Web-Based Question Bank System using Artificial Intelligence and Natural Language Processing

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Abstract

Due to the impacts of the current pandemic COVID-19 and the continuation of studying online. There is an urgent need for an effective and efficient education platform to help with the continuity of studying online. Therefore, the question bank system (QB) is introduced. The QB system is designed as a website to create a single platform used by faculty members in universities to generate questions and store them in a bank of questions. In addition to allowing them to add two types of questions, to help the lecturer create exams and present the results of the students to them. For the implementation, two languages were combined which are PHP and Python to generate questions by using Artificial Intelligence (AI). These questions are stored in a single database, and then these questions could be viewed and included in exams smoothly and without complexity. This paper aims to help the faculty members to reduce time and efforts by using the Question Bank System by using AI and Natural Language Processing (NLP) to extract and generate questions from given text. In addition to the tools used to create this function such as NLTK and TextBlob.

Keywords:
Question Bank, Artificial Intelligence, Natural Language Processing, E-learning.

1. Introduction

Nowadays, lecturers are required to do more with less resources and time. So, the transition to online education has provided some comfort for lecturers who deal with assessing large groups of students. And opened new horizons in teaching for both lecturers and students, also introduced online education. Certain features are particularly useful in finding solutions to situations with Covid-19 pandemic, and new tools and systems have been developed within education to aid in this situation. The process of evaluating students in educational systems is essential to ensure that the required knowledge is properly transferred and to ensure that students have succeeded in acquiring it. Also helps teachers to know how they are doing the work correctly. One of these features should be in place to deliver effective solutions for lecturers. And that improves the quality of online education with a system that maintains many questions in one platform. In this paper, a "QB System" is introduced. Which can be used with any curriculum course to add multiple choices questions manually. In addition, the "Generate Questions" function generates direct questions from any English text in one platform. It also saves hours on preparing and scoring exams. That is for the lecturer, while the students can submit their exams within the specific time to get their scores.

To make the QB System more innovative in online education aspects, both generating questions and creating exams are merged to reduce the burden on the lecturers when creating exams and writing questions separately. The lecturers can create exams and view questions to select from the bank of questions on the same page.

2. Related Works

A Questions-Bank system to enhance E-Learning in school education is introduced by Farouk EI-Sofany, H., 2009. The system facilitates the generation of automatic, balanced, and different exams, containing differing types of questions, covering the whole curriculum, and displaying gradually from easiness to difficulty. The exam sheet produced by the system, takes under consideration the various levels of the from excellent, good, to fair, and avoids any mistakes of language and non-clear terminologies. The system allows the faculties to make a Questions-Bank database that stores the previous exams, the model answers, the reviews, and useful exercises for every course. And may save hours in exams and quizzes preparation and correction, also may save resources like photocopying and distributing the exams papers. The proposed system has the following functionalities and features: Knowledge evaluation - Exams generation - Exam grading - Communication- Course management. The system is very flexible and does not necessitate any programming skills from its potential users. The algorithm

Manuscript received December 5, 2022
Manuscript revised December 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.12.17

can detect the difficulty/easiness of a question based on a student's reply and adjust the difficulty value accordingly.
New e-learning software for the mathematics courses is developed by M. S. Pereira, R., 2010. Run M. S. Pereira. (2010). It's known that self-regulated learning is an activity where learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided, and restrained by their goals and the contextual features in the environment. Therefore, many universities for the time being are gradually adapting their courses to take advantage of the new technologies. One of the educational options most used nowadays is called the Web based learning. However, these platforms are not prepared to have the appropriate facilities needed in mathematics to go further in e-learning methods. For instance, Maple T.A testing evaluation and grading software is an easily used webbased system for creating tests and assignments, automatically assessing student responses and performance. To sum up, Randomization of variables on Maple T.A. allows to explore the possibilities of having different types of exercises, as well as many exercises as wanted. The use of LaTeX offers a powerful and easy way to design a homework/test that can assess students with immediate feedback. Furthermore, all the work of marking papers is not a matter for lecturers anymore. The students found that the homework assignments implemented in Maple T.A. helped them to study the course of calculus. The homework assignments implemented using Maple T.A. also helped students to achieve a best result.

