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# LMS bot: enhanced learning management systems for improved student learning experiences using robotic process automation

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**ABSTRACT**

In this paper, a workflow for bot is designed using robotic process automation (RPA) that is used to enhance learning management systems (LMS) by providing content from external sources along with educator made course content for better student learning experiences. Many students prefer to watch YouTube videos for learning, even if they have been taught the same content by an educator. YouTube is a dynamic platform where video rankings change based on viewer engagement, relevance, and newly included videos. This variability poses a challenge for educators seeking to include external videos, as the content environment within the LMS platform is unpredictable and can change significantly. The bot addresses the challenge by conducting periodic searches for related courses and topics on YouTube. It retrieves top-ranked videos based on relevance, which are then seamlessly integrated into external links within LMS. The LMS external links option enhances accessibility by offering videos sorted by popularity, ensuring students receive updated and relevant information seamlessly. The bot efficiently retrieves details of 750 videos from YouTube in just 17 seconds, showcasing its exceptional performance. Moreover, its capability to autonomously update LMS external links content weekly represents an added advantage. The bot is designed and tested using UiPath tool.

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## 1. INTRODUCTION

The internet revolution has transformed education by turning traditional classrooms into a ubiquitous, technology-driven learning environment. Educational institutions leverage computer-aided platforms for personalized e-learning experiences, intensifying global outreach, and content delivery efficiently [1]. Modern education relies on vigorous learning management systems (LMS) supporting diverse offline, online, and blended formats. LMSs replicate classroom settings through interactive websites that distribute materials and integrate tools for learner engagement with content and assessments, aiming to enhance online interaction, availability, accessibility, and flexibility [2]. LMS such as Moodle are mostly preferred due to their open-source framework, cost-free accessibility, and customizable features, making them exceptionally popular among educational institutions [3]. Current research trends in LMS, Table 1 illustrates significant findings from recent studies on LMS, with a particular emphasis on Moodle. It outlines key research areas and their implications for enhancing educational practices and learner engagement.

Importance of YouTube in e-learning, in current times, despite the availability of LMS, many students favor using YouTube as a learning platform for enhanced learning experiences [4]. YouTube is deemed essential in education due to its adaptability in accommodating various educational settings,

including large online classes [5], interactive learning environments [6], and opportunities for lifelong learning [7]. It significantly enhances engagement and motivation [8], [9], boosting student confidence and reducing anxiety of students [10], [11]. The platform hosts a diverse array of educational content such as lectures, tutorials, and practical demonstrations [12], offering flexible methods to elucidate complex subjects [9]. Additionally, its unrestricted accessibility contributes significantly to its educational utility [12], [13]. These attributes highlight YouTube's crucial role in enhancing educational practices across diverse learning contexts.

Table 1. Current research trends in LMS

| Research focus | Key findings | References |
|---|---|---|
| Enhancing Moodle's structure | Improvements in design can lead to better asynchronous learning experiences | Gedera *et al.* [14] |
| Development of learner-centered approaches | Application of Moodle's features fosters active learning environments | Iryna *et al.* [15] |
| Exploring student use of online LMS during the COVID-19 pandemic | This study highlights the complex relationship between student engagement with online learning resources and academic performance, while acknowledging its limitations and suggesting avenues for further research to deepen understanding of online learning dynamics | Liu *et al* [16] |

Identified research gaps, despite the widespread popularity of YouTube among students, several significant gaps in the current literature highlight the need for further exploration: i) integration with LMS: existing research does not sufficiently investigate how YouTube can be integrated with LMS like Moodle. Understanding this integration is essential for enhancing user experiences and improving educational outcomes; ii) difficulties in content retrieval: despite YouTube popularity, students often face challenges finding relevant materials, as they search independently, leading to inconsistent results; iii) role of automation technologies: research on applying robotic process automation (RPA) to streamline course content management and integrate external references, such as YouTube, is limited; iv) effect on learning results: although there is no current evidence to support this approach, this approach could potentially enable collaborative access to content and enhance the learning process; and v) engagement and feedback dynamics: understanding these dynamics could lead to improved content curation and greater user engagement.

