Enhancing Informal Education with Robotic Process Automation: A Method for Automating Course Search on E-Learning Platforms

Jelena Nakić, and Dora Boban

Original scientific article

***Abstract*—Robotic Process Automation (RPA) is a cutting-edge technology that empowers software robots to perform repetitive digital tasks based on predefined rules. Traditionally, these tasks are carried out by humans interacting with various software applications through mouse and keyboard actions. RPA robots excel at emulating human actions with exceptional precision, speed, and consistency. RPA has gained widespread popularity across industries for its capacity to streamline business processes, increase productivity, and reduce operational costs. In educational settings, RPA is becoming an integral part of broader digital transformations. The related work discussed in this paper highlights that RPA is commonly utilized to automate administrative tasks for university staff, teachers, and occasionally students, while its potential applications in the learning process remain largely unexplored. Addressing this research gap, we introduce an innovative approach to leverage RPA in informal learning. Our method focuses on automating the course search process on e-learning platforms. The proposed algorithm includes interaction with platform interface, extraction of essential course details, storing retrieved data, and generating structured reports, all while communicating with various systems. Subsequently, we present a solution developed based on this approach, along with its outcomes, evaluation, and discussion of findings.**

***Index terms*—automation, data retrieval, education, e-learning, Robotic Process Automation, RPA, web scrapping.**

I. Introduction

In recent years, there has been a rapid increase in the significance of digital technologies in achieving organizational business objectives. The utilization of advanced digital technologies is reshaping the business models, products, processes, and organizational structures of companies. Such transformative changes are referred to as digital transformation and they are revolutionizing not only individual enterprises but entire industries as well [1, 2].

One of the prominent pathways of automation within the field of computer science has become service automation, specifically the direction of business process robotics [3, 4].

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This kind of robotics should be understood in a broader sense, as the automation of business processes through extensive utilization of robots. A robot is a software that replaces humans in certain activities with the goal of enhancing efficiency, revenue, quality, and employee satisfaction, while also contributing to cost reduction [3,5,6]. This shift towards a virtual workforce releases workers from repetitive tasks and allows them to allocate their time and efforts to more value-driven activities.

By combining some of the automation technologies, such as RPA, with other advanced technologies of the Industry 4.0, such as machine learning (ML) and other AI elements, today's businesses are becoming an integral part of the digital era [1, 2, 7]. Among many technologies that drive the digital transformation of businesses, RPA is considered a disruptive solution as it penetrates the core operations of a company [3]. However, the technology is non-invasive [8] and the benefits of implementation are significant. Case studies commonly report improved efficiency, reduction of full-time equivalent, constant availability and agility, while the retrieved data are complete, accurate, and consistent [2, 8, 9]. Another reason may be to ensure business continuity, for instance, during unexpected crises like the COVID-19 pandemic [10].

However, the implementation of RPA in educational environments is still in its early stages [2, 9]. In this work, we present a literature review on RPA in education, which highlights the existing research gap. Building upon this, we propose an innovative approach for automating the process of searching for courses on the internet. The automation of processes typically arises not from a problem, but from identified opportunities. The goal of our proposed approach is to ease the search for publicly available courses on the internet and empower users to make informed selection of learning resources. This method has been specifically designed to be adaptable across various e-learning platforms, providing a versatile solution for efficiently and effectively discovering specific courses. This research significantly enriches the understanding of RPA in education, contributing through both a novel literature review featuring the most recent publications and the original proposal for introduction of RPA into informal learning.

The paper is structured as follows. First, we introduce the definition and significance of RPA and review related work (Section II), with a specific focus on its recent application in the educational domain (Section III). In Section IV, we detail our proposed method, present a proof-of-concept solution. The evaluation of the solution performance is elaborated in Section V. In the discussion section, we highlight implications of our approach and discuss its limitations. Finally, in the concluding section, we summarize our findings, provide practice recommendations, and outline directions for further research.

II. Background and Related Work

We begin with the definition of RPA and its significance as reported in the literature. We then identify crucial factors for successful automation based on related works. Subsequently, this section offers a brief overview of the current state of RPA implementation across various sectors, with a specific focus on its application in the educational sector.

A. Definition and Significance of RPA

RPA encompasses a range of complementary definitions that vary based on the breadth of perspective within this field [2,8]. IEEE defines RPA as "a preconfigured software instance that uses business rules and predefined activity choreography to complete the autonomous execution of a combination of processes, activities, transactions, and tasks in one or more unrelated software systems to deliver a result or service with human exception management" [4]. In other words, RPA is a technology that enables the execution of repetitive digital tasks based on predefined rules. These tasks, traditionally carried out by humans through user interfaces using a mouse and keyboard, are now performed by software robots. These robots emulate user actions on computers, understand content across various forms, execute designated commands, communicate with other systems, and identify as well as retrieve data. They operate with greater efficiency and speed, requiring little to no supervision from humans [2, 3]. Higher-level objectives encompass business optimization, cost reduction, production enhancement, and easing the burden of errors on employees [11, 12]. Routine tasks are standardized and entrusted to automation technology, allowing humans to engage in higher-value tasks.

B. Success and Sustainability of RPA

While the advantages of integrating RPA into businesses are widely acknowledged, it's important to note that not all processes can be automated. In fact, many authors agree that the basis of successful automation lies in the thoughtful selection of a suitable process [2, 8, 13, 14]. Moreover, a misjudged process selection can often yield more adverse outcomes than benefits and such instances run counter to the fundamental philosophy of RPA [15].

