A Proposal for Combining Project Based Learning and Lean Six Sigma to Teach Robotic Process Automation Development and Enhance Systems Integration

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Abstract

This paper proposes a Project-based team instruction methodology with open-ended projects to teach students critical analysis, design and implementation steps of developing Robotic Process Automation (RPA) for information systems. The use of project-based learning is appropriate for teaching RPA analysis and design with lean Six Sigma tools because of its experimental approach and documentation of logical steps needed to learn how to implement RPA successfully. The approach systematically documents work currently performed and defines future actions of the process while ensuring significant benefits are achieved with the RPA enhanced process. This methodology is important because the application of RPA is not commonly taught in Management Information System (MIS) programs. MIS students may not understand the significance of combined methodology, RPA tool, and usefulness of RPA until they enter the workforce where RPA is rapidly becoming available and easier to implement. The lecture sessions and exercises are valuable because it is easy to communicate the value of RPA in terms of time, quality, volume of transactions, etc. using Lean Six Sigma analytic approaches. The exercises involve hands on activities to make this learning experience interesting for students to readily associate the theoretical process improvement agreement and visualize the practical value of RPA enhanced projects. The paper discusses the need for process changes (and new development approaches) in organization to match the properties and functions within enterprise systems and ERPs that has led to criticism of the enterprise systems. This criticism is attributable to the ERPs' many sub-functions and operations that have limited adaptability and reduced functional and operational flexibility. The RPAs require limited prior knowledge of ERPs or their sub-processes for the improvements that are made in the performance of the organization. Thus, students do not have to "learn" how these enterprise or ERP systems operate to make changes or task improvements. This paper presents a project-based methodology and design approach focusing on development of RPAs that help students learning how to make the improvements using the RPS tools. The students learn that projects can deliver significant and tangible benefits to organizations while engaging students in key activities of the analysis, design and development process from a low code-no code perspective.

Keywords: Robotic Process Automation, Six Sigma, Project-based, PBL, Process

1. INTRODUCTION

This paper proposes a Project-based team instruction methodology for information systems education using RPA. The discussion proposes that a Project-based methodology can be used to combine Learn Six Sigma and Robotics Process Automation in an educational program. The education value is to enable students to integrate systems and improve wok processes without low-code or no-code tools. It also provides a literature-based history of the relevant concepts.

The objective is to improve students' education by teaching them how to advance performance with analysis using lean six sigma techniques. These techniques are applied to document and target needed system improvements and integration. Students can learn how to deliver great benefits by performing functional system tasks and enhancing operations as part of a PBL development project.

RPA may be loosely defined as using software technologies designed to facilitate devising and managing software robots to behave like humans when interacting with systems and software. Here, we discuss how Lean Six Sigma and Project Based Learning (PBL) synergistically add value when combined to teach students RPA concepts.

Information Systems Integration

Systems integration is a critical part of enabling the paradigm of using Lean Six Sigma and PBL to yield value to development projects and operations. Although it may be seen as a side topic, a prerequisite for efficient collaboration within and between organizations units is this integration of information systems. Although it is often viewed as simple from a holistic standpoint, the inability of systems to interoperate remains a consistent problem in the enterprise. As information systems proliferate, opportunities for IT systems integration have increased greatly, and these must be leveraged to add value.

However, difficulties with integration continue, due to a lack of systems interoperability and data definition and formatting related problems. Despite intensive research on integration issues, organizations continue to encounter significant challenges. Schmidt, Otto, & Österle (2010) developed a research framework, categorizing concrete integration cases from business practices.

This framework was developed by examining integration cases from the literature. The work proposed 9 problem categories and 21 integration problems plaguing those efforts. The authors suggest that detailed problems inhibiting integration vary by business segment, goals, and roles. Semantics, data object heterogeneity, data value mismatches and attribute differences also affect these problems. The conclusion from this work and the literature is that there are many open integration challenges in the Information Systems discipline (Schmidt, Otto, & Österle, 2010).

