing phase. This involved organizing four separate sessions, each tailored to observe a different teacher's interaction with the operating system. In these sessions, teachers were not provided with specific guidelines or instructions on how to use the system. Instead, they were given the freedom to explore the system's interface, initiate various applications, and delve into the different functionalities at their own pace. During these exploratory sessions, careful attention was paid to the teachers' behavior, their verbal and non-verbal responses, and any particular points of interest that arose. Following their interaction with the system, these teachers were interviewed to gather their impressions, focusing on aspects such as the system's

ease of use, its utility in a teaching context, and its overall intuitiveness. Importantly, they were also encouraged to provide suggestions for any potential enhancements to the system.

The second part of the assessment was adapted to the constraints imposed by the COVID-19 health pandemic, leading to the creation of an online questionnaire. This questionnaire was structured using a Likert-type scale and included a comprehensive video demonstration of the Aula operating system, showcasing all its functionalities (accessible at https://forms.gle/1DTdvuAtUVEbVzLq6). This demonstration served as a reference point for the questions on the form, which were specifically designed to gather feedback on the teachers' observations and opinions after viewing the video. This form was completed by a group of 75 teachers, offering them a range of response options from 1 (Strongly Disagree) to 5 (Strongly Agree). Besides these response options, the questionnaire also collected some sociodemographic data from the participants, including their gender, country of origin, and the educational level at which they taught. The evaluation instrument encompassed several key items, such as:

- The comprehensibility of the operating system.
- The utility of the applications demonstrated for teaching purposes.
- The perceived customizability of the operating system.
- The teachers' willingness to employ this operating system in their teaching activities.
- Suggestions for any additional enhancements to optimize the operating system for educational use.

Results

Needs exploration phase

Once the telematic interviews were carried out, the transcripts of the responses were read and reread to identify thematic categories until the saturation point was reached. Each category was assigned a code consisting of a specific colour. Subsequently, the texts were underlined with their corresponding colour. The categories identified are shown in Table 1.

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Teacher interview	Technical interview
Useful applications for student work	Easy installation
Encourage the work of teaching	Hardware requirements
Help the teaching organisation	Applications license type
Inclusive applications	Ease of maintenance
	Security management

Table 1. Subject categories of responses

Regarding the category "Useful applications for student work", the participants commented on the importance of including software that facilitates interaction and that is motivating as well as the presentation of content in a playful way, screen capturer, educational platforms, calendar for meetings and video calling apps, simulation and gamification programmes in addition to ICT-based assessment applications. Reference was also made to those tools that make student–teacher contact possible and that allow screen recording, office applications, calculator, dictionary and language translator.

Subject 12: *"On the one hand, applications that allow student–teacher contact (video calls ...) and that allow screen recording (videorecorder ...). On the other hand, basic applications such as Office or similar and calculator, translator, dictionary, …"*

Subject 4: *"Applications to upload tasks and materials, chats, videoconferences, easy-to-use digital resources (for example a screen like a whiteboard with which you can work comfortably, another application to easily correct, to propose questionnaires ...)"*

In relation to the category "Encourage the work of teaching", the participants requested that the design of the operating system be easy to learn to handle and understand, that it be quick to start with very efficient internet access, which allows the student to observe in screen what the teacher is doing and explain it on their computer. The need to incorporate video recording and editing applications and access to anti-plagiarism software was also mentioned.

Subject 6: "*...That allows work between group development of an education-oriented operating system for online teaching in times of the COVID-19 pandemic, simplicity when evaluating, which has all the necessary tools to be able to innovate in education…"*

Subject 4: *"...The operating system should have as characteristics organisation, dynamisation, clarity, simplicity…"*

According to "Help the teaching organisation", the operating system should have characteristics such as educational platforms, for example, Moodle or Classroom, as well as management applications that can be shared with the students.

Subject 9: "*It should be similar to online learning platforms, Classroom or Moodle type with which we can maintain fluid communication with the student. Propose didactic resources, send tasks, so that the student can solve them at home or in the classroom, return them to the teacher so that he can correct and evaluate them, as well as notify the student of the grade or possible corrections or even the resubmission of the task.*"

Regarding "Inclusive applications", the participants highlighted the importance of the operating system being as customizable as possible, facilitating cooperative work. In addition, the tools should be able to adapt to the different levels and rhythms of student learning.