Incorporating dynamic YouTube content within LMS, incorporating YouTube videos within LMS platforms, in addition to the existing course videos, offers several advantages for educators and students. Kostka and Lockwood [17] recommended that educators use a combination of educator-created and readily available videos to strengthen the educator-student relationship and provide students with varied explanations. Firstly, having course videos already embedded on LMS ensures comprehensive coverage of the curriculum, allowing students to access structured learning materials conveniently. Secondly, by integrating YouTube videos, we can introduce variety perspectives, expert opinions, and real-world examples that supplement and enhance the course content. Thirdly, readily available videos offer accessibility and flexibility to a wide range of topics and teaching methods that may not be practical for educators to produce independently. Embedding links directly into LMS activities keeps students engaged, accommodates various learning styles, and enhances the overall educational experience by minimizing distractions, minimizing excessive YouTube use [18], and saves time that would otherwise be spent searching for relevant content, ensuring students stay focused on lesson objectives.

Challenges while incorporating external content in LMS, educators encounter distinct challenges when integrating curated videos into coursework. They must navigate the varied landscape of YouTube content to select and align educational videos with course objectives and academic standards effectively. Research by Supendra and Amilia [19] underscores that some students think that educators should help them choose YouTube videos because educators are experts at this because of their extensive expertise. By carefully curating materials that are both relevant and beneficial, educators can ensure students better understand and engage with the course content. However, searching for YouTube for each individual course is impractical, so we can implement RPA to address this issue.

Role of RPA in incorporating YouTube content dynamically within LMS, these difficulties for educators emphasize the necessity for adequate assistance and training in efficiently handling LMS [20]. The growing popularity of artificial intelligence (AI) has brought about a revolutionary change in how businesses and organizations function, substituting human participation with automated processes. RPA has played a major role in facilitating this change [21]. The technology's effectiveness depends on identifying repetitive tasks and bot development which enabling autonomous task execution with less employee intervention [22]. The proposed bot is developed using UiPath [23], UiPath is RPA tool [24] used for large-scale end-to-end automation. The bot autonomously searches for, extracts, and integrates YouTube videos

relevant to each course section in LMS. It systematically gathers the title and URL of each YouTube video, seamlessly incorporating them as external links within the corresponding sections of LMS. This integration operates automatically, ensuring up-to-date content without the need for manual intervention, such as daily updates, weekly updates, monthly updates, as chosen by educator. Moreover, within the LMS system, students benefit from streamlined access to valuable content, saving time and enhancing efficiency. The developed system includes a feature where students can like and comment on integrated YouTube videos, fostering a community-driven approach. Peer influence, particularly through word of mouth and shared enjoyment, plays an important role in driving students intention to continue using a YouTube-like e-learning system [25]. Based on user interactions, the most favored YouTube video for each course section rises to prominence, ensuring that students discover and engage with the most pertinent and highly rated content. As YouTube prioritizes videos based on popularity, relevance to user interests, and viewing history [26] rather than on their educational quality, adopting a community-driven approach allows us to address these challenges within our system.

Additionally, to support educator engagement, the developed system introduces a feedback mechanism where educators can provide comments and rate top videos based on their relevance and quality. Educators, where there is no possibility to view all videos, can prioritize viewing the top-rated video, as determined by student likes. They then assign ratings such as poor, average, good, or excellent, adding valuable insights to the platform. This process not only enriches the experience by aligning content with student's preferences but also empowers educators to make informed decisions efficiently. YouTube's video library is constantly expanding with a steady stream of new content being added every day, the bot is made to create or update data in the system automatically. The bot's correct operation has been verified by testing on LMS. By ensuring that automation operates consistently across many circumstances, this type of testing eventually produces a more robust solution. Table 2 showcases the extensive research currently being conducted on RPA, highlighting its growing importance across various sectors. Given these insights, we have chosen to focus on RPA for our novel approach, aiming to explore its potential further and contribute to the advancement of automation technology.