In general, every standardized, repetitive process that consistently follows predefined rules and involves human-computer interaction holds the promise of automation. In the existing body of literature, specific criteria have been identified to assess the suitability of a process for integration into RPA framework and to assist in identifying processes to novel strategies are still proposing [14]. The most prominent suitability criteria are constituted by routine, manual, repetitive tasks with high frequency of execution [1, 2, 11, 15, 16, 17], along with massive processes, also known as high-volume processes, which refer to operations performed relatively frequently on substantial tasks [1, 11, 15, 17, 18,]. Processes should be highly standardized, clearly and precisely defined with no exceptions to handle [2, 8, 12, 16, 17]. Simplicity of the process, low cognitive demands, and the presence of more or less straightforward repetitive tasks are also important. RPA struggles or cannot handle complex processes that combine a multitude of different and intricate tasks, especially those requiring human decision-making during execution [1, 2, 15, 16, 17, 18].

Processes with a high likelihood of human error are also prime candidates for automation, as robots make significantly fewer mistakes than humans [3, 11, 16, 18].

Processes can involve multiple different systems in interaction [8, 17, Moreira], which is particularly applicable to stable systems that do not change frequently, thus ensuring that the robot interacting with the interface encounters fewer exceptions and errors [2, 8].

From a technical perspective, processes should be digitized and utilize software applications on a user's computer or server, where inputs and outputs, as well as data format and quality, are standardized; examples include Excel, email, PowerPoint, PDF, and similar formats [8, 11, 15, 18].

Apart from selecting the appropriate process for automation, the project's success is significantly influenced by the successful alignment of the RPA initiative with the organization's strategic goals and the adept management of resulting changes [5, 13]. Additional challenges of RPA implementation include dealing with human aspects and mistrust in RPA along with the assessment of digital readiness [2]. To overcome these barriers, literature suggests developing RPA adoption guidelines and definition of metrics for measuring the achieved benefits [8].

Bringing RPA into a business usually does not follow a simple or direct path; instead, it requires a substantial number of decisions. Managers should carefully assess technology integration, considering disruption impact and other possible challenges [19]. To assist managers in making informed choices, [Asatiani et al] have developed a decision checklist for managers, along with additional recommendations, to aid in analyzing conditions and making well-informed decisions regarding RPA implementation. These decisions are related to three main issues: the human resources responsible for RPA development (internal or external resources), the deployment method (local or cloud-based), and the technology itself (open-source or proprietary solution).

Ylä-Kujala et al. [20] introduce a systematic step-by-step method for evaluating RPA and provide a practical business case to demonstrate its application. This method enables organizations to quantify the costs and benefits of RPA, facilitating decision-making regarding automation adoption.

Considerable attention in literature is paid to sustainability in the implementation of RPA. Innovations enhance technological processes and contribute to sustainability [19, 21]. For instance, within the domain of supply chains, automated sustainable business processes improve production levels, bolster supply chain resilience, and foster a company's competitiveness [22]. In accounting sector, Zhang et al. [23] identified system sustainability as one of the crucial factors that contribute to RPA adoption. Patrício et al. [5] investigate into the theme of sustainable RPA implementation and its evaluation across environmental, social, and economic dimensions. Through literature analysis, they ascertain that existing models predominantly assess decision-making from an economic viewpoint, with somewhat lesser emphasis on the social perspective, and identify a lack of studies that evaluate the technology's environmental sustainability. They stress the importance to integrate all three pillars of sustainability into the implementation and evaluation of RPA solutions.

C. Application Areas

RPA finds applications across a diverse spectrum of domains, automating numerous processes. According to analyzed literature, it is predominantly used in the manufacturing industry [13, 21, 22, 24, 25], financial sector [1, 11, 16, 24, 25, 26], and accounting [1, 11, 25, 19, 8, 23, 25, 27]. Following closely are the healthcare [24, 25, 26], insurance [1, 11, 18, 24, 25, 26], public administration [1, 11, 25], human resources management [1, 8, 11, 18, 24, 25], automotive industry [25, 28], and telecommunications [1, 11, 25]. Additionally, there are few applications the IT sector [1, 8, 18], e-commerce [24, 25], tourism [25], and the military [25]. The application in the education sector is moderately frequent when compared to other domains. However, given that this is closely related to the focus of this study, we have explored it in more detail.

III. RPA IN EDUCATIONAL SETTINGS

RPA is one of the prominent technology trends being introduced in educational environments as part of the overall digital transformation of systems.

Within higher education, RPA is primarily used for administrative functions such as scheduling, data entry, and record maintenance [2, 29, 30]. Oluçoğlu [31] described the utilization of RPA for managing student and staff tasks associated with back-office functions and reported substantially reduced time required for completion of automating repetitive tasks (96,9% compared with manual execution). Gajra et al. [32] introduce a system merging RPA and a chatbot to streamline student management tasks. RPA automates attendance and report generation, while the chatbot aids students and faculty in accessing information The system enhances efficiency and accuracy in tasks, improving the overall student management process.

In addition to enhancing processing speed, the goals of automation are to reduce human errors and improve the user experience for students. In using of RPA for result investigation of college brings about a scholarly foundation, Nandwani et al. [30] found zero errors and significantly time reduction (94,4% compared with manual execution).

The potential of RPA is being actively investigated for purposes beyond administrative utility, such as student enrollment and getting financial support as well as efficient dissemination of academic grades [29]. Turcu et al. [33] have proposed an RPA solution for student admission and the verification of the applicant information from submitted documents. When required criteria related to entry documents are met, the robot can conduct verification with higher accuracy.

