Design of Online Teaching Platform for Printing Color Course Based on Visualization Technology

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Abstract. Due to the unclear entity relationship logic of the traditional online teaching platform, the security of the platform is insufficient in practical application. Therefore, the design of online teaching platform for printing color course based on visualization technology is proposed. The platform architecture is designed based on B/S mode and PHP web development framework. With the support of the architecture, the database is designed to provide data support for the retrieval function of the design, meet the operation needs of users for teaching resources, and intuitively display the required teaching information to users through the designed visual page or interactive device. So far, the design of online teaching platform is completed. The experimental results show that: the designed online teaching platform of printing color course based on visualization technology has low memory leakage probability, fast response time and high fault tolerance rate, and its overall security performance is better than the traditional online teaching platform.

Keywords: Visualization technology · Printing color course · Online teaching · Information retrieval

1 Introduction

With the rapid development of computer communication technology and mobile terminal technology, the spread speed, breadth, target and efficiency of knowledge have been greatly improved, and people have more ways to learn and receive knowledge. According to relevant statistics, the number of Chinese websites and Internet penetration rate in the past three years have shown an upward trend [1]. The development of network technology has promoted the learners' learning form from a single traditional teaching to a mixed learning mode which combines classroom teaching and network learning. Traditional teaching mode can not meet the diversified learning needs of learners. In this context, web-based education, which is based on an online teaching platform with personalized, autonomous, interactive and other characteristics, has become an indispensable form of education [2, 3].

With the help of network technology, online teaching makes it easier for learners to share learning resources and to interact with each other through forums and chat rooms [4]. Because of the low cost and high profit of network teaching, many colleges

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and universities in our country have begun to use online teaching platform to carry out teaching activities. With the help of the effective online teaching platform, the high-quality digital learning resources designed and developed are pushed to students in a way that students are willing to accept, and the pace of information construction in colleges and universities is accelerated [5].

Therefore, we need to combine the characteristics of professional resources in Colleges and universities, with the help of relevant platforms, strive to build a digital resource library and build an online teaching platform. From the research at home and abroad, the construction of online teaching platform and website has entered a new stage of development, which is reflected in: the online teaching environment has formed a scale, and the functions of online teaching platform are constantly enriched and improved [6]. These online teaching platforms basically include the following systems: online teaching system, online educational administration management system and online course development system, which respectively complete the functions of web teaching implementation, web teaching management and web course development [7]. In addition, some network teaching platforms also include online teaching resource management system, which includes test database, case database, network courseware database, literature database, etc. Now many products in the market are developed from one of these aspects. After years of accumulation and expansion, they have become a comprehensive platform that can support web-based teaching delivery, teaching management and curriculum development. However, the online teaching platform developed is more for common and popular majors, and some unpopular majors are not used too much. Especially in the teaching of printing color course, in addition to the basic theoretical teaching resources, the teaching of printing color also needs intuitive visual experience, which puts forward higher requirements for the online teaching platform and the security of the platform. The teaching method of early printing color course is more based on theoretical knowledge. As a kind of design major, teachers teach the relevant content to students. With the help of information technology, multimedia technology is used to teach the course. The design of the relevant online teaching platform is only based on the mature teaching platform of other majors, There are still some restrictions on the teaching of printing color course, and many practical operations still need offline teaching. Therefore, the design of online teaching platform of printing color course based on visualization technology is proposed to solve the problems existing in the previous online teaching platform of printing color course.

2 Design of Online Teaching Platform for Printing Color Course Based on Visualization Technology

2.1 Design Platform Architecture Based on B/S Mode and PHP Web

The online teaching platform is based on the open source platform for architecture and secondary development. In order to standardize the development process and improve the development efficiency, the overall structure of the online teaching platform adopts B/S structure design, and the PHP WEB development framework of the Symfony2 Web Framework realizes the design objectives of the platform [8, 9]. The top layer does not

need to rely solely on the implementation details of the bottom layer, and changing the structure of the top layer will not affect the bottom layer, making the code more concise, thus meeting the coupling requirements of the various modules of the platform [10–15].