Table 2. RPA research insights

| research focus | key findings | References |
|---|---|---|
| RPA and AI integration | This research explores how the fusion of RPA and AI is redefining ERP-related operations, improving optimization, user interface, and comprehensive process intelligence in the industry 4.0. | Ribeiro *et al.* [27] |
| RPA in educational settings | This research highlights how RPA bots can support educators by evaluating teaching effectiveness and identifying areas where instructors may need additional training, while also considering the possible difficulties if some subjects are taught by robots. | Khan *et al.* [28] |
| Automation in student management | The study presents the application of RPA in automating tasks within an ERP-driven student management system, enabling educators and administrators to streamline notifications, assignments, and class schedules. | Gajra *et al.* [29] |
| Overview of RPA research | An in-depth examination of the RPA research landscape, identifying key themes and comparing RPA to related technologies while proposing strategies for better adoption and integration. | Wewerka and Reichert [30] |
| Bot for email management | This study introduces a bot designed to efficiently manage emails by sorting, labeling, and organizing messages, thus enhancing communication flow and task efficiency. | Khare *et al.* [31] |

The rest of the paper is organized as follows: the suggested novel method is presented in section 2. The results are discussed in section 3. Section 4 concludes the paper and provides directions for future research.

## 2. PROPOSED METHOD

Figure 1 illustrates the design of the proposed bot and the order in which it performs various tasks within LMS. The bot is developed using the UiPath tool on the Windows operating system, leveraging its capabilities in automating tasks at scale. UiPath serves as an RPA platform, offering enterprise solutions to streamline repetitive office tasks and support fast business transformation. Additionally, Python, HTML, and CSS coding logics are integrated, enhancing their functionalities and enabling robust automation across various processes.