It can be seen from this discussion that while there are many blocks and challenges to integration, there are also an increasing number of opportunities to foster improved integration, and it is essential to consider these as we help students develop skills using Lean Six Sigma and RPA.

Low-code/ and No-code Tools

Low-code/no-code development approaches are terms that describe the uses of software tools and templates to integrate system and process operations. No-code/base-code tool platforms may be guided platforms with a drag-and-drop process or more automated incorporating machine learning services. (Villegas-Ch, García-Ortiz, & Sánchez-Viteri, 2021). Low-code and no-code approaches employ visual software development tools and environments. Robotics Process Automation (RPA) tools are categorized among the low-code/no-code approaches. These tools allow developers and end-users to select, drag and drop application components. The components are then connected with the applications to create enhanced applications or augment programs with previously unavailable functionality.

The RPA technology may be seen as an evolution of the low-code/no-code environments developed following the Computer Assisted Systems Engineering (CASE) tool failures of the 80's and 90's (Kuhn, 1989; Dias, 2017). RPA became a development alternative because few case tools were successful for complete database application generation. The case tools were costly and difficult to implement and maintain, requiring extensive training for developers and systems maintenance personnel (Schmidt, 2006). Jones (2002) notes that as much as 70 percent of CASE tools were not being used by the end of the first year.

This generally accepted software failure figure (believed to be based on the 1994 Standish Chaos study) has been questioned by Glass (2005). He argues that the failure rate is assessed from varying perspectives such as cost over runs, functional performance, etc., and that the true rates are even lower. Regardless, there is no question that failure rates during this period were sub-optimal.

RPA's no-code characteristics and drag/drop technology are similar to other low-code/no-code development environments such as Mendix, a low-code Model Driven Development (MDD) platform that also grew from the Computer CASE tools of the eighties and nineties.

Tools like these enable system development to occur at higher levels of abstraction, generating fully functional applications from a model driven environment (Hailpern & Tarr, 2006). The higher levels of abstraction are achieved by automating and simplifying development steps using the context of domain models. The tools employ templates, generate code, and in many cases, generate fully functional applications.

Hyun (2019) provides a useful example of this approach with a discussion of an environment-based low-code and no-code execution platform and an execution method that combines hybrid and native apps, offering the advantages of each. The environment enables the use of iPhones, Android devices, and operation templates. The development platform is a visually integrated environment that enables drag and drop components by non-technical developers. The environment to construct modules can be dynamically loaded when called. The system provides functionality for authentication, user authorization, commerce, messaging, social publishing, and vision.

Early releases of RPA sought to minimize coding. Many of these tools are approaching a high level of ease of use today. However, it is marketing jargon to say that they are truly low code or no code. The users of the early RPA tools were required to incorporate logic and instruction programming to complete the automation process. Avoiding marketing jargon, the low-code RPA automates straightforward processes through a drag & drop user interface that executes a user's activities. Coded bots can still complete more complicated or complex processes. The low/no code tools are presently used to complete and automate standard work tasks, such as Excel operations, email responses, report creation, and authorization recoding. Full no-code RPA is currently not available or in use. However, user prototyping and testing of RPA tools can assess readily the ease of use and amount coding required. Progress toward a more complete low-code/no-code target environment is being made.

Although the low-code/no-code development approach has become an increasingly important factor and tool for current software development challenges, it is not always adopted. Global trends do not always represent the popularity, adoption, and use of the low-code/no-code development approach. This was assessed in the Slovenian environment with regard to one specific toolset, Power Automate. The results showed that use of this low-code/no-code development approach in Slovenian organizations is low because of limited usability and functionality concerns (Beranic, Rek, & Heričko; 2020).

The need for RPA is couched in the integration required to improve legacy systems regardless of the environments available for system operations. The movement of systems to the cloud, combined with integration difficulties, promulgates the lift/shift approach of cloud migration. In this migration approach, information systems and applications are migrated into a cloud environment without making process changes even when systems are moved into cloud environments with available resources (Engelsrud, 2019).