The View layer of the teaching platform is implemented using the Symfony2 Web Framework framework. Using the Symfony2 Web Framework template tag to implement PHP code functionality, for some complex functions can be directly used PHP tag code to achieve, and finally through the Symfony2 Web Framework template engine to convert the template to PHP files, and then through the caching mechanism to improve access efficiency; the access control layer is implemented through the Symfony2 Web Framework controller, through module mechanism and namespace to distinguish the controller of different modules; the model layer can use the model of the Symfony2 Web Framework, or can directly use the custom model to achieve. The data access layer is implemented by the ORM mechanism of Symfony2 Web Framework, which reduces the complexity of writing data access statements and improves the efficiency of development [16–18].

When the server receives the request of the user to visit the page, it first loads the global configuration file, initializes to load the core framework such as data operation, route, security and so on, schedules the controller and the action according to the route configured by YML, requests the business logic layer and the data layer to load the data, and renders the data to the HTML page, thus completing the whole process of the request operation, and then renders the data to the HTML page. The overall architecture of the online teaching platform is shown in Fig. 1.

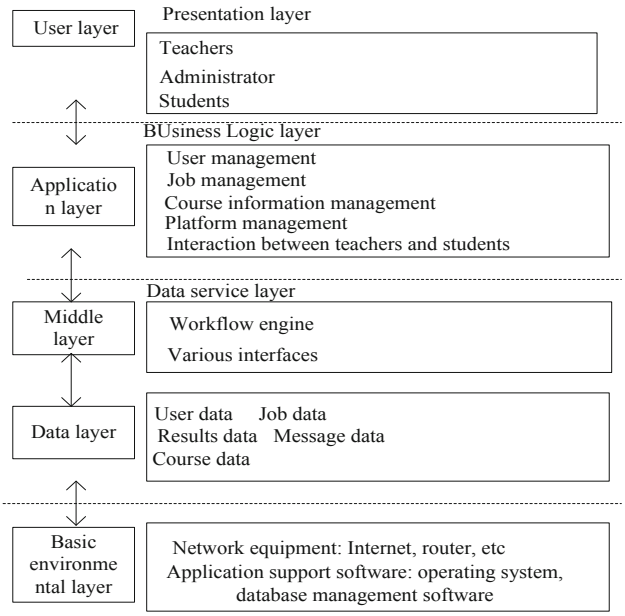

Fig. 1. Overall architecture of online teaching platform

The online teaching platform is designed with hierarchical tree structure. Its business logic layer can be divided into 5 modules: user management, course information management, teacher-student interaction, operation management and system management [19–22]. According to the actual functions of the five modules, a database supporting the operation of the platform is designed.

2.2 Design of Operational Database Based on Platform User Requirements

Design the key data tables in the database considering the interconnections between the platform users. Identify entity-attribute relationships before designing database key data tables.

The properties of an administrator include the serial number, name and password; the properties of a student user include the serial number, name, password, student number, grade, and selected course number; the properties of a teacher include the serial number, name, password, teacher number, major, course number, and uploaded video number; the properties of a course include the serial number, course name, course classification, course video, class time, teacher name, and student name; the properties of a course examination include the serial number, examination time, examination arrangement, student name, and teacher name; the properties of a student user's message after class include the serial number, student name, teacher name, question content, question time, reply content, reply time, and status; the properties of a score record include the serial number, student name, course title, teacher's score, and answer time; the properties of a course video include the serial number, video name, course title, teacher name, and video description; from the above contents, the users of the platform mainly include administrators, students and teachers, The basic user information data sheet is shown in Table 1.

Table 1. Basic information of platform users

Form serial number	Field name	Type	Length	Describe
001	A_seq	Int	8	Administrator serial number
	A_name	Char	8	Administrator name
	A_pwd	Char	8	Administrator login password
	A_id	Int	8	Primary key, unique
002	S_id	Int	8	Primary key, unique
	S_name	Char	8	Student name
	S_pwd	Char	8	Student login password
	S_seq	Int	8	Student serial number
	S_grade	Char	4	Student grade
	S_cid	Int	8	Course number selected by students in the platform
003	T_id	Int	8	Primary key, unique
	T_seq	Int	8	Teacher serial number
	T_name	Char	8	Teacher's name
	T_pwd	Char	8	Teacher login password
	T_cid	Int	8	Course number offered by teachers
	T_vid	Int	8	Course video ID uploaded by teacher

The number format in Table 1 is the standard format of database, all of which are integers. In the database, the relationship between entities is as follows: administrator manages several students, and the relationship between administrator and students is one to many; several students choose several teachers, and the relationship between students and teachers is many to many; a teacher can open several courses, and the relationship between teachers and courses is one to many; a student has several achievement records, and the relationship between students and achievement records is many It is a one to many relationship; a course examination has several students to participate in, students can participate in multiple examinations, the relationship between course examination and students is many to many; a student puts forward a message after class, a message after class is replied by a teacher, and a teacher can reply to multiple messages, the relationship between message after class and students is many to one, message after class and teacher There are many to many relationships between teachers and students; there are many to many relationships between homework and students; there are many to one relationships between homework and teachers; a course is like a course video, a teacher publishes several course videos, there are many to one relationships between course videos and courses, and there are many to one relationships between course videos and teachers. The key data table diagram of the system is shown in Fig. 2.