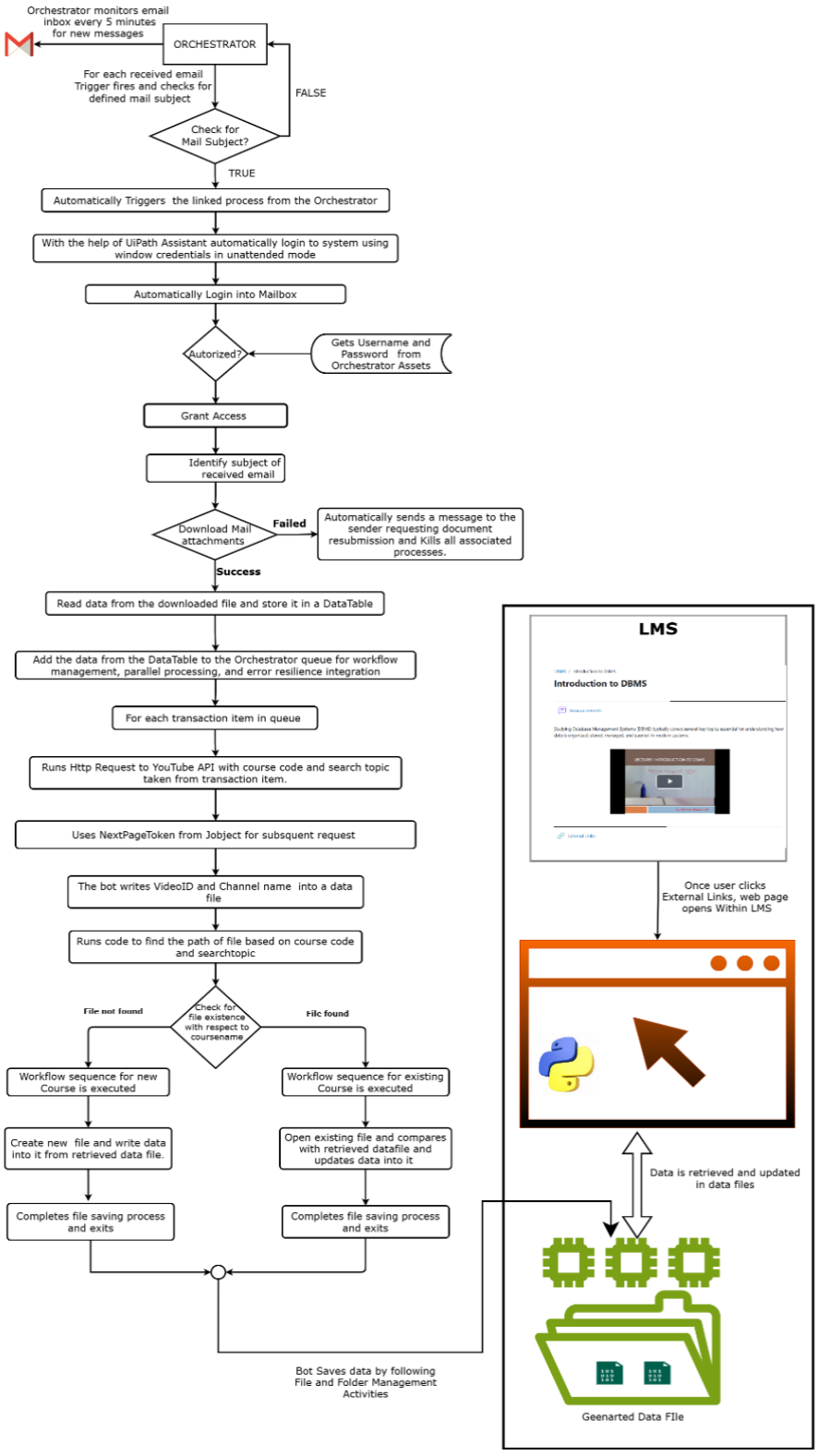


Figure 1. System design of proposed LMS bot

### 2.1. Conditional bot activation

Whenever a new course is created by the educator in LMS, he sends mail with attachment containing course name, courseID, search topics, and topicID to the given official mailID for enabling external links with respect to the course. Once the mail with desired subject line appears orchestrator triggers

a process automatically without manual intervention creates course related content, and next schedules task that can occur weekly, monthly, or as determined by the educator to update course related content. A process in UiPath specifies the automated workflow that a bot will carry out in a certain machine environment. The bot's main task is to utilize the user's Windows login credentials to access the user's computer [32], however providing assets directly is not a legitimate approach. UiPath uses the robotic enterprise framework (REFramework), which states that private data, such as application programming interface (API) keys or passwords, including those for Google accounts, shouldn't be directly included into workflows. It is advised to manage credentials securely by using techniques like orchestrator assets or configuration files.

### 2.1.1. Email API activity

The bot will log in to the system on the machine using windows credentials sourced from orchestrator assets. This action is performed by the UiPath assistant installed on the machine. Once UiPath assistant grants authorization on the system, the bot will then use API integration activities to automatically log in to the email. UiPath offers a variety of email activities, including Outlook, Exchange, post office protocol version 3 (POP3), internet message access protocol (IMAP), and simple mail transfer protocol (SMTP). In UiPath, the process of connecting to email and downloading files starts with setting up and configuring the "GetIMAPMailMessages" activity. Then bot identifies the useful attachments (i.e., course name, courseID, search topic, and topic code), if any attachment is not downloadable or if the attachment doesn’t meet the required format, an auto-reply is sent to the sender requesting that they resend the document in the correct format. Once bot download files, it initiates the UiPath hypertext transfer protocol (HTTP) request activity. This activity enables communication with various web services by sending HTTP request activity and receiving corresponding responses. It supports various HTTP methods such as GET, POST, PUT, DELETE, and allows customization of headers, parameters, and authentication methods to ensure seamless data exchange between different systems and services. Integrating this activity into workflows enhances automation capabilities by facilitating real-time data retrieval and interaction with web-based platforms efficiently.

### 2.1.2. YouTube API activity

Integrating the YouTube API involves first registering the project on Google Cloud platform and enabling the YouTube data API v3, which grants access to YouTube's extensive database. Upon receiving an API key for authentication, we can begin leveraging a variety of essential parameters to tailor their queries. Parameters such as ‘q’ for search queries, ‘part’ to specify resource properties, ‘type’ to filter results by content type, ‘MaxResults’ to limit the number of items returned, ‘order’ to sort results, and ‘videoEmbeddable’ to include only embeddable videos, empower developers to fine-tune API requests. These parameters enable precise retrieval and manipulation of YouTube data. The bot initiates YouTube search through an HTTP request activity with configured parameters and obtains a JavaScript object notation (JSON) response as shown in Figure 2. The output which is in JSON format from HTTP request is stored in a string variable “Str_httpOutput”.