Another usage in educational settings is to automate the process of preparing and conducting online meetings. Thorave et al. [9] demonstrated the automation ranging from scheduling meetings to sharing the meeting link within WhatsApp groups and monitoring student attendance during the meeting. Khan et al. [34] used RPA to develop an assisting robot tailored for educators. This innovative software takes the role of a personal tutor, significantly enhancing educators' pedagogical skills.

RPA can significantly streamline learning analytics. Munawar [35] presented a software robot that is used to monitor students' engagement and performance within an e-learning system. In four testing scenarios, the results demonstrate that the robot completes tasks 4.44 times faster than a human.

The greatest advantages of RPA technology become evident when combined with other cutting-edge technologies such as blockchain, ML, and natural language processing (NLP), resulting in added value through these synergistic combinations. Sibanyoni [36] employed an online school registration system to demonstrate how blockchain-based RPA can effectively address the existing difficulties in enrolling the schools. The proposed system enables parents to register their children for their preferred school, addressing competition and unfair resource allocation through a transparent blockchain-based mechanism.

Furthermore, as a result of incorporating a range of AI technologies, educational robots are shifting from administrative tools and mere information providers to intelligent assistants capable of replacing humans in cognitively more demanding tasks. Somasundaram et al. [37] have developed a tool based on RPA and AI to generate reports on students' performance in learning programming, which includes their attendance, the problems they solved, and their scores. The tool sends personalized feedback to students, their mentors and counselors as well as study coordinators to aid in better understanding of students' knowledge, including their strengths and areas that need improvement. Hu et al. [38] developed an Intelligent Tutoring Robot to support the student learning process using NLP and ML. In empirical study using design with a control group, they found that teaching through the Intelligent Tutoring Robot was equally successful as teaching by a human teacher.

To ensure comprehensive coverage of the most relevant literature in this study, an additional systematic literature review was conducted following the method outlined by Watson and Webster [39]. A search was conducted in Web of Science using the phrase *"robotic process automation" and education** in the topic field (title, abstract, keywords) to cover the terms education and educational.

The search resulted in 21 articles. Although we did not specify specific year restriction, all resulting articles were published from 2019 to the present. These were subjected to several exclusion criteria. Based on a review of titles and abstracts, articles not directly related to education (such as accounting or health), studies on student attitudes toward RPA in education (1 article), teaching RPA platforms in secondary and tertiary education (3 articles), literature reviews (2 articles), and theoretical models (1 article) were excluded. After applying these criteria, 8 articles remained for analysis. These articles were then closely examined to explore the practical applications of RPA in education.

The application categories we observed were automation of administrative tasks, automation of student services, automated data management (including grading and learning analytics), automated teaching, and automated learning.

The results of categorizing the articles according to the specified criteria are presented in Table 1. Given the limited number of resulting articles and the overlap with some papers we have previously studied [29, 34, 38], the table presents the consolidated findings from both this systematic literature review and our research previously presented in this section.

TABLE I
APPLICATION OF RPA IN EDUCATION

RPA application	References
Administrative tasks automation	[2, 29, 30, 31, 40, 41]
Student services automation	[29, 33, 36, 40]
Automated data management	[35, 37, 40, 41, 42]
Automated teaching/learning	[34, 38]

The systematic literature review confirms that RPA in education is primarily used to automate business processes such as administrative tasks and student services, with applications in data management and grading as well. However, the automation of the learning process itself is still in its early stages and largely remains a potential area for development [41]. This analysis also highlights the significant potential for the application of RPA in education due to the limited number of articles found.

In the context of implementing RPA to automate tasks, institutions are expected to benefit by facilitating student learning, both administratively and in the learning process. For teachers, the use of robots reduces the time spent on routine responsibilities, enabling them to design more interactive and engaging lectures and allocate more time to meaningful interactions with their students. Despite these benefits, there is currently insufficient support for the learning process through RPA. Further studies are needed to explore how RPA can be leveraged to enhance the learning experience for students.

IV. RPA METHOD FOR COURSE DISCOVERY

The objective of this research is to develop an approach to support informal learning by retrieving information about e-learning courses from various platforms, thereby simplifying the course selection process for the learner. The hypothesis that addresses this research question is that we can develop an RPA solution on automating the process of searching for courses on the internet. The solution is intended to enhance the user experience by providing a streamlined and efficient course selection process, ultimately supporting the goal of facilitating informal learning through e-learning platforms.

A. Analysis of the Process

As a first step in developing an RPA method we need to analyze in detail the manual procedure of the process which we want to automate and check its suitability for automation. The process is typically carried out by individuals in search for tutorials and similar self-learning resources on an e-learning platform such as Udemy, Coursera, edX, Khan Academy and others. User goal is to identify courses that align with their personal criteria, which often include factors such as course prices, ratings from former participants, certification possibility, and sometimes even preferences for specific instructors. Thus, the typical flow of the manual procedure involves the steps:

(i) finding the designated e-learning platform on the internet,
(ii) entering the search phrase into the platform,
(iii) for each course on the search results page(s):
   1. retrieving the data about the course,
   2. checking the compliance with the personal criteria (course prices, ratings from former participants, certification possibility, etc.)
   3. taking the notes about the course that meet the criteria, in the structured manner,
   4. returning to the search results page,
(iv) analysis of the notes, and finally,
(v) selecting a course.