Ming, Calvo., 2012. developed an intelligent automatic question generation system for academic writing support. The system called G-Asks, which generates some specific questions to help the students learn through writing. In addition to supporting the students by identifying some of the most common problems which they mostly lack and being not sufficient when writing literature reviews. It discussed some related works regarding using the NLP technique to develop some tutoring system for the purpose of academic writing support. These works vary from an automated feedback system to writing support to automated question generating system finishing by citation classification and extraction for the question by using a machine learning approach.

A system framework for an intelligent question bank system is proposed by Janpla, S., 2018. The proposed question bank system consists of five main modules. These modules vary from user management module, question management module, examination management module, evaluation management module and scoring management module. These five main modules are divided into 15 further sub models, each sub model gave a different response. The system framework for an intelligent question bank and examination system are divided into three parts: 1-The relevant persons for the question bank system, such as teachers, students, and system administrators. 2-The question bank framework which consists of the previous five main modules and the fifteen sub modules. 3-The cloud computing through applying an intelligent question bank system on cloud computing would provide many advantages. In this system the machine learning was applied to three modules: Examination, Evaluation and Question module.

Ahamed, M., 2019. proposed a question bank system launched a web-based, stable, automated paper generation questioning system that is robust to challenge paper leakage as it replaces the conventional paper generation questioning mechanism. This system includes the question bank development process and generation process of the question paper. Only the registered teachers will have the authority of addition and update in the question bank database and set the pattern, i.e., the total number of questions, chapter, and complexity level of each question. When creating a question sheet, a random one-time password is generated after each successive generation of the question sheet to ensure the security of the question that will be sent to a specified cell phone or email address.

3. Available Applications

There are many applications available for interested users to use, however, they have some features and disadvantages. A summary of disadvantages is shown in table1, moreover, a short description for each of them is listed below:

Blackboard: is an application provides an intuitive way to interact with courses, content, instructors, and other students. The Blackboard application shows only the courses where you are enrolled as a student. So, you can perform several tasks most notably: Question Bank: A Question Bank is a collection of questions that is stored for repeated use. When you select bank questions for an assessment, copies of the questions are created and added to the assessment. You can edit the copies in your assessment without concern. Other assessments are not affected. Changes you make to one instance of the question or content are not reflected in the other instances. Question Pools: On the add Question Pool page, you will browse, preview, filter, and choose questions from other assessments and question banks within the course you're currently in. You can view the questions, but you cannot make edits until you add the question pool to your assessment.
Qorrect website is a system that helps to create an exam, transfer it to the examinees through multiple platforms like computers, tablets, smartphones, or printed papers and analyze the results in a few simple steps. Moreover, they

have many services like create exam, deliver exam, analyze exam using powerful analytics to get a detailed analysis of the results, bank questions, reporting system: Powerful reporting system and instant psychometric analysis.

Kaldin is a platform provides real-time results to the students, import, and export the results from anywhere and customize the study material as per need with the help of Kaldi. The open-source assessment software is SSL safe and provides a readymade question database.
The first version of the Moodle platform was developed in 2002 by Martin Dougiamas. This platform can help lecturers to provide free courses, different types of exams and share questions among them. But the role must be created by the administrator and then given to selected lecturers to access questions. The questions sharer stores in question bank and the lecturer can add, delete, or edit questions according to the roles given to him. The platform supports different types of questions (true and false, multiple choice, Drag and drop into text, etc.) determined by the lecturer and those different students are likely to get a different selection of questions.
Quillionz creates a variety of questions about any content, including multiple-choice questions, call-up questions, and short descriptive questions. Once the questions are ready, it allows you to format and improve them as often as needed. Questions can be selected, and some edited that need some tweaking, it could also ask to suggest more. it also generates editable Notes from the content, using its AI capabilities. Highlight important parts, summarize main points, and reinforce key concepts using the Notes feature.

Table 1: Summary of disadvantages of some available applications that is used for creating a bank of questions.

Name	***Disadvantages***
Blackboard	Creating a bank for questions is complicated. Sometimes unstable.
Qorrect	Not easy to use.
Moodle	- The system may not work efficiently with large schools or universities. - If the number of users increases, the system will slow down. - There are several features that require training to use the platform.
Kaldin	- Supports English language only. - Doesn't support video option.
Quillionz	- Supports English language only. - Not all services are free to use.