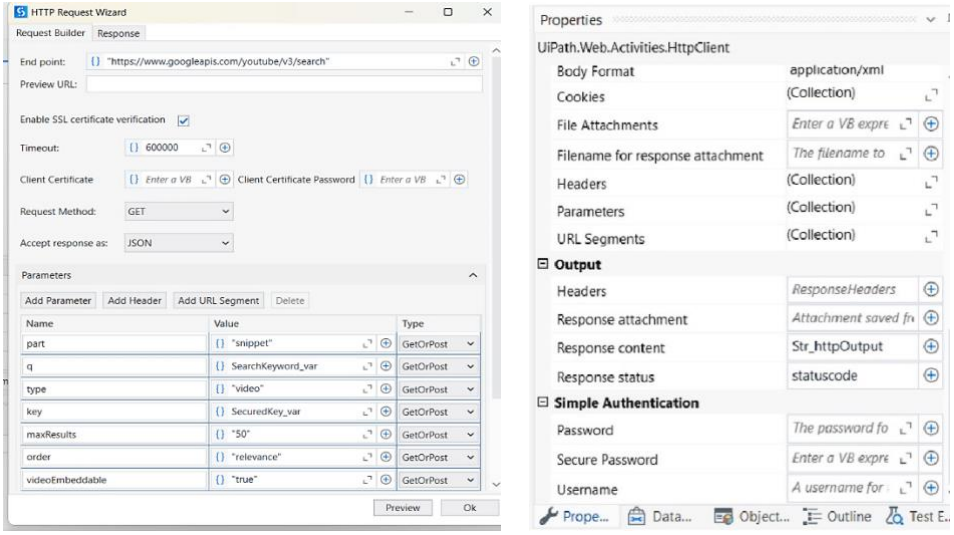


Figure 2. HTTP request Wizard with properties window for YouTube search

To process the JSON data, UiPath utilizes a deserialization activity as shown in Figure 3 to convert the string into a usable JSON format variable “jsObject”. Activities like “Deserialize JSON” converts JSON string into a JObject type. The JSON format result contains comprehensive data retrieved from YouTube, encompassing 50 responses arranged according to the "order" parameter.

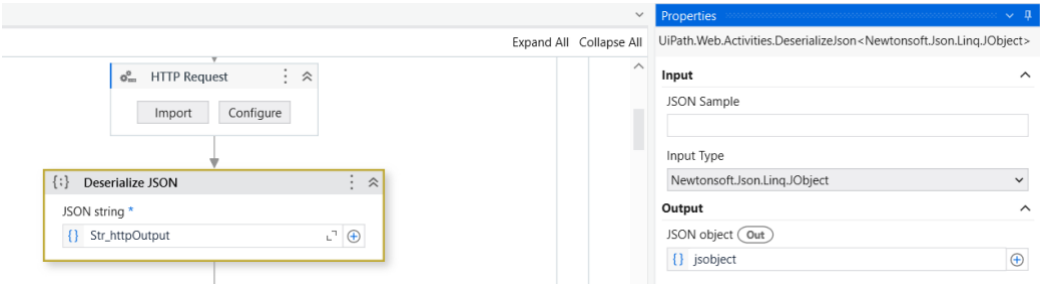


Figure 3. Deserialize JSON activity to convert string to JSON format

This parameter dictates the sequence in which the results are presented, based on criteria such as relevance, date, view count, and rating. To retrieve the next set of 50 results according to our needs, we iterate by using the appropriate parameters in our API request, such as "pageToken" and "nextPageToken" in the YouTube data API. These tokens allow us to navigate through paginated results, ensuring we can sequentially fetch additional batches of data beyond the initial set of 50 responses. This iterative process enables us to manage and expand our dataset according to specified requirements. Once parsed, the values of the “videoid” and “channel name” are extracted from the JSON object, providing a concise list of unique identifiers corresponding to each video and channel name in the response dataset. Values of the “videoid” and “channel name” are extracted from a JSON object. Subsequently, the “build data table” activity was employed to construct a data table. Using the “add data row” activity, values “videoid” and “channel name” were inserted into this data table.