Subject 11: "*Possibility of changing the design, for example, to darker colours, enlarging the font size, etc.*

Be very intuitive in the application icons"

Subject 7: "*Customisable and adaptable to existing functional diversity*"

Technical interview

According to an "Easy installation", the importance of it being intuitive, the installation process being as automated as possible and that it presented a friendly interface was pointed out. It is also desirable that the operating system has the possibility of easily installing applications from a repository and that the installer can detect the drivers.

Subject 1: "*Have a simple, automatic installer and the ability to detect drivers. Being able to install applications from a repository in a simple way (let's say a store).*"

As for the "Hardware requirements", these will depend on the needs of the user; the more functionality, the more resources will be required. The minimum capacity would be a 1 GHz processor, 1 GB of RAM (32-bit) or 2 GB of RAM (64-bit), 16 GB of available hard disk space (32-bit) or 20 GB (64-bit).

Subject 1: "*The requirements will depend on what we want to obtain from this OS. If we want a good user experience they must be higher. The more features/facilities for the user, the more hardware the equipment will need*."

Subject 3: "*1 GHz processor, 1 GB of RAM (32-bit) or 2 GB of RAM (64-bit), 16 GB of available hard disk space (32-bit) or 20 GB (64-bit).*"

Regarding "Applications license type", it was pointed out that although proprietary software is more intuitive and aesthetic, free software has the advantage of being accessible to many people and having fewer errors. There was a preference for pre-installed office applications of the freeware type and free software since they will not provide an explicit economic benefit to the user in the same way as scientific applications that should also be free software.

Subject 2: "*Free software has the advantages that many people contribute and fewer errors. Proprietary software is more aesthetic and intuitive*."

Subject 1: "*Multimedia applications should be part of the S.O., so it would be subject to the license of this. As for Office Suites, they should be free software or freeware since they will not provide an explicit economic benefit. There are other applications for scientific use that should be free software.*"

Related to "Ease of maintenance", it was pointed out that updates should be carried out automatically in the background online and ask when to update so that the user's work is not affected.

Subject 1: "*the S.O. must be 'autonomous' to offer these updates and, at most, ask when they should be installed so as not to affect the work.*"

Regarding "Security management" features such as antivirus, firewall, as well as the presence of an administrator user with a password that prevents unwanted installations were pointed out. On the other hand, the need to find the balance between usability and security was commented on. It would also be necessary to weigh whether the information should be encrypted since it would penalise performance.

Subject 2: "*antivirus (comes from the factory), firewall, an administrator user with a password that blocks accidental installations.*"

Subject 1: "*The higher the security, the lower the usability. You have to find the balance, but at least firewall and modern antivirus (antivirus not only detects viruses but also other threats or attack patterns). Encryption will depend on the information we want to protect (encryption has a performance penalty and would raise hardware requirements).*"

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Development phase

The free software philosophy encourages users to freely take software licensed in this way, improve it, and then distribute it. In consonance, the system was built on the basis of "Ubuntu Linux" with the "Xfce" desktop environment because they required a lower consumption of resources and because it meets a high standardisation at the drivers level. It also has an extensive application store, and the installer is very intuitive, allowing the option of carrying out an encrypted installation. Furthermore, updates are carried out in the background, and administrator permissions are required to install any software. As extra security tools, a firewall and an antivirus were added. These characteristics were suggested by the technicians who were interviewed.

The Aula operating system has a sidebar with the icons of a person's favourite applications. Aula has an application menu organised by categories and a file explorer. The following pre-installed applications are included in the "Education" category:

- Open Board, which is an application for a digital whiteboard with multiple functionalities, including annotating on a shared screen.
- Jitsi Meet, which is an application for videoconferencing with the possibility of storing the recordings in a Dropbox account.
- Vokoscreen, which is a tool to record the computer screen, as well as the webcam.

Also included in "Education" are web links to Google Classroom, Google Calendar, Kahoot, Socrative, Riot (collaborative communication), Symbaloo and Trello (collaborative work management).

Other pre-installed applications are screen capture, notes, email client and translator. The Aula operating system is highly customisable, including numerous options to improve accessibility. In addition, it has other tools, such as audio and video player, as well as office automation applications and a pdf document viewer.