4. System Architecture and Implementation

The system is independent, does not require building any specific networks, or supplying a certain party. The architecture of the QB System will be the "Client-Server" architecture. Cloud server: The database server stores information about the users, and uploads the questions based on their levels and retrieves them based on the request of the clients. Client: Could be any device can access the internet and can log in to the QB system platform, see Fig.1. The used database software is "MySQL database".

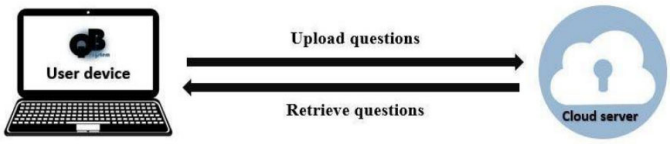


Fig1. The system architecture.

"Apache" software is used as well as the "XAMPP" software to run the localhost. The process of generating questions will be done by using Artificial Intelligence (AI).

To implement the QB System, the Web Development Languages such as PHP, MySQL, Python, HTML, CSS and JavaScript were used. In addition, many tools have helped to implement the system successfully such as XAMPP and Notepad++.

4.1. Features of the QB System

The proposed QB systems has many features to make the experiences useful and easy for lecturers and students, those features are illustrated in fig.2. These features are described in detail below:

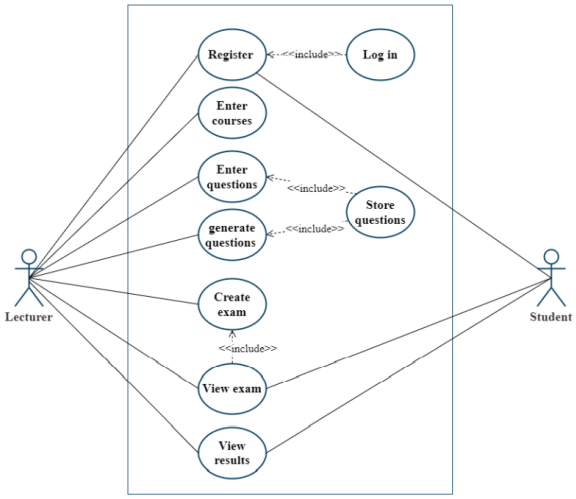


Fig2. Features of the proposed QB system.

- **Registration**: The QB System will allow the users to register into the platform.
- **Course Registration:** Lecturers can register their own courses and view them. Then save questions to the question bank and create exams for the course.
- **Enter and store questions:** Lecturers can enter "multiple choice questions" manually and save them in one platform.
- **Update questions**: Lecturers can update their questions if needed.
- **Generate questions:** Lecturers can generate a direct question automatically from text by using AI and save them.
- **Create exams:** Lecturers can create exams from the registered courses and select the questions from the saved questions.
- **View exams:** Students can view their exams and they can view their score directly after submitting the exam.

4.2. Services of the QB System

In addition to the features mentioned earlier, the proposed QB system provide more services to the users. These services are:

- **Security:** Only the registered lecturer and student can access the QB system. Also, the entered password will be encrypted, and it must contain at least 8 characters mixed of small, capital letters and numbers. The system requires captcha verification as well.
- **Performance:** The system will respond quickly in no longer than 5s and the database updated in real-time.
- **Availability**: All requires information are available when the users needed.
- **Usability:** the QB system provides easy access to assure effectiveness, efficiency, satisfaction, and ease of use.
- **Portable**: The system can be used on different operating systems such as windows and MAC.

5. The QB System's Interfaces

The QB system's home page is shown in Fig.3. The home page gives a quick detail about the system and services.

Fig.4. show adding question page, where the lecturer can add multiple-choice questions. The lecturer can only include three options in one question.

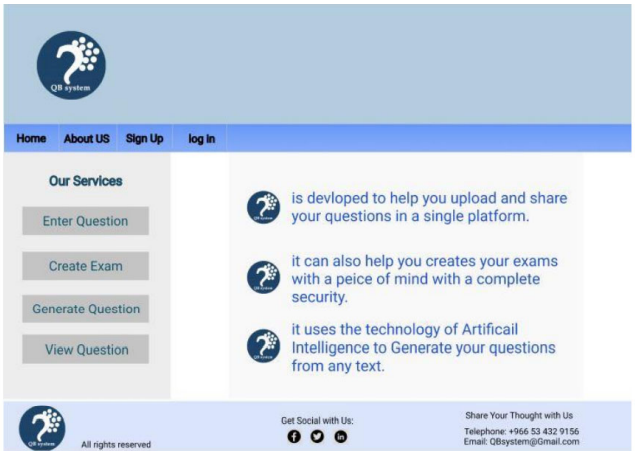


Fig3. Home Page of the proposed QB system.