### 2.1.3. Data update process

After collecting responses iteratively through multiple HTTP requests, the data was sequentially written into a datatable. Once all HTTP requests were processed, the information stored in the datatable was then exported to an Excel file using the “Excel write range” function. With UiPath's robust Excel management capabilities, we can seamlessly interact with Excel files and incorporate Excel-related tasks into automation workflows. These features are valuable within various business processes for reporting, data processing, analysis, and other Excel-dependent operations. In order to detect faults or handle any follow-up actions during processing, UiPath additionally makes advantage of exception handling. Additionally, UiPath has a retries mechanism for any activity failure since slow network conditions might cause activities to take longer to locate the targets. The bot will either update an existing excel file for a course that has already been created or generate a new one for a newly added course. The bot uses activities like “file exists” to check if the file already exists. The bot is designed to search for file based on file and folder management activities. When a matching file is found, it updates “videoid” and “channel name”. It chooses rows of videoid’s to replace based on having ‘0’ likes or “poor” review from educator. When a matching file is not found all “videoid” and “channel name” are written into Excel file and saved based on file and folder management for subsequent requests.

## 2.2. Displaying data in LMS

The developed system utilizes Flask for its web framework, SQLite3 for database operations, and the comma separated values (CSV) module for initial data loading. Frontend styling and functionality are enhanced using Bootstrap and jQuery. These packages collectively enable the application to manage video data, handle user interactions such as liking, commenting, and decision-making, and provide a responsive user interface.

## 3. RESULTS AND DISCUSSION

The machine running Windows 10 with a 64-bit Intel(R) Core(TM) i5-8250U CPU at 1.60 GHz and 8 GB of RAM has UiPath version-2023.8.0 (Community edition) installed. This testing aims to show that the bot is operating correctly with all of the designated features.

Faculty were requested to create new course in Moodle LMS and asked to keep external links and configure developed bot with course name, courseID, topic name, and topicID. Once bot is configured at initial, it will do all activities for subsequent requests without manual intervention. The orchestrator triggers a process automatically without manual intervention, based on a scheduled task that can occur weekly, monthly, or as determined by the educator to update course related content. The bot logs into the machine of the educator and starts extracting videoids and channel names into excel based on topic name which is retrieved upon clicking external links option in LMS.

Figure 4 showing students of the LMS are provided with wide selection of 150 videos to explore their knowledge for better learning experiences. They can watch videos of their choice, express their preferences by liking and commenting based on their viewing experience. Additionally, students can benefit from educator reviews to help them decide on videos. They can also see which videos are liked by their friends, making it easier to discover content that aligns with their peers' preferences. This personalized approach ensures students make informed choices and enjoy a tailored viewing experience. Students always get updated content from YouTube, as bot replaces videos with least likes and poor educator reviews periodically showing great learning experience for students.

Figure 5 illustrates how educators recommend videos to students by providing reviews in external links. With limited time available, they rely on user interactions such as likes and comments to identify the most popular videos. The ability to see the top-ranked video allows educators to quickly gauge which content resonates the most with students. This streamlined process enables educators to provide informed opinions and feedback effectively, ensuring that they can contribute valuable insights without the need to individually review all 150 videos. The following are the results are presented to show how performance evaluation effectively measures bot performance efficiency and cyclomatic complexity assures code maintainability and identifies potential risks.

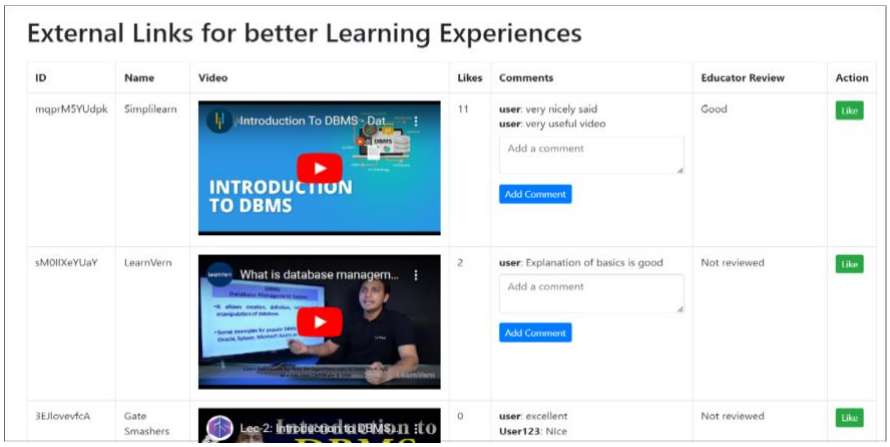


Figure 4. Students choosing videos based on educator review and community driven preferences