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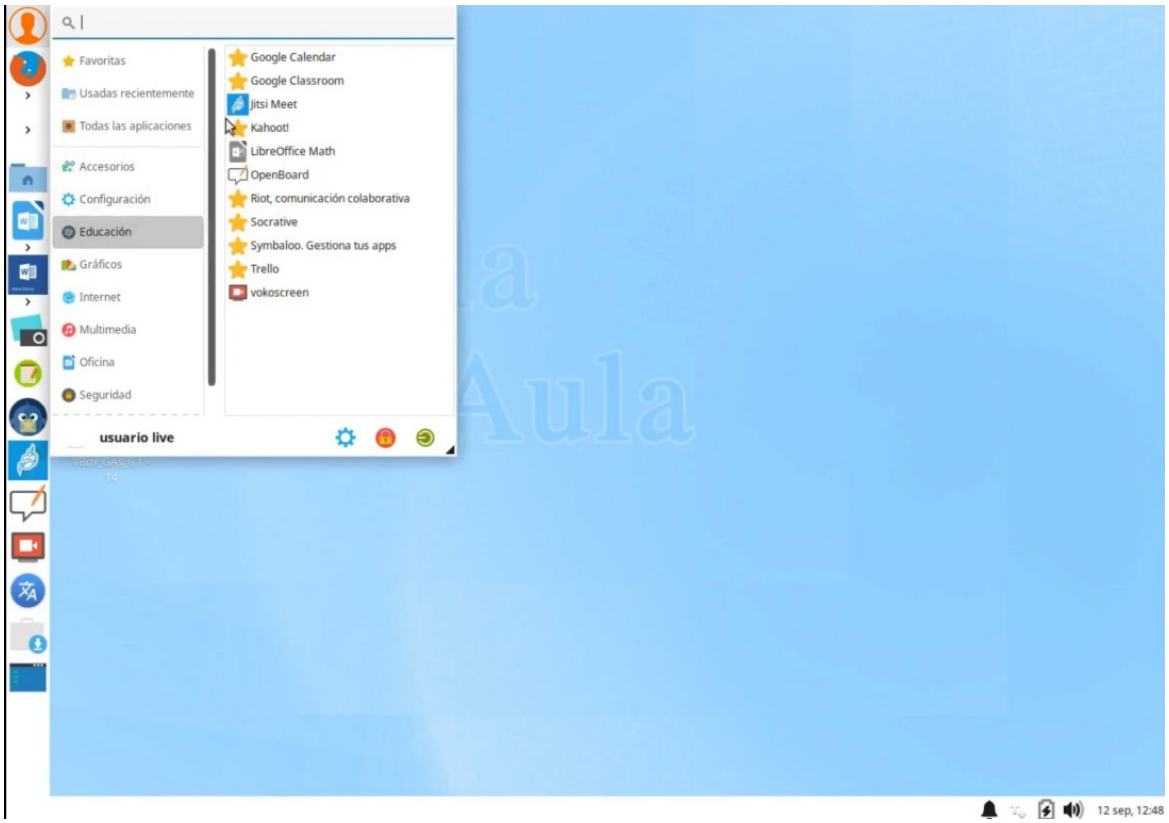

Figure 1. Education tools

As for the accessibility-oriented applications, Aula has a pre-installed screen reader featuring the possibility of visual enlargement and increasing the contrast of elements on the screen. All the tools and pre-installed software were included in response to the answers given by the teachers in the previous phase. When this beta version was ready, it was packed using the "System Back" software and exported as an operating system image, ready to be tested.

Operational system valuation phase

The first part of the assessment phase was positive. The people interviewed had no difficulty in starting and managing the system. On the other hand, they did not suggest any substantial improvement that would require rebuilding the operating system image.

Secondly, analysis of the responses to the online questionnaire after viewing the demonstration of the functionalities of the Aula operating system was carried out with the PSPP statistical software licensed under free software. All the participants—75 in total —were from Spain. Regarding the distribution of the sample, 65.3% of teachers were women, and 66.7% belonged to the university level (Table 1).