As seen in cloud-computing adoption, many large organizations are struggling to obtain the full value of the migration to the cloud. This is because the cloud migration (especially lift/shift) simply moves information systems to the cloud without the integrating functions and possibly transforming processes with new strategies needed to obtain full cloud value. Utilities can simplify the packaging, migration, and deployment of applications for the cloud whether the target is AWS, Google Cloud, Oracle Cloud, or other cloud infrastructure.

However, without improvements or resolving process integration concerns associated with systems integration, taking legacy applications and moving them to the cloud does not automatically yield the benefits that cloud infrastructure and support systems can provide, because the work processes are still not integrated. The information technology architectures that are the result of these migrations may be complex, difficult to manage, and costly (Bommadevara, Del Miglio, & Jansen, 2018). It is critical that systems not be simply migrated to the cloud, but that work processes be integrated to the cloud infrastructure.

A PBL educational approach is an appropriate teaching method for students who *must* learn about cloud migration and how to integrate systems. As PBL is implemented in the classroom, students design, build and employ solutions to a problem through a hands-on, collaborative methodology. The true objective is to improve performance with analysis using lean six sigma techniques to document and target system improvements that will deliver great benefits by performing functional system tasks and improving operations as part of the PBL development project.

2. EDUCATION FOR INTEGRATION

To foster integration in their PBL projects, students must understand the underlying importance of the work and the task performed in the processes to integrate systems. In large projects and organizations with decentralized work packages and task areas, it is important to integrate properly the various outputs to provide the customer with a coherent deliverable.

MIS students who join organizations that design and support information systems see first-hand how the work performed by organizational information systems is subdivided into segments for system execution, functional performance and completion. This concept – the division of labor (specialization) is evident in the segmentation of systems that are consistently used by various divisions, departments, and offices of organizations.

The individual tasks contribute to productivity increases by focusing effort on the tasks and data used by each functional area. For example, in the field of manufacturing, use of business applications has expanded significantly over the years. This expansion has increased both the availability and volume of planning and execution information for managers and decision makers.

The information enables decision makers to assess and monitor performance at all levels of the organization. Developed applications let end users obtain predefined management reports including information needed for managerial execution. The information is of significant value for strategic planning, increased productivity, reducing service cycles, reducing product development cycles, reducing marketing life cycles, and increasing the understanding of customer’s needs, thus facilitating business and process reengineering (Sharma, 2012: 553). This breaking up of work elements is essential to delivering large projects. However, the breaking up and decentralization make it difficult to assemble and integrate tasks for a coherent deliverable to the customer.

Managers and organizations remain faced with the significant task of assembling and integrating the divided work elements to produce the output desired by the customer. Further, managers must deal with migrating into business and organization environments that lead to changes in the data, knowledge information systems and business strategy.

To gain the greatest benefit from information systems, one must also understand the relationship between knowledge and information system strategies, and their overall impact on firm performance. It is important that the dynamic capabilities of knowledge strategy and planning result in necessary changes in systems to enable dynamic and innovative capabilities to be developed.

Findings from a study of 234 Brazilian companies support this logical argument. It finds performance is positively impacted through alignment between knowledge strategy planning and information systems strategy. Managers must recognize that the work of the firm is dynamic, and that alignment between information systems and the strategic actions of the organization is important to success (Yoshikuni, Galvão, & Albertin, 2021). It can be deduced that knowledge and information system strategies must also be reconciled and integrated.

Research and improvement attempts have focused on business processes supported by information systems (and the data, information, and knowledge derived from the systems) for many years. Business has been designing and integrating processes as business and industrial organizations evolve to offer systems that are more complex, with useful data, insights, and knowledge for decision makers. The systems also seek to meet the information requirements of highly complex stakeholder demands and governance regulations.