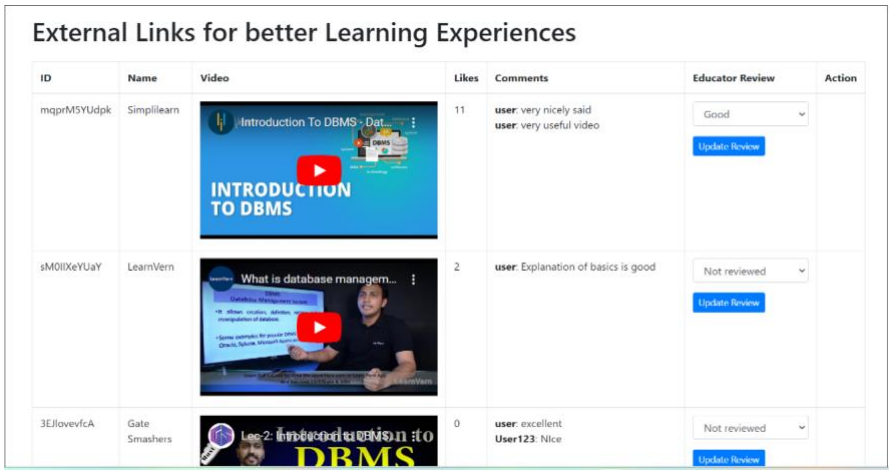


Figure 5. Educator giving reviews based on most liked video which comes on top

### 3.1. Performance evaluation

The following are some quality-of-service metrics used to gauge how well the LMS enhanced bot works: i) efficiency: the percentage of worthwhile work completed by the bot; ii) time consumption: processing and throughput time of the bot; iii) accuracy: a precise assessment of the bot's effectiveness; and iv) precision: the precision metric shows how exact or accurate the bot's model is.

To assess the performance evaluation of the system, a LMS for database management systems course has been developed in Moodle with a link to external sources in addition to educator made course content, as shown in Figure 6. Developing such LMS is compared using two cases.

a) Case I-carrying out tasks manually (i.e.: without using the bot): as a case study asked Faculty of Telangana University, India to develop LMS with external links to YouTube videos. They have taken lot of time for extracting videoids, channel names from YouTube application and copying them into excel one by one. They have taken nearly 70 seconds per video.
b) Case II-automating processes with the bot (i.e.: automation): in case II, the bot performs the process without human involvement. Once educator triggers bot, bot automatically extracts videoids, channel names from YouTube application and saves data into excel sheets accordingly. The automated technique works much more effectively than a manual process and requires less human participation to complete tasks.

- Efficiency: regarding case I, human work presents several difficulties, including mistakes, inconsistencies, and emotional impacts, which highlight the drawbacks of depending only on human effort. YouTube is a platform which always grow by adding the new content and rating of a video in YouTube applications will always change. In such situation updating videos by rating periodically will become a cumbersome activity. On the other hand, in case II, the effectiveness of the created bots highlights the major benefits of automation with the potential for periodic updates.
- Time consumption: in case I, it has been noted that more manual labor is required when automation is not there, which results in a higher time consumption. In comparison with case I, which does not use RPA, case II takes a far shorter amount of time. There are certain factors like the number of topics and the extent of the content should present in external links (no of videos) will determine how much time will be taken for performing the task in both cases. As can be seen in Figure 7, the bot took 17 seconds to scrape and save the findings of 750 YouTube videos into an Excel file. It also managed folders and created material for external links. In contrast, human took 70 seconds for each video, resulting in a total of nearly 2 hours 50 minutes to extract 150 videoids approximately.
- Accuracy: the number of videoids and channel names that are suitably scarped from YouTube in the specific Excel file for each topic determines the accuracy level. Because of their misconceptions, humans may make mistakes when doing jobs like reading file content, entering or copying material into YouTube, and putting data into a precise file. This reduces the process's accuracy in case I. The accuracy of reading material and storing data into an Excel file while working on the RPA is substantially higher when done by a bot (i.e.: case II).
- Precision: the bot regularly completes tasks with minor errors or deviations from the intended result. It implies that the bot's programming, algorithm, or decision-making procedures are well-tuned and successful in accomplishing the desired goals.