Steps (iii) and (iv) are repeated as many times as the user prefers, until they are satisfied with the results or the process becomes too time-consuming, prompting the user to discontinue the search.

The described manual discovery of the courses and systematically assessing whether they align with the established criteria can prove to be both laborious and time intensive, especially if the number of criteria is significant. Given the multiple recurring steps involved, this process readily lends itself to exploration through automation. The selection of the process aligns with the criteria for RPA suitability (section II. B). As the process caters to individual users and not for corporate purposes, the criteria for massiveness and high process frequency were not considered as significant factors in this context.

B. Automation Method

The automated process will follow the steps identified in the manual procedure, although with some distinctions. The analysis of notes and the final course selection decision should remain under human discretion. Considering that, particular emphasis should be placed on structuring the obtained data into a comprehensible report. Structured data refers to specific information that is highly organized and presented in a predictable pattern.

After collecting all the necessary information about the courses, the final step that the automated process needs to do is to deliver the report to the user. To address the needs of the automation process and the intended use of the collected data, RPA tools usually offer several ways of data sending, such as email automation, API integration, cloud storage and reporting dashboards. By effectively handling the data output, the automation process completes the task of gathering and organizing course details, providing valuable insights for decision-making and analysis.

Another aspect where an automated process, unlike a human, cannot decide, is when to conclude the search process. Hence, before starting to gather information about courses, the RPA robot needs to be informed of the specific number of courses we want it to obtain and include in the report.

Taking all aspects into account, we propose the method for RPA process which is designed as a sequence of steps as follows:

(i) initiating a web browser and navigating to the desired e-learning platform,
(ii) entering the search phrase into the platform,
(iii) defining the number of courses to obtain,
(iv) defining the data to include in the report, such as link to the course, course description, price, ratings, instructors' names, certification possibility, etc.
(v) defining the type of the report file,
(vi) for the specified number of courses, RPA robot is repeating the steps:
    1. retrieving the data available at the search page,
    2. entering the course page to retrieve all other data,
    3. storing the data into report file,
    4. returning to the search results page,
    5. browsing to the next page with the results,
(vi) sending the output to the user.

IV. Implementation and Results

In this section, we present the key points of the illustrative use case, which has been developed strictly following the proposed method. We begin with brief introduction of the used technology.

A. RPA Technology

Forrester and Gartner have analyzed RPA tools from the perspective of functionality, scalability, security, user-friendliness, integration capabilities, and vendor support. According to Forester Wave [43] for 2023 and Gartner Magic Quadrant for 2023 [44, 45], the leaders with highest ranking in RPA are UiPath, Blue Prism and Automation Anywhere. A vast amount of recent literature is dedicated to comparisons of these three and other platforms [15, 6, 46] thus enabling the well-founded decisions of businesses when selecting technology solutions or service providers. Price, functionality, and adaptability are the key factors when choosing among these tools, considering the specific needs of the organization and the complexity of processes they plan to automate [6, 19].

UiPath offers two distinct versions [47]: Studio and StudioX. UiPath StudioX is a development environment specifically designed for users without technical backgrounds or programming skills, allowing them to create simple automations effortlessly. On the other hand, UiPath Studio is the original development environment, catering to programmers and empowering them to build more sophisticated automations to address complex business needs.

For implementation of our approach, we used UiPath development environment, particularly the UiPath Studio version, due to its numerous advantages:

- The presence of workflow recorder, wizards, selectors, and document understanding capabilities, enabling automation for both desktop and web applications.
- A comprehensive set of commands that support efficient searching through libraries, activities, projects, and open workflows.
- The ability to write custom code in various languages such as VB.NET, Python, AutoHotkey, JavaScript, PowerShell, and Java, directly integrated into the automation.
- Robust debugging tools to identify and address errors in the automation process effectively.
- Activity libraries containing pre-built templates, RPA components, and AI components, streamlining the automation development process.
- Seamless integration with version control systems like Git, TFS, FSTS, VSTS, and SVN, facilitating collaborative automation development and management.

B. Implementation of the Approach and Results

A process in UiPath is based on sequential task-solving. Tasks are logically grouped into units, related to search, data retrieval, data output, and data sending. These units are executed in a predefined order, thus forming the process flow, and represented in a flowchart, as shown in Fig. 1.

As an implementation of our approach, we have developed an RPA solution designed to search the Udemy platform for courses focused on learning about UiPath.

B.1 The Search Sequence

First, we define the *Search* sequence in UiPath Studio which involves opening a web browser and navigating to the Udemy website. This is done using *the Open Browser* activity, where we select the desired browser type and provide its URL. The next step involves searching for UiPath courses on Udemy, accomplished with the *Type Into* activity, which inputs the keyword "UiPath" into the search field. Upon executing the search, the results are displayed.

B.2 Data Scrapping

The *Data retrieval* sequence is facilitated through *Data Scraping*, a feature within UiPath that enables the extraction of structured data from web interfaces.

To automate specific actions within the user interface, communication with various windows, fields, and buttons is required. One way to identify elements of the user interface is by using their position on the screen, but this approach can be unreliable. Therefore, UiPath Studio uses selectors to store attributes of the graphical user interface element and its parents in the form of an XML fragment. The data scraping activity generates a container, i.e., *Attach Browser* with a selector for the top-level window and the *Extract Structured Data* activity with a partial selector. This ensures that the application from which the data needs to be scraped is correctly identified.