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Items	Man	Woman	Total	Pre-university	Academic	Total
Frequency	26	49	75	25	50	75
Percentage	34.7%	65.3%	100%	33.3%	66.7%	100%

Table 1. Sample characteristics

The highest percentages of responses for all the items in the questionnaire (Table 2) are for options 4 (partially agree) and 5 (totally agree), suggesting a broad positive predisposition towards the variables considered regarding the operating system in question: easy to understand, useful for teaching, customisable, as well as favourable for taking a test.

Items	1-Strongly disagree	2-Partially disagree	3-Neither agree nor disagree	4-Partially agree	5-Strongly agree
This operating system is easy for me to understand.	4%	0%	16%	41.3%	38.7%
In general, the applications shown are useful for teaching.	0%	0%	13.3%	30.7%	56%
I believe that this operating system can be customised.	0%	2.7%	29.3%	37.3%	30.7%
I would be willing to try this operating system to carry out my teaching work.	4%	8%	21.3%	30.7%	36%

Table 2. Assessment of the functionalities of the operating system

For each of the items assessed through the questionnaire, the means were compared, with a confidence interval of 95% not assuming equal variances. In no case were the differences significant (Table 3).

Items	Pre-university group N (mean, SD)	University group N (mean, SD)	P value
This operating system is easy for me to understand.	25 (4.16, ±0.69)	50 (4.08, 1.07)	0.696
In general, the applications shown are useful for teaching.	25 (4.28, ±0.74)	50 (4.50, 0.71)	0.223

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I believe that this operating system can be customised.	25 (4.04, ±0.79)	50 (3.92, 0.88)	0.553
I would be willing to try this operating system to carry out my teaching work.	25 (3.68, ±1.03)	50 (3.96, 1.16)	0.292

Table 3. Comparison of means between pre-university group and university group for each item

Discussion and conclusions

Designing a free-access operating system that can be easily installed on computers with modest hardware features, as is the case of Aula OS, is close to what (UNESCO, 2021) has indicated when it points out the importance of achieving an egalitarian approach to opportunities for digital learning. Along the same lines, Aula OS has software aimed at being as accessible as possible, a fact that is reinforced by the high degree of customisation it offers. Many of the tools included by default in Aula OS, such as Open Board (digital whiteboard), Jitsi Meet (videoconference) or Vokoscreen (computer screen recorder) will enable offering feedback to students, which is in line with the suggestions of Fernández Batanero and Colmenero Ruíz (2016). The direct access that this operating system allows to applications, such as the online calendar, as well as tools for communication and collaborative work, such as Riot or Trello, facilitate active, cooperative and collaborative, creative, integrative and evaluative learning, aspects that have also been considered by Raja and Nagasubramani (2018). In addition, the characteristics of this education-oriented operating system will help to stay abreast of the latest scientific and technological advances, facilitating e-learning, chat channels, access to digitised material and ultimately an open education distance, which agrees with that shown by Ratheeswari (2018). In summary, the design and development of the Aula operating system represents an attempt to turn towards online education during the COVID-19 pandemic, a fact that poses an immediate challenge, as Mishra et al. have stated (2021). These are final conclusions:

• The Aula operating system facilitates online teaching during the COVID-19 pandemic.

• The tools included in Aula OS can help with teaching tasks such as organising work, providing feedback to students and maintaining an open communication channel.

• The fact that Aula is free software makes it possible to reach a greater number of members of the educational community, helping to reduce inequality.

• Teachers consider the characteristics of Aula OS to be positive regardless of the educational level to which they belong.

As limitations, it can be pointed out that the present study has overlooked the lower Internet connectivity that may be available in countries with developing economies, which may be a factor to be taken into account when offering different modalities of online resources, attending to the specific needs of different learning groups (Singh & Arya, 2020). On the other hand, and with a view to future work, the design of the operating system could be optimized in terms of its functionality by giving greater prominence to the use of the cloud (Fan, 2023).