It is therefore important for students entering the workforce to understand these concepts in order to integrate work segments and processes so the information presents a coherent whole from a holistically consistent system.

How to Integrate Systems in the Age of Processes and Computerized Information Systems

Porter and Millar (1985) discussed linkages between computerized information systems and the integration mission, and projected a future role that information technology would play in the value chain. They argue that information technology and information that businesses create would enable management to employ this information in executing work processes. These combined factors provide an advantage derived from the information-processing component that executes steps required to capture, manipulate, and channel the data.

This support enables managers to perform the value chain activity. The data handling improvements they describe are attributable to barcodes for error handling reductions, databases for knowledge and experience storage, management of services with data, improved weather satellite data uses, financial analysis through data, transfer of data between suppliers and manufacturers, data for improved designs for manufacturing coordination, uses of office support data, and communication data.

The value chain framework addresses the role of computer information systems in achieving helpful integration. White and Person (2001) suggest this as a framework for integrating a firm's activities within a supply chain. They recognize the requirements for integrating customer service activities into the decision-making process of manufacturing organizations. These authors also discuss the dynamic nature of the organization, and argue that just-in-time computer systems and new product process combine with information technologies to provide the mechanisms for integration of the various supply chain task activities.

The tasks and processes are conceptualized as frameworks containing steps in a sequence. The processes have many components, agents, and outcomes.

The many authors and managerial perspectives indicate that difficulties with the integration of organizational processes have always been challenging. As these references summarize, within the last 40 years, information systems implemented with electronic technology through computer information systems and electronic data processing technologies have been "inserted" into this essential mission of attempting to manage processes and their data, and improve the coordination and integration of the work within and between organizations. As Schmidt, Otto, & Österle (2010) discuss, this "levied" integration requirement for information systems is a prerequisite for efficient collaboration within and between organizational units that results in substantial tasks.

Information systems have grown and become ever more complex to meet the needs of large organizations. The large category of enterprise information systems has become standardized with more carefully pre-defined data and processes to meet broadly the needs of many large organizations, and for wider marketability. This tendency to force process changes on organization (to match the properties and functions within enterprise systems) has led to criticism of the enterprise systems. This criticism is attributable to their many sub-functions and operations that have limited adaptability and reduced functional and operational flexibility.

Information systems such as Enterprise Resource Planning systems are caught in this dilemma. It is exacerbated by the large enterprises and matrix structures of originations that utilize federation (decentralized control and local unit development of some functionality) as their information systems implementation approach.

The standardized enterprise systems are thus less flexible and adaptive, and the decentralized enterprises are incapable of exchanging and making information available in many instances. This creates a situation where managers lack visibility into the results of processes, or where data from one process are simply not accessible to another work unit. A large adaptive enterprise requires information systems to meet a business strategy that can deliver information visibility across the enterprise, and that are flexible for use in new and innovative ways (Evgeniou, 2002). Thus, integration is critical for the large enterprise.

General Problem with Major Applications

The need for change after implementation was addressed by Gattiker, & Goodhue, (2005). They offer the theory, supported by their research, that because these systems include data and effect greater process integration, an ERP will be a relatively better fit, requiring fewer changes, when interdependence is high and differentiation is low among/between the subcomponent of the company using the ERP. If differentiation is high at the subunit level of the organization (business function or location, such as a manufacturing plant) ERP customization will be required. Further, the amount of time since ERP implementation will increase the need for further customization (supported by a large number of manufacturing plants).

A comprehensive discussion of ERP systems published by Sheik, & Sulphey (2020) discussing Enterprise Resource Planning (ERP) failures and limitations over the past 20 years indicates that implementation is still difficult, and changes after implementation are still required. It identifies the reasons for failures documented in numerous ERP studies. The literature recognizes many types of failures associated with information systems project implementation, planning, management support, culture and management process.