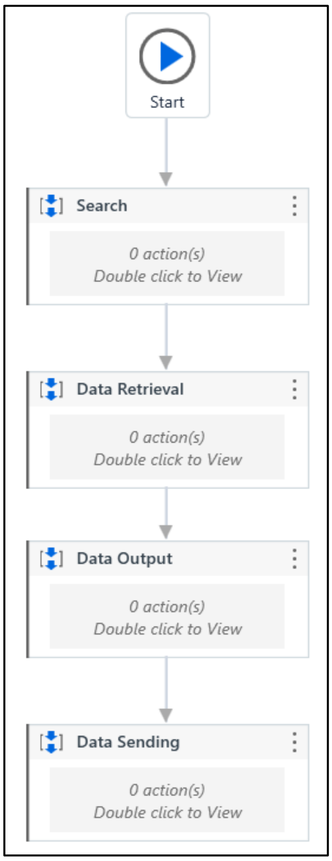

Fig. 1. Process structure represented as a flowchart with sequences: Search, Data Retrieval, Data Output and Data Sending

Furthermore, the *Extract Structured Data* activity comes with an automatically generated XML string that specifies the data to be extracted from the web page. The extracted data is stored in a *DataTable* variable, a tabular representation of the specified fields from the interface. This data format allows for efficient manipulation and organization of the data into databases, .csv files, or Excel spreadsheets. Fig. 2 provides a preview of the *DataTable* containing the scraped data which includes a column for the title and description, while URL is shown by scrolling the window to the right. For example, the first obtained title is "Complete UiPath RPA Developer Course: Build 7 robots", and the accompanying description is: "Master Robotic Process Automation (RPA) and UiPath – go from beginner to advanced." Fig. 2 also shows that number of results is limited to 100 (bordered with a red square).

To collect data about instructors' names, course prices, ratings, and certification possibilities, it is necessary to access each course individually and retrieve the desired values, typically by using the *Get Text* activity. In other words, a loop needs to be created that will iterate through each course, or each row in the table, and access the corresponding link. To maintain organization and clarity, each of these components can be separated into individual sequences. This way, the collected information is easier to track and manage. For example, we illustrate the process of scrapping the instructors' names from the interface. This activity requires selecting the appropriate field on the screen, as shown in Fig. 3 where instructor's name is bordered with a red square.

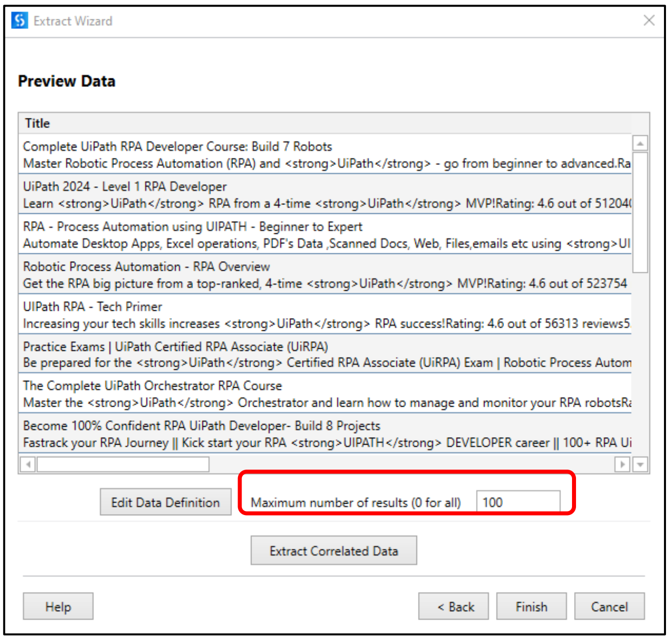

Fig. 2. Overview of the results of data scraping. The first column contains the titles and descriptions of obtained courses.

Fig. 3. Selecting the field on the interface with the instructor's name

The selector of the course lecturer from Fig. 3 has the following structure:

```
<html app='chrome.exe' title='Complete UiPath RPA
Developer Course: Build 7 Robots | Udemy' />
<webctrl aaname='Leon Petrou' css-
selector='body&gt;div&gt;div&gt;div&gt;div&gt;div&gt
;div&gt;div&gt;div&gt;div&gt;div&gt;div&gt;div&gt;di
v&gt;div&gt;span&gt;a' href='#instructor-1'
parentid='udemy' tag='A' />
<webctrl aaname='Leon Petrou' parentid='udemy'
tag='SPAN' />
```

Due to the dynamic nature of software programs, their layouts and attribute nodes can vary with different values. UiPath Studio lacks the ability to anticipate these changes, making it necessary to create certain selectors manually. For instance, in the automation process for this course, the selected selector is accurate. However, as we move on to the next courses, the corresponding element sometimes cannot be recognized. This highlights the importance of adapting and adjusting selectors to ensure successful automation across different courses or software environments.