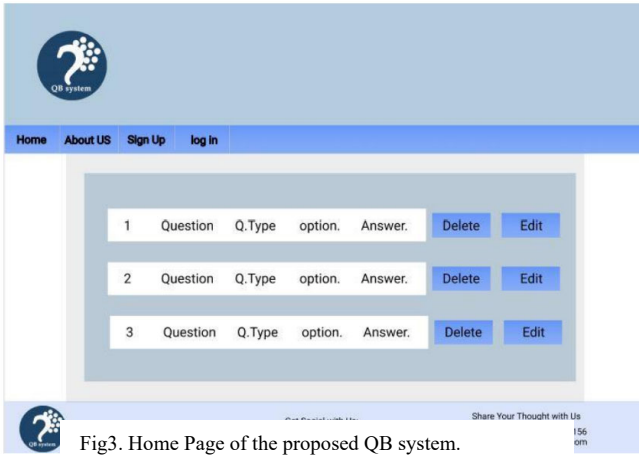


Fig4. Adding questions page. The lecturer can add multiple choice question with three answers options.

In addition, the courses registration interface is shown in Fig.5. The lecturer can add the courses he/she wants. It shows the already registered courses along with the exam and banks buttons.

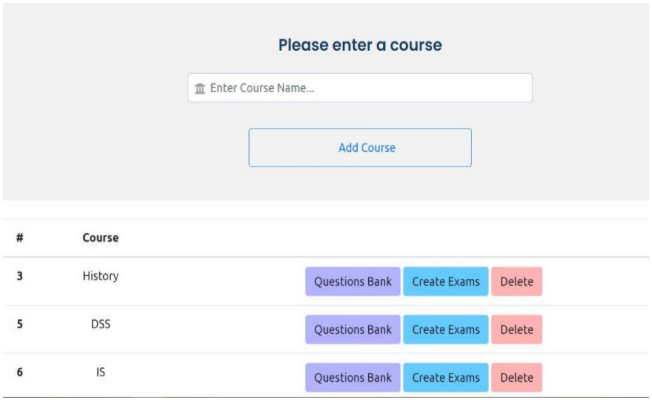


Fig5. Registering a course page. It also shows the courses entered previously and creating exams for each of them.

The exam page allows the lecturer to create exams for the selected course. After Entering the exam title, the lecturer can select specific questions or select all questions that are displayed. As well as the ability to delete the created exams, see Fig. 6. All questions are generated using AI from the course content entered by the lecturer.

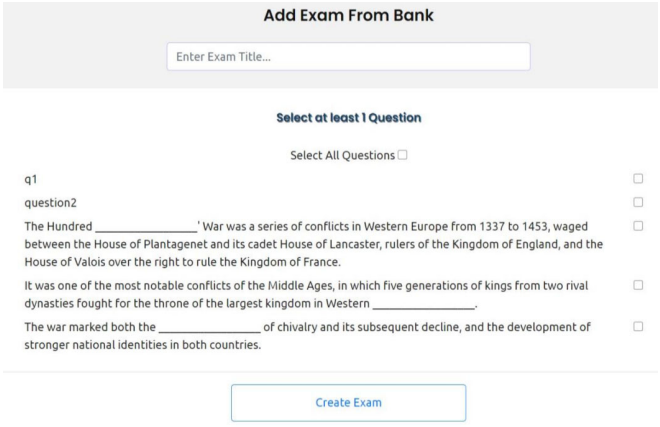
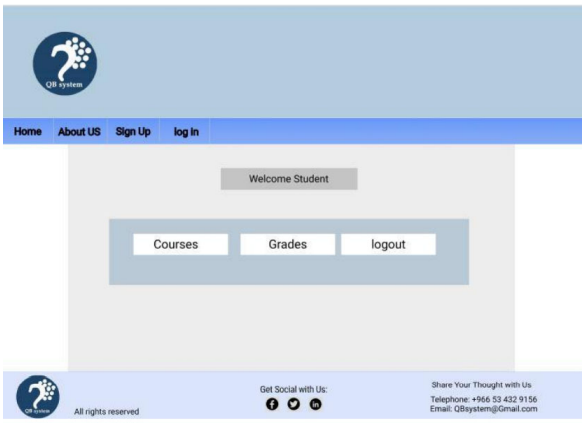


Fig6. Adding exam page. The lectures can choose the questions wanted after generating them by the system.