The work is useful because it notes that even overcoming these issues does not assure success for an ERP system or the organization seeking to obtain value from this effort. These authors discuss the tendency of organizations to underestimate the efforts needed to handle change in the organizations. In these initial implementations, ERP systems can affect any functional area of the company's basic business model, and require systemic modifications. Integration is required.

In discussing the problems in large scale ERP implementations, research studies of integrated supply chains show that effective operations and integration are achieved by linking information from suppliers, partners and customers within and across national borders. This can be by implementing information technologies and systems such as ERPs to facilitate the desired level and details needed for integration. There are cases of successful and unsuccessful implementations. The principal reason for failure is often associated with poor management of the implementation process (Sheik, & Sulphey, 2020).

This paper identifies the different types of issues that can arise and require adaptation for ERP systems within a large manufacturing organization. The core issues to confront for successful implementation of enterprise information system according to this case study were addressed by piloting a small portion of the enterprise implementation to assess and demonstrate how business principles, processes, procedures, role definitions and behaviors (as well as software, hardware and data transfers) would influence the organization.

The initial problems experienced in the attempt to *go live* included user authorization and clearance levels, work routing and tracking (via cards), incorrect data values existing between the legacy systems and the new system, incorrect inventory levels and WIP data, and incorrect MPR transactions (Yusuf, Gunasekaran, & Abthorpe, 2004). They conclude that adaptation is necessary throughout the development lifecycle.

User Developed Apps and Desktop Tools Proliferate with Increased Workforce Mobility

Development frameworks are necessary. Large enterprise systems and changes are not the only forces driving information systems today. User empowerment, education, and the widespread use of technology have influenced the organizational end user. Workers are not afraid to develop apps and seek to access information needed in their work activities through user development and the widespread proliferation of desktop tools.

Coronado, Mastrogiovanni, Indurkhya, & Venture (2020) addressed this increasing demand for tools and expansion of interest in user developed information systems. Individuals in social situations will trust robots (automated programs performing a work function or task) to execute work in industries and in scenarios where the robot is directed by an information system (perhaps some form of AI) to interact with humans. These authors surveyed user development environments that might foster application development involving robots with social capabilities, features that could support social research goals, and serve professional employees not educated or trained in more traditional programming languages and techniques.

The work identified and assessed sixteen programming environments with modeling approaches, Component-Based Software Engineering, and web technologies. The research found that few of the environments enable end users to be independent from high-tech support. Their work calls for objective and comparative evaluations, usability studies, and design validations of the tools for designing working applications. Engaging robot-based applications requires the availability of usable, flexible and accessible development frameworks that can be adopted and mastered by practitioners who are truly adult end users.

3. METHODOLOGY

This educational experience applies a Project Based Learning (PBL) approach to the learning experience. In project-based learning the instructional focus is student-centered. The experiences are based the principles that (1) learning is context-specific, (2) learning processed actively involved those learning, and (3) goals are reached through social interactions and Knowledge sharing (Jalinus, Nabawi, & Mardin, 2017, September; Cocco, 2006). It is considered to be a particular type of inquiry-based learning where the context of learning is provided through authentic questions and problems within real-world practices

The learning experience is agile based. It involves an introduction to the requirements for changes and adaptations for enterprise information systems, data and process integration, and the continued need for user developed applications that work in the desktop environments and in mobile applications. In this paradigm, use of Lean Six Sigma in the analysis and development sections of the PBL project adds value and improves integration.

Analysis: Lean Six Sigma Designs Steps for Value

The goals of improving flexibility and supporting operations have contributed to the Six Sigma approach to process improvement and selecting changes to implement in organizations. It is a strong foundation for improvements and innovations because it involves doing the work better and actually improving the work to be accomplished in many instances. It is applicable to processes used to produce products and services, expand markets, and deliver operational performance. The work focuses on customer needs, detailed data analysis and facts about performance levels, errors, and required actions.