	A	B	C	D	E	F
1	Title	URL	Instructor	Rating	Price	Certification
2	Complete UiPath RPA Developer Course: Build 7 Robots	/course/complete-uipath-rpa-developer-course/	Leon Petrou	4,6	89,99	Yes
3	UiPath - Level 1 Robotic Process Automation	/course/uipath-robotic-process-automation/	Bryan Lamb	4,5	89,99	Yes
4	UIPath RPA - Tech Primer	/course/rpa-tech-overview/	Bryan Lamb	4,6	89,99	Yes
5	RPA - Process Automation using UIPATH - Beginner to Expert	/course/rpa-uipath/	Rahul Shetty	4,6	19,99	Yes
6	Robotic Process Automation - RPA Overview	/course/robotic-process-automation/	Bryan Lamb	4,5	89,99	Yes
7	UiPath RPA - Level 2	/course/uipath-rpa-2/	Bryan Lamb	4,5	89,99	Yes
8	Go From Zero To Hero-Build 8 RPA UiPath ProjectsFrom Scratch	/course/go-from-zero-to-hero-build-rpa-uipath-project	Sharath Raju	4,6	19,99	Yes
9	UIPath RPA Tutorial - Zero To Advanced RPA UIPath Developer	/course/uipath-rpa-tutorial-0-to-advanced-robotic-prc	Shahansha Shaik	4,7	29,99	Yes
10	Complete UiPath RPA Developer: Theory + Build 7 robots	/course/complete-uipath-developer-theory-building-r	Daniel Tila	4,6	89,99	Yes
11	UiPath Test Automation	/course/uipath-test-automation/	Bryan Lamb	4,6	99,99	Yes
12	UiPath Advanced REFramework - Everything Explained	/course/uipath-reframework-everything-explained/	Jan Langdeel Pedersen	4,5	109,99	Yes
13	UiARD: UiPath Certified Advanced RPA Developer Tests	/course/uiard-uipath-certified-advanced-rpa-develope	HUB Academy	4,4	54,99	No
14	Practice Exams | UiPath Certified RPA Associate (UiRPA)	/course/practice-exams-uipath-certified-rpa-associate-	Wade Henderson	4,5	19,99	No

Fig. 4. Search results - Data output in Excel file

Collecting the course price and certification information differs from the previous data because not all courses have these details listed. Some courses may have a price, while others might be free. Consequently, they have different interfaces: a paid course might have a card with elements like the "Buy now" button while free courses do not have this element. For determining the existence of an element on the interface, the *Element Exists* activity is used along with its selector, which often requires modification to become more generic. The information about whether a course provides a certification option is obtained in the similar way.

B.3 Data Output

In this use case we choose to write the data output to an Excel spreadsheet. The scrapped data is exported into an Excel file using the *Excel Application Scope* activity. The *Write Range* activity is utilized to transfer data from the *DataTable* variable into the Excel spreadsheet, ensuring a structured format for subsequent analysis. A part of the resulting spreadsheet is shown in Fig. 4.

B.4 Data Sending

The final step in our automation involves sending the acquired Excel document via Microsoft Outlook to the designated email address. This process is achieved using the *Send Outlook Mail Message* activity. The recipient's email address, subject, and content are configured, with the reference for Excel file to be attached. The automation process concludes with the successful transmission of course details to designated recipients and the resulting email is shown in Fig. 5.

V. Evaluation

The automation robot that implemented the course search in Udemy platform has proven to successfully obtain data and deliver it for further analysis. The process can be represented using a relatively simple algorithm, and this structure has been effectively captured in UiPath Studio. The entire process adheres to high standardization, and contingencies for exceptional cases have been thoroughly addressed.

The process itself does not require extensive cognitive capabilities from the robot, as it follows a straightforward flow and performs tasks typical of an RPA. The robot interacts with digital data, communicates with various applications, and generates an Excel file as its output. Throughout execution, the robot establishes connections with four different systems, namely UiPath, Udemy, Excel, and Microsoft Outlook.

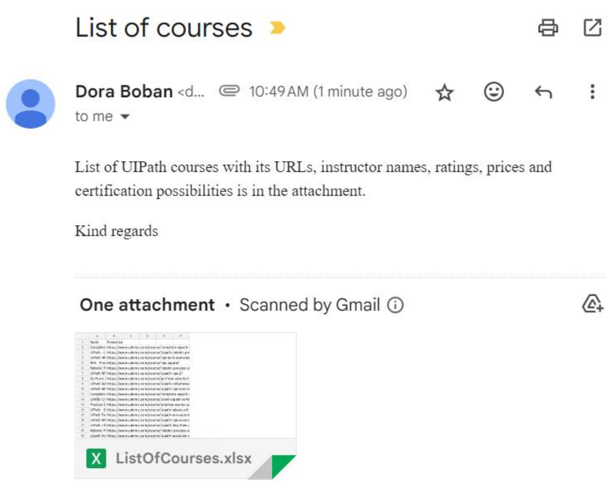

Fig. 5. Received email containing the output document

To assess the impact of described RPA case, we have conducted performance evaluation through two comparative analyses. Firstly, we compared the robot performance with manual execution of the identical task. Secondly, we built another robot using UiPath StudioX and compared both the development process and the resulting solution.

A. Comparison with Manual Execution

For the software robot built in UiPath Studio, we restricted the number of courses the robot needed to gather to 100. The execution of this automated process took 25 minutes. In a parallel scenario, one of the authors replicated a nearly identical procedure manually, managing to collect data for 18 courses within a span of 20 minutes. Evaluation shows that, as far as for these 18 courses, the results obtained by the robot are complete and accurate.

A notable distinction from the robot's approach lies in the manual process, where an individual has to enter each course to extract data. In contrast, the robot adeptly acquires the course title and URL without entering the course itself. Additionally, the manual process involves the meticulous formatting of cells in an Excel spreadsheet according to data types during data copying. The process quickly becomes tedious, errors start to occur, and additional time and concentration are needed to correct them. By disregarding the potential escalation of human fatigue and error occurrence over time and treating it as a linear component, we can estimate that manual collection of data for 100 courses would consume one hour and 51 minutes. This timeframe is 4.44 times longer than the duration required by the robot for the same task, indicating that the robot accomplishes the task in up to 22.5% of the time of human execution.