Fig. 7. the students page, which has three options. The students can view the registered courses and try a mock exam if available the lecturer of the course. Students can view their



6. Conclusion

A question bank (QB) system is introducing in this paper. Its web-based platform that allows the lecturers to save, update, generate questions and create an exam. For the implementation, two languages which are PHP and Python were combined to generate questions by using AI. These questions are stored in a single database, and then these questions could be viewed and included in exams smoothly and without complexity. The QB system has many features and services to help lectures and save time while creating exams for many courses and for large number of students. Thus, it minimizes the chance of cheating that happened a lot with online exams. For future work, the QB System will have more sophisticated features which can help both the lecturers and students to move more toward online education. Also, develop different versions of applications that supports IOS and Android operating systems.

References

[1] M. S. Pereira, R., 2010. New E-Learning Objects For The Mathematics Courses From Engineering Degrees: Design And Implementation Of Question Banks In Maple T.A. Using Latex. [ebook] p.9. Available at: [Accessed 3 October 2020].
[2] Farouk EI-Sofany, H., 2009. Questions-Bank System To Enhance E-Learning In School Education. [ebook] p.13. Available at: [Accessed 3 October 2020].
[3] Ahamed, M., 2019. Development Of A Web-Based Question Bank For Automated Question Paper Generation. [ebook] p.64. Available at: [Accessed 4 October 2020].