Analysis of organization results derived from the application of Six Sigma programs show improvements in broad-based innovation and financial performance. The key characteristics of these approaches include an improvement - innovation vision based on data (from customers, insights, and analytic studies), clear objectives, organizational commitment to the change objectives or vision, alignment across the organization, training, and target processes to demonstrate the Six Sigma program.

Lean Six Sigma is a combination of lean methods (analysis, documentation, and analytic tasks that are performed within the organization) and Six Sigma approaches that organizes the tasks in an understandable and executable fashion. Lean Six Sigma utilizes knowledge (from the experience of many organizations that have followed the approach), methods designed to elicit specific data and understanding of activities and operations, and tools derived from operational improvement research and implementations.

The *lean* portion of the approach targets cost reductions through process optimization. The six-sigma portion focuses on meeting customer needs and stakeholder expectations. It seeks to improve quality, via measurement and defect or error elimination. This is accomplished by both eliminating the opportunities for errors in a process and improving the steps, materials, and performance of a task. The simultaneous goals are to achieve both effectiveness and efficiency (Byrne, Lubowe, & Blitz, (2007).

There are five major steps in a lean six-sigma process as shown in table 1. It is labeled "DMAIC", an acronym for the five sequential phases: Define-Measure-Analyze-Improve-Control. These phases flow logically from defining a problem through implementing solutions. The changes introduced are directly associated with causes (George, Maxey, & Upton, 2004).

Step Name	Value
Design	Review, validate charter; define: customer, problem, benefits sought, financial objectives, plan, schedule
Measure	Build value stream map, inputs, operational definitions, data collection plan, measurements, process capability, measure gate
Analyze	Determine critical inputs, potential root causes, reduce root cause list, estimate root cause effects on outputs, prioritize root causes
Improve	Develop potential solutions, analyze and evaluate solutions, develop "To-Be" value stream map, develop pilot solution, confirm attainment of project goals, develop full scale implementation plan
Control	Implement mistake proofing, SOPs, training. Set process controls, implement solution and on-going process measurements, develop opportunities to apply project lessons, transition to monitoring control office

Table 1. Summarized Lean Six Sigma Steps

Analysis Results: A New Process Design

The result of the analysis using the steps outlined is a process that will perform more effectively and efficiently. Further, the approach and tools employed document the pre – post outcome metrics that will be used to demonstrate to stakeholders that there are real benefits and improvements from the process changes.

4. RPA: IMPLEMENTING THE AUTOMATION

The objectives of this learning experience are to deliver students a clear understanding of the technology and methods. Students will understand the actions and sequence of steps needed to apply lean six sigma methods and RPA tools that enhance processes and information systems. The lessons focus on RPA tools (after a full analysis) and use various product offerings to provide a hands-on set of educational exercises. This section discusses RPA and how the tools implement the designs documented. It also provides an overview of the tools that will be used in the exercises.

Robotic Process Automation

This paper argues that Robotic Process Automation (RPA) is a recent improvement (evolving in the past ~10 years) in computer information systems. This technology is applied in organizations to achieve integration between systems and to perform mundane and repetitive tasks without altering or modifying the information systems that are the targets or sources of the data required. RPAs execute rule-based, routine, and predictable tasks in combination with structured, understood, and stable data in a semi-automated and automated manner. (Primer, 2015).

RPA Functionality and Operation

How does RPA perform integrative and productive tasks? RPA moves data and information seamlessly between systems and processes. RPA technology can be implemented across many functions. It is a practical linkage technology for many different process focused tasks (definable, repeatable, and rules-based). It can be optionally executed at the explicit direction of employees and can therefore assist them in their work. RPA can assist with diagnosing when decisions are not always clear (the data do not legitimately fit) and the business rules-base is not complete for all situations (present and those introduced by business changes). In these instances, the "error" or unaddressed states can be recorded and handed directly by the user. New "rules" or actions can be added to the RPA automation to handle the situation when it is encountered in the future.