References

Bao, W. (2020). COVID-19 and online teaching in higher education: A case study of Peking University. *Human Behavior and Emerging Technologies*, *2*(2), 113–115. https://doi.org/10.1002/hbe2.191

Basak, S. K., Wotto, M., & Bélanger, P. (2018). E-learning, M-learning and D-learning: Conceptual definition and comparative analysis. *E-Learning and Digital Media*, *15*(4), 191–216. https://doi.org/10.1177/2042753018785180

Economic Commission for Latin America and the Caribbean, United Nations Educational, Scientific and Cultural Organization, (2020). *Education in the time of COVID-19*. Editorial ECLAC-UNESCO. https://www.cepal.org/en/publications/45905-education-time-covid-19

Colás Bravo, M. P., Conde Jiménez, J., & González Ramírez, T. (2015). *Evaluación de políticas TIC: Competencias digitales*. https://idus.us.es/handle/11441/28502

Fan, L. (2023). Online interactive platform for college english intensive reading teaching based on cloud service. In W. Fu, & L. Yun. (Eds.), *Advanced Hybrid Information Precessing, ADHIP 2022, PT I.* (467-480). Editorial. https://doi.org/10.1007/978-3-031-28787-9_35

Fernández Batanero, J. M., & Colmenero Ruíz, M. J. (2016). *ICT and inclusive education: Attitude of the teachers in secondary education*. https://doi.org/10.3926/jotse.208

Guo, S. (2020). Synchronous versus asynchronous online teaching of physics during the COVID-19 pandemic. *Physics Education*, *55*(6), 065007. https://doi.org/10.1088/1361-6552/aba1c5

Horvatić, M., Mikac, M., & Mikac, V. (2022). Using data acquisition instruments and free open source software in engineering education. INTED2020 Conference. Valencia (Spain): *Proceedings of INTED2020 Conference*. https://doi.org/10.21125/inted.2020.1222

Kardum, R. B., & Vukelic, D. J. (2021). The challanges and issues on the University of Zagreb during Covid-19 crisis. Interdisciplinary description of complex systems, *19*(3), 357-365. https://doi.org/10.7906/indecs.19.3.1

Lehtola, S., & Karttunen, A. (2021). Free and open source software for computational chemistry education. *ChemRxiv*. https://doi.org/10.26434/chemrxiv-2021-hr1r0-v2

Mahakul, D. (2018). Imparting art education through free and open source software (FOSS): An experiment with secondary school students. *International Education and Research Journal* [IERJ], *4*(2), 1-3.

Mahmood, S. (2021). Instructional strategies for online teaching in COVID-19 Pandemic. *Human Behavior and Emerging Technologies*, *3*(1), 199-203. https://doi.org/10.1002/hbe2.218

Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open*, *1*, 100012. https://doi.org/10.1016/j.ijedro.2020.100012

Ngadiman, N., Sulaiman, S., Idris, N., Samingan, M., & Mohamed, H. (2021). Systematic Review on Software Quality in Educational Applications. *IEEE Access*, *9*, 60187-60200. https://doi.org/10.1109/ACCESS.2021.3072223

Raja, R., & Nagasubramani, P. C. (2018). Impact of modern technology in education. *Journal of Applied and Advanced Research*, S33–S35. https://doi.org/10.21839/jaar.2018.v3iS1.165

Ratheeswari, K. (2018). Information communication technology in education. *Journal of Applied and Advanced Research*, *3*(Suppl. 1), 45–47. https://doi.org/10.21839/jaar.2018.v3iS1.169

Roblizo Colmenero, M. J., & Cózar Gutiérrez, R. (2015). *Usos y competencias en TIC en los futuros maestros de Educación Infantil y Primaria: Hacia una alfabetización tecnológica real para docentes*. https://doi.org/10.12795/pixelbit.2015.i47.02

Seo, S., & Chul, K. (2022). Online face-to-face instructional design model for Software Education using Virtual Classroom. Journal Of The Korean Association of information Education, *26*(1),075-064. https://doi.org/10.14352/jkaie.2022.26.1.75

Singh, S., & Arya, A. (2020). A hybrid flipped-classroom approach for online teaching of biochemistry in developing countries during Covid-19 crisis. *Biochemistry and molecular biology education : a bimonthly publication of the International Union of Biochemistry and Molecular Biology*, *48*(5), 502–503. https://doi.org/10.1002/bmb.21418

United Nations Educational, Scientific and Cultural Organization, (2021). *Education and technological transformations for human-centered recovery: The Global Education Coalition in action.* https://unesdoc.unesco.org/ark:/48223/pf0000379133

Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., & Monseur, C. (2013). The use of ICT in education: A survey of schools in Europe. *European Journal of Education*, *48*(1), 11–27. https://doi.org/10.1111/ejed.12020