Moreover, when extending our analysis beyond the initial 100 results and explore all possibilities across the 12 pages of search engine output, it is reasonable to expect a significant increase in the efficiency of the robot. Considering that a person would never manually undertake such an exhaustive search, there is no need for a detailed examination of this specific case. Instead, it can serve as an illustrative example demonstrating the potential efficiency of automating a similar process.

B. Comparison with Robot developed in UiPath StudioX

For this evaluation, we created a new robot in UiPath StudioX. Firstly, we compare the robot's performance, and then we assess the implementation process and the developer's experience.

The new robot in UiPath StudioX has been successfully developed to deliver identical results. The execution time for gathering 100 courses from the Udemy platform remained consistent at 25 minutes, just like the first robot. Notably, the data collected for the initial 18 courses is both complete and accurate.

In terms of developer experience, one of the authors' observations suggests that the StudioX interface is likely more user-friendly compared to Studio, resembling a typical user interface in its design and terminology. For instance, when performing the activities related to data output, in Studio, the terms *Excel Application Scope* and *Write Range* are used for creating and populating an Excel table. In contrast, StudioX uses more intuitive terms *Use Excel File* and *Write DataTable to Excel* for the same activities. Figures 6 and 7 display the user interface differences between Studio and StudioX for these specific activities. Considering that StudioX is designed for non-programmers, these interface and terminology differences are in line with expectations [47].

It can also be noted that StudioX offers slightly more features for utilizing Outlook and Excel, even though these functionalities were not necessary for developing this robot. Regarding implementation challenges, such as the need to navigate to each page to collect course prices, they are the same in both Studio and StudioX. Despite the minor technical differences, we can confidently conclude that both Studio and StudioX are equally suitable for implementing our approach.

According to the authors' estimation, the time required to develop a new RPA solution for course search is approximately half an hour for an experienced RPA developer and probably an hour for beginners who have completed at least an 8–hour training session on using the specific tool. When creating a robot, developers can set various constraints to tailor the search, including parameters like video duration and knowledge level (beginner, intermediate, expert). Additionally, they can specify preferences for courses with specific features such as subtitles,

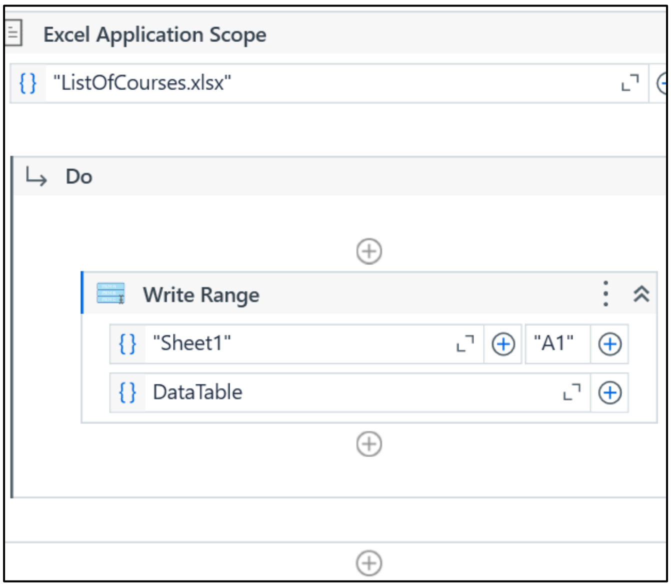

Fig. 6. Writing data activities in UiPath Studio

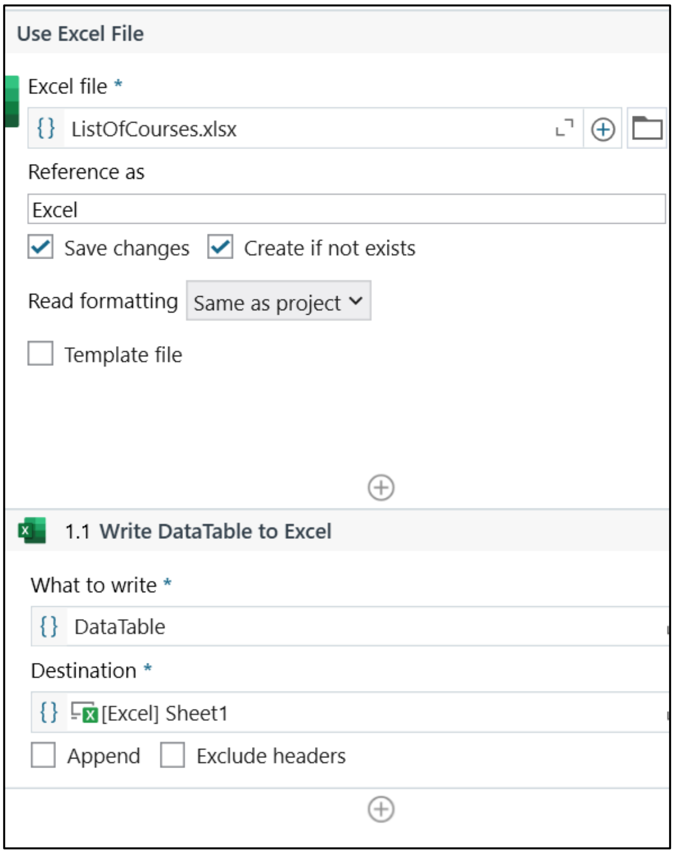

Fig. 7. Writing data activities in UiPath StudioX

coding exercises, quizzes, and practice tests. While these additional requirements enhance the robot's ability to find courses that meet specific criteria, they can also lengthen the implementation time as developer has to add corresponding activities. However, the trade-off is a more refined and customized search result that better fits the user's preferences and needs. Each new RPA solution can then be evaluated, as described, in terms of completeness, accuracy, and execution time.