RPA has multiple operating modes. It can function in attended mode where an employee "triggers" the bot for day-to-day operations or automatically with the employee watching for exceptions and alerts (correct execution or failure to execute). The bot can also function in an "unattended mode" on a server based on user-determined triggers such as a date and time. For example, a bot could be programmed to trigger automatically to execute at 12:00 a.m. on Friday, or when 1,000 cases have been received in a queue. Thus, the RPA bot can serve as an independent automated process that does not demand human intervention in order to execute a work process. It can make or execute a decision if all the data and rules are clear and the outcome decisions are predetermined.

RPA is very adaptive and fits many situations because of its internal capabilities. The RPA has several essential features that provide it competencies beyond those found in code written for scripting, screen scraping, and sequential process management. 1) RPA development utilizes straightforward dropping and dragging via icons that represent steps in a process. RPA process code is then produced automatically without extensive programming, computer training or expertise. 2) The RPA bot accesses data produced by other computer systems or programs. It emulates exactly how an employee accesses this data (because the bot is created to do just this task). 3) RPA has important security and operational controls.

The RPA assumes only that logon ID and password of the user. This is required to access what is normally seen or obtained by the worker from the target or other system's presentation layer. Therefore, the RPA bot is non-interfering or invasive for organization work beyond the explicit instructions executed by the bot's design. 4) Finally, RPA is a secure and scalable technology that executes on the enterprise-protected platform. It can be configured, audited, and managed at the enterprise or organizational level that utilizes this technology.

The output of a bot appears to be the product of code that functions "like a macro," but with more capabilities, options, and functionality that is not restricted to an application like Word or Excel. It can be visualized as a very smart, tireless, and sophisticated desktop assistant. The bot appears as a powerful worker or "aid" that performs scripting and screen scraping (record and replay), acts quickly, and is able to record (without error) what it is doing. The bot replicates the assigned task repeatedly (tirelessly) – like a true robot. It is trained by watching a user's selections (of data or decisions), recording mouse clicks, matching inputs from the keyboard and completing the process as the user does. However, the bot is not intelligent – and does not know why it is doing this work since it only performs the assigned set of actions when called upon. (Madakam, Holmukhe, & Jaiswal, 2019; Peláez, & Kyriakou, 2008; Schmitz, Dietze, & Czarnecki, 2019).

RPA Products

Product Provider	Product name and Description
Power Automate	Power Automate is a business tool (Microsoft code) that automates business processes, sends task reminders, move business data between systems on a schedule, connects data sources or and publicly available APIs, can automate tasks on a local computer.
Automation Everywhere	Automation Anywhere consists of three core components – Bot Creator (drag and drop method to create rule-based automations), Control Room (hub for RPA robots start, paused, stop, or scheduling), and Bot Runner (run robots. provides the end-to-end status of the bot's execution back to the control room). The core components are used in tandem to build and deploy a successful automated workforce.
UiPath	UiPath offers complex and highly featured automation for more complex automation products (standalone end user - not integrated, hosted – on premise, cloud) corresponding to the user deployment requirements. Products include two development environments – Studio and StudioX (with limited capabilities), automations called assistant (bots), and an Orchestrator for management and control of the assistants. The cloud and hosted product link together and can exchange data when installed as Automation Suite.

Table 2: RPA Tools

There are a number of RPA products available in the market today. Three examples of these tools are provided in Table 2 to help students, readers and businesses understand the varying capabilities that can affect the choice of a tool for specific industry and target process. Students can use the prosed methodology with any of the tools. However, the ability of the tool to perform more complex task automation will depend upon the capabilities and functions available in a specific tool.

5. Project Based Learning (PBL) EDUCATION EXPERIENCE

What is Project Based Learning (PBL)?
Project-based learning (PBL) is a learning experience that engages students in experiential activities. The students are able to learn and develop skills while working in teams. This teaching approach stresses real-world projects that can be understood readily and have significance for the students. Larmer & Mergendoller (2010) propose the project be a task that matters and one that the students will want to do well. The project must be well designed and well implemented to serve its educational purpose.