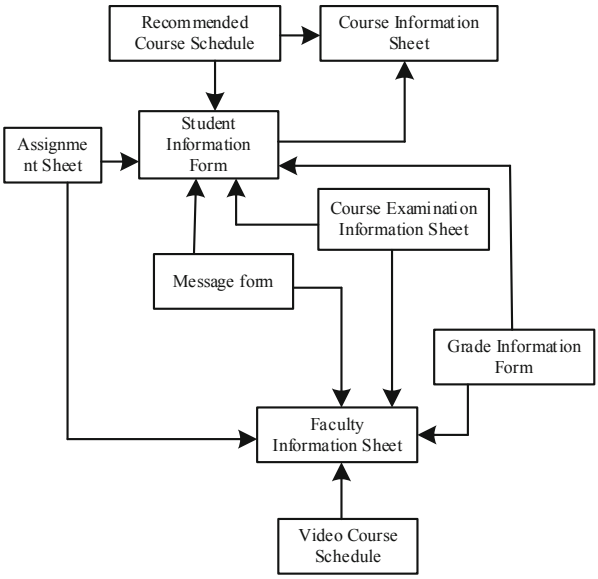

Fig. 2. Key data table diagram of database

Through the above design, the following needs can be met: users have different identities, student user information records student information, teacher information records ordinary teachers, educational administrators information and authority information; student users can register and log in, online learning, learning resources have online course information, online video information, learning progress information, a student

can choose more than one In online learning, a student corresponds to his own learning progress, and a tutorial corresponds to the learning progress of different students according to the chapter directory; in online evaluation, there are many information, such as online homework, examination question bank, performance report and so on; a student submits many assignments he has completed, and a student corresponds to an exam organized in a certain period, which has the success rate of the exam Performance report; online communication has questions (messages) and other information. A student can ask many questions.

2.3 Retrieval Function Design

The retrieval function is to facilitate users to query information, through the user's manual input of vocabulary, and the platform database vocabulary data correlation calculation, and finally present the information needed by users in the platform page.

Assuming that the user manually enters I word and J word in the database, the basic form of the similarity $\kappa(I, J)$ calculation formula is as follows:

$$\kappa(I, J) \approx \sum_{e \in I} \alpha(e, I)\alpha(e, J) \tag{1}$$

Where e represents the term, $\alpha(e, I)$ represents the weight of e in I, and $\alpha(e, J)$ represents the weight of e in J. Since vocabulary I has been determined, its weight can be ignored in calculation. The weight of e is defined as $\alpha_e = \log \frac{N}{N_e}$, and combined with the weighting function value of the term, it is brought into Formula 1 to get formula 2:

$$\kappa(I, J) = \sum_{e \in I} \alpha(si)e \log \frac{N}{N_e} \tag{2}$$

The formula $\varepsilon(si)e$ represents the weighted value of the node e corresponding to the term and the importance of the term. In order to prevent the influence of the importance of words si on the similarity calculation, log processing is done to get the basic formula of similarity calculation of information retrieval model based on weighted network.

$$\kappa(I, J) = \sum_{e \in I} \log(\alpha(si)e) \log \frac{N}{N_e} \tag{3}$$

Through the above calculation, the similarity between the manually input words and the words in the database is calculated, and the results with large similarity are displayed on the platform page.

2.4 Visual Page Design

The visualization of online teaching platform is to present the related data of printing color courses to the users of the platform. The visualization process treats the data as streaming media on the pipeline.

The visualization model is mainly used to process the fitted data and generate the geometry that can be drawn. It includes the processing object and the data object. Data objects are used to represent various types of data. Processing objects act on filters and are used to manipulate data objects and generate new data objects.