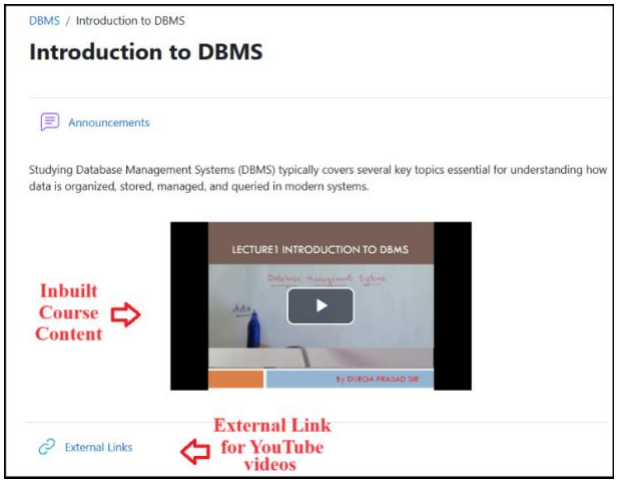


Figure 6. Developed LMS in Moodle with external links option

```
07/05/2024 22:22:34 => [Debug] Execution started for file: Main
07/05/2024 22:22:34 => [Info] Enhanced LMS Bot execution started
07/05/2024 22:22:37 => [Debug] 200
07/05/2024 22:22:37 => [Info] Audit: Using Excel File: D:\CC-1211\DBMS.xlsx
07/05/2024 22:22:39 => [Info] Bot Successfully Extracted VideoId and channel name  for the topic
07/05/2024 22:22:41 => [Debug] 200
07/05/2024 22:22:41 => [Info] Audit: Using Excel File: D:\CC-1211\DBMS.xlsx
07/05/2024 22:22:42 => [Info] Bot Successfully Extracted VideoId and channel name  for the topic
07/05/2024 22:22:44 => [Debug] 200
07/05/2024 22:22:44 => [Info] Audit: Using Excel File: D:\CC-1211\DBMS.xlsx
07/05/2024 22:22:45 => [Info] Bot Successfully Extracted VideoId and channel name  for the topic
07/05/2024 22:22:47 => [Debug] 200
07/05/2024 22:22:47 => [Info] Audit: Using Excel File: D:\CC-1211\DBMS.xlsx
07/05/2024 22:22:48 => [Info] Bot Successfully Extracted VideoId and channel name  for the topic
07/05/2024 22:22:51 => [Debug] 200
07/05/2024 22:22:51 => [Info] Audit: Using Excel File: D:\CC-1211\DBMS.xlsx
07/05/2024 22:22:51 => [Info] Bot Successfully Extracted VideoId and channel name  for the topic
07/05/2024 22:22:51 => [Info] Enhanced LMS Bot execution ended in: 00:00:17
```

Figure 7. Exported log of enhanced LMS bot

### 3.2. Computational complexity

Computational complexity in the context of UiPath RPA usually relates to how well the bots carry out automation tasks. It includes things like how long it takes the bot to do a task, how well it handles errors, how scalable the automation solution is, and how well it manages bigger datasets. It's crucial to remember that the computational complexity of UiPath RPA bots cannot be directly assessed using conventional computational analysis techniques like Big O notation. Figure 7 makes it evident that the bot took 17 seconds to manage folders, create external link material, and scrape and save the findings of 750 YouTube videos into an Excel file. After being put into use and evaluated on various test cases, the bot reliably and efficiently carries out the assigned functionality. It constantly works in the range of 17 to 23 seconds, exhibiting effective performance.

## 4. CONCLUSION AND FUTURE WORK

This paper deals with the automation of external content references for LMS. Automation reduces the burden on educators in maintaining links to external content accompanied with inbuilt course content for better student learning experiences. The well-defined capabilities of the bot provide educators a high degree of comfort. Testing and workflow execution have been conducted on many test courses, and the results show that the bot works as intended. In the future, the bot can grow better at managing a greater variety of jobs and adjusting to various user demands through ongoing learning and development. Key future approaches for improving RPA systems include optimizing RPA bots, especially in tackling the issue of frequent API interface changes, and utilizing machine learning and AI techniques to increase platform capabilities.

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## AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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| Nandini Balusu | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | ✓ | | ✓ | ✓ | |

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

## CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

## DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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