[4] M, P., 2012. WEB-BASED QUESTION BANK IN INDIAN HIGHER EDUCATION: AN OPEN EDUCATIONAL RESOURCE. [ebook] p.6. Available at: [Accessed 4 October 2020].
[5] Janpla, S., 2018. System Framework For An Intelligent Question Bank And Examination System. [ebook] p.7. Available at: [Accessed 5 October 2020].
[6] Dalziel, j., n.d. Integrating Computer Assisted Assessment With Textbooks And Question Banks: Options For Enhancing Learning. [ebook] p.10. Available at: [Accessed 5 October 2020]. [7] Blackboard.com. n.d. Blackboard Learn | Responsive & Advanced LMS System | Blackboard. [online] Available at: [Accessed 8 October 2020].
[8] Typeform. n.d. Typeform: People-Friendly Forms And Surveys. [online] Available at: [Accessed 8 October 2020].
[9] Kaldin.in. 2020. Kaldin - Open Source Web-Based Online Examination Software. [online] Available at: [Accessed 9 October 2020].
[10] Moodle.org. n.d. Moodle - Open-Source Learning Platform | Moodle.Org. [online] Available at: [Accessed 9 October 2020].
[11] El-Sofany, H.F., S.A. El-Seoud, F.F.M. Ghaleb, S.S. Daoud, J. M. AL Jaam and A.M. Hasna, 2007. XML and databases for e-learning applications. Int. J. Emerg. Technol. Learn., 2: 6-12 https://telearn.archivesouvertes.fr/hal-00197274/document
[12] Qorrectassess.com. 2017. Qorrect Assessment System | Automate Your Exam Creation EN. [online] Available at: [Accessed 10 October 2020]. [13] Calvo, R., 2012. G-Asks: An Intelligent Automatic Question Generation System for Academic Writing Support. [ebook] Available at: [Accessed 20 April 2021]. [14] El-Sofany, H., 2007. XML And Databases For E-Learning Applications. [ebook] p.13. Available at: [Accessed 4 November 2020].
[15] Al Jabri, T., 2020. Software Requirements Specification. p.23.[Accessed 2 October 2020].
[16] Al Jabri, T., 2020. Software Design. Available at: [Accessed 29 October 2020].
[17] Dumas, M. and La Rosa, M., 2018. Fundamentals Of Business Process Management. 2nd ed.
[18] Liu, B., 2020. Asking Questions the Human Way: Scalable Question-Answer Generation from Text Corpus. [ebook] p.12. Available at: [Accessed 17 April 2021].
[19] Lelkes's, A., 2021. Quiz-Style Question Generation for News Stories. [ebook] p.11. Available at: [Accessed 17 April 2021]. [20] Hendered, V. and Jönsson, A., 2020. Automatically Generate Questions for National Examinations in English Reading Comprehension. [ebook] Available at: [Accessed 17 April 2021]. [21] Gao, Y. and Chen, W., n.d. Difficulty Controllable Generation of Reading Comprehension Questions. [ebook] p.7. Available at: [Accessed 17 April 2021].
[22] Lindberg, D., 2010. AUTOMATIC QUESTION GENERATION FROM TEXT FOR SELF-DIRECTED LEARNING. [ebook] Available at: [Accessed 17 April 2021].
[23] Thinh, N., 2014. Automatic Question Generation for Educational Applications – The State of Art. [ebook] Available at: https://www.researchgate.net/publication/288371218_Automatic_Question_Generation_for_Educati onal_Applications_-_The_State_of_Art [Accessed 17 April 2021].
[24] Kumar, V., 2019. Putting the Horse Before the Cart: A Generator-Evaluator Framework for Question Generation from Text. [ebook] Available at: [Accessed 17 April 2021].
[25] Heilman, M., 2011. Automatic Factual Question Generation from Text. [ebook] Available at: https://lti.cs.cmu.edu/sites/default/files/research/thesis/2011/michael_heilman_automatic_factual_question_generation_for_reading_assessment.pdf [Accessed 17 April 2021].
[26] Clay, B., 2001. Is This a Is This a Trick Trick Question? Question? A Short Guide to Writing Effective Test Questions. [ebook] Available at: [Accessed 17 April 2021].
[27] FILP, A., 2015. THE CREATION OF "QUESTIONS BANK" AND INTRODUCTION OF 2.0. EXAMINATION SESSION. [ebook] Available at: https://yadda.icm.edu.pl/baztech/element/bwmeta1.element.baztech-46b5bcd9-c613-48ec-bfe3-02e548ace38b/c/Filip_A._Drag_P..pdf [Accessed 17 April 2021]. [28] Lumoslearning.com. 2021. Free Question Generator Tool Online - Generate Questions & Answers from Any Text | Lumos Learning QA Generator. [online] Available at: [Accessed 14 April 2021].
[29] Lovenia, H., 2018. AUTOMATIC QUESTION-ANSWER PAIRS GENERATION FROM TEXT. [ebook] Available at: [Accessed 14 April 2021].
[30] Quillionz.com. n.d. World's first AI-powered platform for creating questions, quizzes and notes. [online] Available at: [Accessed 17 April 2021].
[31] Incorporated, D., n.d. Quizbot. [online] Quizbot.com. Available at: [Accessed 17 April 2021].
[32] Maguire, J., n.d. How to Create an AI Solution. [Blog] Available at: [Accessed 17 April 2021].
[33] Goutham, R., 2020. Practical AI : Automatically Generate True or False questions from any content with OpenAI GPT2, Sentence BERT and Berkley Constituency parser. [Blog] Available at: https://medium.com/swlh/practical-ai-automatically-generate-true-or-false-questions-from-anycontent-with-openai-gpt2-9081ffe4d4c9 [Accessed 17 April 2021].
[34] Lee, K., 2021. AI-Powered Question Generator. [Blog] Available at: [Accessed 17 April 2021].
[35] Arbuzova, Y., 2018. Automatic Question Answering. [Blog] Available at: [Accessed 17 April 2021].
[36] Swalin, A., 2018. Building a Question-Answering System from Scratch— Part 1. [Blog] Available at: [Accessed 17 April 2021]. [37] GitHub. 2021. GitHub:question-generation. [online] Available at: [Accessed 17 April 2021]. [38] W3schools.com. n.d. Tryit Editor v3.6. [online] Available at: < https://www.w3schools.com/> [Accessed 17 April 2021].
[39] App.diagrams.net. n.d. Flowchart Maker & Online Diagram Software. [online] Available at: [Accessed 18 April 2021].
[40] Easy LMS. n.d. Getting started. [online] Available at: [Accessed 18 April 2021].

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