There are two basic objects in the data flow in the visualization pipeline: process objects and data objects. The data object has many data types, its parent class is a DataSet class, and the data structure has a standard format. The data types supported by visualization pipeline are structured grids, structured points, polygon data, unstructured grids and unstructured points, etc. Process objects operate on data objects using system-level algorithms for data to generate new data objects. Process objects can be divided into mapping objects (Mapper), filter objects (Filter) and source objects (Source) depending on their role.

The data for the Source object can be either known read in or obtained programmatically. The filter will process the data object through the Source object to generate a new data object. The newly generated data object enters the mapper, maps the color data to a geometric image, and then binds to the presentation object, where the user can set the properties of the presentation object (such as text, color, etc.). After setting properties such as light and camera, the renderer adds the presentation object to the renderer window to draw and display the printing object. Interactive devices provide human-computer interaction (such as scaling, rotation and text display) for demonstration objects.

3 Experimental Research on Online Teaching Platform of Printing Color Course Based on Visualization Technology

3.1 Database Parameter Settings

In the experiment, contrast experiment is the main method, which includes the visualization based online teaching platform, the spark based online teaching platform and the web based online teaching platform. The contrast experiment is based on the security performance of online teaching platform. Two groups of experiments are designed, one is the platform page operation experiment and the other is the memory leak probability experiment. In order to ensure the impartiality of the experimental results, a unified experimental configuration is set up, which is shown in Table 2.

The setting of experimental parameters is to ensure the fairness of the experiment. Different data types, different acquisition time and different interfaces will have different effects on the attribute and size of the data. For online teaching platform, the change of data size affects the internal data transmission. The larger the data, the longer the transmission time, It will also increase some unnecessary burden and certain data risk for the platform. Therefore, in order to avoid the change of data size affecting the security experimental results of the platform, the same parameters are set.

Table 2. Data acquisition field configuration table

Field name	Field description	Is it required	Remarks
Source tag specification	Source point name		Node name
Source system type	Source system type	Yes	If the node type is calculated point or manual point, select local
Source tag type	Source point type	Yes	Numerical type
Source tag attribute	Source point properties	Yes	VALUE
Source tag unites	Source point unit		If not, it will be consistent with the target unit
Collector name	Interface name	Yes	Select a specified interface name defined in RDI
Scan frerquency	Acquisition frequency	Yes	120
Scan timestamp unit	Acquisition timestamp unit		S
Tolerance, type	Tolerance, type		

The experiment is mainly carried out in the local area network, through a switch to test the connection of the experimental environment network, all the platform experiments are carried out in the local area network, try to eliminate external interference, to ensure a closed experimental environment. The experimental environment for deployment is shown in Fig. 3.

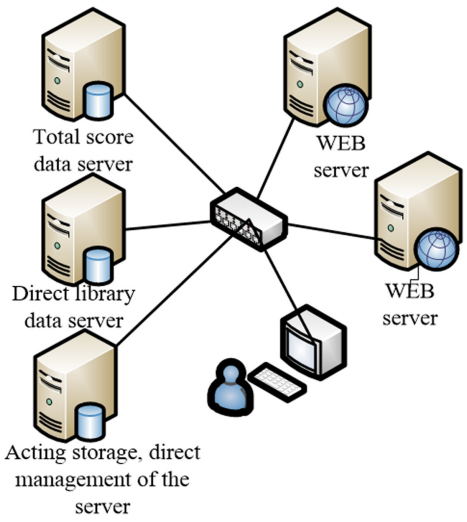

Fig. 3. Experimental environment deployment diagram.

Based on the experimental parameters in the table, the energy-saving performance of different databases is tested under the same experimental conditions.

3.2 Experimental Results and Analysis of Platform Page Operation

We set the same task for different platforms, and use external plug-ins to calculate the page response time and fault tolerance rate of different platforms. The response time of the page is based on the access time that the user can accept under the normal network. In the experiment, the limit is 2 s. The time below 2 s is the acceptable time, and the time above 2 s is the unacceptable time. The fault tolerance rate mainly determines whether the platform can recover from non serious errors by itself, and its value is between 0 and 1. The closer the value is to 1, the better the fault tolerance rate is, and the platform has a high level of performance Self recovery ability. The experimental results of the two platforms are shown in Table 3.