VI. Discussion

The automated process has confirmed several stated advantages and disadvantages of RPA. For this type of process, specifically one serving individuals, most of the drawbacks mentioned in the study did not significantly manifest. However, several limitations are recognized during the development of the robot. Challenges were faced during the identification of elements on the interface, imposing the modifications and handling of exceptions during development. These factors influenced the time required for implementation and the satisfaction of the developer, but they are considered inherent to the RPA development process. Another limitation encountered was the non-deterministic behavior of the robot. In other words, the robot's functioning could be inconsistent, as sometimes it would not yield the expected outcome even with no changes in the environment or process. However, such issues are not unique to this project and can arise in various automation initiatives. They can be mitigated through experience and knowledge gained in the process of developing RPA projects.

Other limitations of the conducted research are as follows. The research is utilized exclusively the UiPath platform for the case study demonstration. Developed solution is limited to a single e-learning platform and cannot integrate searches from different platforms. The research also lacks usability study with suitable participants, i.e. RPA developers.

On the other hand, the benefits achieved through the implementation of this automated course searching process are substantial, and they justify the development of a dedicated robot for online course discovery. The automation has significantly increased the process's efficiency by outperforming human capabilities, allowing for the search and processing of a larger number of courses to cater to multiple users simultaneously. Moreover, the accuracy of the robot's actions is notably enhanced, as it is configured correctly once within UiPath Studio, eliminating the potential for human errors that may arise from fatigue or monotony during manual searches.

The implementation of this automated process seamlessly integrates with existing IT systems and adheres to the logical flow of the course search. One of the notable advantages is that it does not require high-level programming skills, making it accessible to a broader range of developers. This enables organizations and individuals to leverage the power of automation without extensive technical expertise.

By automating the repetitive and monotonous tasks of clicking, typing, copying, pasting, and reading, individuals are freed from these burdensome actions. As a result, they can redirect their time and energy towards more cognitively demanding areas. For instance, individuals can focus on optimizing the automated process to increase data collection efficiency, reduce the number of clicks and page navigations during course searches, and improve overall user experience.

Since this process is not intended for corporate use, aspects such as workload redistribution, reduced full-time equivalent, enhanced user experience, and scalability were not considered. However, with the implementation of these enhancements and taking the process to a business level, these criteria would likely be justified based on the results of the existing process. This demonstrates the potential for the automated course search process to evolve into a valuable tool for various organizations and individuals, with broader applications and benefits. Additionally, careful consideration of ethical and legal issues related to automation is crucial, along with ensuring compliance with all relevant regulations and guidelines.

VII. Conclusion and Future Work

Considering a comprehensive analysis of relevant literature, it becomes evident that the development of a compelling digital transformation strategy, with a focus on automation, becomes crucial for ensuring the long-term success and resilience of organizations in the contemporary market landscape. Within the expansive framework of intelligent automation platforms, RPA functions emerge as a leading component, often requiring collaboration with other automation technologies, including business process management. The current limitations of RPA can be seen as gateways to expansion and as areas where RPA's current capabilities are ready for evolution. Some promising directions for the growth of RPA encompass the scientific identification of business processes that lend themselves to automation, the capacity for robots to acquire new proficiencies and incrementally enhance their performance, automation of increasingly complex business processes, and the comprehensive automation of end-to-end processes.

In synergy with AI/ML, this technology aspires to elevate work to more sophisticated levels and realize the full potential of digital transformation of both businesses and academy. Recent educational research underscores the pivotal role of AI and RPA in reshaping the dynamics between educators and learners, transitioning from repetitive tasks to harnessing AI for tailored learning experiences and data-driven insights into student progress [37, 48]. Machine learning algorithms used with RPA robots facilitate the comprehension and prediction of students' learning patterns and outcomes, empowering educators to intervene promptly and assist students at risk of falling behind [38, 49]. As enterprises and educational institutions progress towards fully automated systems, it becomes essential to maintain a consistently comprehensive and unbiased perspective on the impact of automation and its implications and to ensure sustainable development.

The solution presented in this study efficiently automates the course search process on the Udemy platform. Using features such as workflow recording, selectors, and data manipulation capabilities it efficiently interacts with the website's interface to extract crucial course details. The inclusion of customizable code options and seamless version control integration enhances flexibility and collaboration, ultimately optimizing the course discovery procedure. This developed solution serves as a compelling demonstration of RPA's transformative potential in education, particularly in automating routine administrative tasks like course searching. This automation significantly reduces the time for educators and students (by at least 77.5%), but it also cultivates a more personalized and efficient learning environment.

The described automated process can be further improved and made more valuable by enhancing user satisfaction through personalization. This can be achieved by tailoring the course search according to each user's interests, independent of the course topic. Users can specify their criteria based on course ratings, prices, instructor ratings, course content, additional materials, language, course duration, and more. Such personalization would result in a more tailored output, increasing the significance, usefulness, and efficiency of the process, ultimately leading to higher user satisfaction for both the end-users and the creator of the automated process. We plan to obtain these data in future work through usability studies, and this is also a recommendation for RPA practitioners. Additionally, further research is needed to enable integration of data from different e-learning platforms.

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