Table 3. Experimental results of platform response time and fault tolerance

Concurrent visits	An online teaching platform based on visualization technology is proposed		Online teaching platform based on Web		Online teaching platform based on spark	
	Response time/s	Fault tolerance	Response time	Fault tolerance	Response time	Fault tolerance
20	0.1	0.98	3.4	0.75	4.2	0.69
50	0.1	0.97	3.6	0.72	4.3	0.67
100	0.2	0.95	3.7	0.67	4.3	0.62
200	0.3	0.93	4.0	0.65	4.5	0.59
400	0.5	0.93	4.2	0.62	4.7	0.55
800	0.8	0.90	4.3	0.58	5.1	0.53
1000	1.2	0.89	4.6	0.52	5.6	0.49

Comparing the results in Table 3, we can see that with the increase of concurrent access, the response time of the platform increases and the fault tolerance rate decreases. In this case, the response time of the proposed online teaching platform is always less than 2 s, the lowest is 0.1 s, the highest is 1.2 s, and the fault tolerance rate is between 0.89 and 0.98; the response time of the web-based online management platform is up to 4.6 s, the lowest is 3.4 s, and the fault tolerance rate is between 0.52 and 0.75 with the increase of concurrent visits; the online teaching platform based on spark is between 0.52 and 0.75 with the increase of concurrent visits The maximum response time is 5.6 s, the minimum is 4.2 s, and the fault tolerance rate is between 0.49 and 0.69. To sum up, the design of online teaching platform for printing color course based on visualization technology has less response time, high fault tolerance rate, and high security performance with the increase of concurrent pressure.

3.3 Experimental Results and Analysis of Memory Leak Probability

In the experiment of memory leak probability, the leakcanary automatic test tool is used to automatically analyze the memory leak when the platform performs tasks and calculate the memory leak probability. Memory leakage refers to the wrong reference of objects in the platform, which leads to the object occupying the heap resources can not be recycled, and the memory space is seriously wasted. Serious memory leakage will lead to the internal data loss of the platform.

The leakcanary tool is used to automatically detect the internal memory leakage of the platform. The dependency library is introduced into build.gradle to initialize the global configuration. After the initialization configuration, an application named leaks is installed locally to record the log information. If the internal memory leakage is detected, the error information will be sent to the notice and recorded in the leaks. In the actual teaching process, teachers and students need to share courseware or homework and other teaching resources. The size of these shared resources is an important factor affecting the security. In order to verify the relationship between the two, the third-party security plug-in is used to verify.

The probability of memory leakage is closely related to the security of the platform, and its data accuracy is high. Therefore, the experimental results are accurate to two decimal places based on the percentage. The experimental results are shown in Table 4.

Table 4. Experimental results of memory leakage probability of different sharing platforms

Shared resource size/M	An online teaching platform based on visualization technology is proposed	Online teaching platform based on Web	Online teaching platform based on spark
500	9.93%	9.24%	0.52%
1024	19.24%	15.62%	1.26%
5012	33.69%	29.45%	2.31%
10240	41.42%	36.22%	5.62%
20480	56.35%	47.85%	9.41%

By comparing the results in Table 4, we can see that with the increase of the amount of shared resource data, the memory leakage probability of online teaching platform increases gradually. When the amount of shared resource data is the largest, the memory leakage probability of traditional online teaching platform based on Web and spark is about 50%, which is a relatively high level. The design is based on visualization technology The probability of memory leakage of the online teaching platform is low, which is in line with the actual requirements of the normal online teaching platform. Combined with the experimental results of the platform page operation, we can see that the designed online teaching platform of printing color course based on visualization technology has low memory leakage probability, stable operation of the platform page, and higher security performance.

4 Conclusion

According to the actual needs of teachers and students for online learning and teaching in printing color course teaching, this paper studies and designs an online teaching platform based on visualization technology. While realizing the basic function module of the online teaching platform, the secondary development of the teaching platform is carried out, with the addition of homework management, video recommendation and other related functions. The application of online teaching platform provides convenient teaching means for teachers, provides more abundant teaching resources for students, and meets students' personalized, diversified and interactive learning needs. At the same time, it will also promote the construction of informatization and digital campus. In order to achieve the construction of this platform, after the completion of the design, a large number of experiments were carried out to verify the feasibility and effectiveness of the online teaching platform. Of course, the platform is not perfect, there are some problems, the overall design is still rough, the function is still lacking. Due to the limitation of time and personal experience, the functions of the website, the composition and design of page elements are not fully considered, and the development tools are relatively simple. In the follow-up research, we will carry out in-depth research and development from this aspect. After further improving the teaching platform, we will put it into the printing color course teaching of university design major, and realize comprehensive online teaching from theory to practice. It can not only save human and material resources, but also greatly reduce the learning time, so that students have more time to review and practice, Improve teaching efficiency.

References

1. Wang, J., Wang, X., Yan, M.: Design and implementation of 3D visualization platform based on World Wind . Modern Electron. Tech. **43**(08), 15–18 (2020)
2. Zhou, C.: Visual teaching design of hydrolysis of salts based on IrYdium chemistry lab. Chinese J. Chem. Educ. **40**(03), 75–79 (2019)
3. Hong, D., Li, F., Yao, L., et al.: Design and implementation of a fast data visualization framework for e-learning behavior analysis. Microelectron. Comput. **35**(07), 6–12 (2018)
4. Yang, H., Zhang, Z., Yang, M., et al.: Design and development of online visualization platform for meteorological grid data. Comput. Eng. Appl. **55**(18), 207–211+255 (2019)
5. Tan, Z., Jiang, X.: Interaction design of e-learning platform based on the fogg's behavior model. Packag. Eng. **41**(04), 189–194 (2020)
6. Liu, J.: Construction of real-time interactive mode-based online course live broadcast teaching platform for physical training. Int. J. Emerg. Technol. Learn. (iJET) **13**(06), 73 (2018)
7. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)
8. Liu, S., Bai, W., Zeng, N., et al.: A fast fractal based compression for MRI images. IEEE Access **7**, 62412–62420 (2019)
9. Sun, L., Liang, Y., Wang, W.: Blended teaching design and preliminary exploration of Environmental Microbiology based on SPOC+Problem orientation. Microbiol. **46**(05), 1226–1234 (2019)
10. Xie, Y., Song, Z., Fu, J.: Design and realization of SE/AIP training simulator based on simulation platform. Comput. Simul. **37**(07), 20–22 (2020)

11. Wei, X., Gu, Q., Luo, Y., et al.: The reform of computer experiment teaching based on O2O model. Comput. Appl. Eng. Educ. **27**(1), 102–111 (2019)
12. Zhao, L., Chen, L., Liu, Q., et al.: Artificial intelligence-based platform for online teaching management systems. J. Intell. Fuzzy Syst. **37**(1), 45–51 (2019)
13. Wei, W., Durbadal, M., Ahmed, F., et al.: Research on the construction of teaching platform of drama film and television literature based on IoT. J. Intell. Fuzzy Syst. **37**(3), 3417–3424 (2019)
14. Peng, F., Hoshang, K., Balas Valentina, E., et al.: Application of deep learning and cloud data platform in college teaching quality evaluation. J. Intell. Fuzzy Syst. **39**(4), 5547–5558 (2020)
15. Wu, D., Shen, H., Lv, Z., et al.: An artificial intelligence and multimedia teaching platform based integration path of IPE and IEE in colleges and universities. J. Intell. Fuzzy Syst. **40**(2), 3767–3776 (2020)
16. Jing, L., Bo, Z., Tian, Q., et al. Network education platform in flipped classroom based on improved cloud computing and support vector machine. J. Intell. Fuzzy Syst. **39**(2), 1793–1803 (2020)
17. Karen, H., Tracie, K., Uyen, L.-J., et al.: Preparing students to be ready for practice: An innovative approach to teaching advanced physical assessment skills online. J. Am. Assoc. Nurse Pract. **31**(11), 640–647 (2019)
18. Fatani Tarah, H.: Student satisfaction with videoconferencing teaching quality during the COVID-19 pandemic. BMC Med. Educ. **20**(1), 396 (2020)
19. Leticia, R., Marco Antonio, M.A., Juvenal, R.R., et al.: Teaching challenges in COVID-19 scenery: teams platform-based student satisfaction approach. Sustainability **12**(18), 7514 (2020)
20. Murray, H., Walker, M., Dawson, J., et al.: Maggio. Teaching evidence-based medicine to medical students using wikipedia as a platform. Acad. Med. **95**(95), 382–386 (2020)
21. Xu, J., Wang, J., Wang, X., et al.: iTest: a novel online testing system based on the WeChat platform. Comput. Appl. Eng. Educ. **27**(4), 885–893 (2019)
22. Marco Antonio, Z.A., Juvenal, R.R., Leticia, R.S., et al.: Analysis of emergency remote education in COVID-19 crisis focused on the perception of the teachers. Sustainability **13**(7), 3820 (2021)