Larmer & Mergendoller (2010) propose seven essential characteristics for these PBL experiences. The criteria listed in Table 3 are conceptual ways of engaging students in the exercise.

1	A Need to Know	Relevance of the information
2	A Driving Question	How to improve, reduce, speed up, etc.
3	Student Voice and Choice	How to reduce tedium, improve situation, minimize errors),
4	21st Century Skills	Collaboration, communication, sharing
5	Inquiry and Innovation	Gathering information, alternatives, suggestions for improvement
6	Feedback and Revision	Critiques, reviews, examinations of project work
7	Publically Presented Product	Exhibit and present the solution
	(Larmer & Mergendoller, 2010)	

Table 3: Essential Exercise Characteristics.

Amaral (2021) described how projects taught by using the PBL approach could have different goals, and actively involve students so they get their hands dirty. This work notes that students might learn and discover skills and materials required to complete the project. They will also reassess their learning process at the end of a project.

Value of PBL
The project technique is effective in imparting the

educational understanding and hands-on learning experience to students. Alacapınar (2008) assess how the delivery of a course using the project-based learning technique affects student opinions on cognitive, affective and psychomotor domains using questionnaires and semi-structured interviews. The results report on project technique effectiveness. The interview feedback results are that the project technique enhanced student creativity, helped them acquire high-level information, target domain skills, appreciation of group work and collaboration, and that separation into groups during the work consolidated affinity, trust, and friendship.

How PBL Works for Lean Six Sigma and RPA

The projects used in the class sessions apply the seven essential project design elements as a framework. The interesting and relevant problem is how to complete the work required of an administrative assistant in demanding situations. The situations are those where the work is tedious, repetitive, with manual steps, error prone and required to have very high accuracy. The work may also require display, moving (copy or cut/paste), reformatting and/or validating data submitted by emails, and through spreadsheets, and audits with summary reporting.

The project is meaningful for students because it is work derived from real world tasks, and essential to the job and eventual promotion. The project deliverable is a working system utilizing the RPA tool.

Appendix A lists the steps a student will execute to complete the analysis, design, and coding of an automation (bot) using two different RPA tools. The first exercise provides the steps for the use of Power Automate, a simpler and easier to use RPA tool with basic product features. The second exercise utilizes UiPath Studio to perform the task. This tool has more features and functionality. Appendix B lists the task actions a student will execute to complete an RPA project with straightforward output objectives. Appendix B task actions can be perfumed with either tool.

6. CONCLUSIONS

This paper describes the use of project-based learning to teach design skills for RPA development to management information system students. A Project-based team instruction approach is followed using open-ended projects to teach students critical analysis, design, and the implementation steps of developing Robotic Process Automation (RPA) for information systems. It describes why the project-based learning method is appropriate for teaching RPA analysis and design, and uses lean Six Sigma tools to perform the analysis needed to support a low-code/no-code development project. Lean Six Sigma is an important analysis step because of its analytical approach and complete documentation of logical steps needed to understand how to select and implement successful RPAs. The general issues considered in the design of class sessions emphasize the use of Lean Six Sigma and RPA in improving organization tasks. Consideration of the literature on the application of PBL suggests many skills, including problem solving, task design innovation, group-work and collaboration skills desired by employers can be improved with this approach. The paper discusses factors involved in the development of problem-based leaning (PBL) sessions, and summarizes exercises planned for the educational experience.

7. REFERENCES

Alacapınar, F. (2008). Effectiveness of project-based learning. Eurasian Journal of Educational Research, 32(1), 17-34.

Amaral, J. A. A. D. (2021). Using project-based learning to teach project-based learning: lessons learned. Pro-Posições, 32.

Beranic, T., Rek, P., & Heričko, M. (2020). Adoption and usability of low-code/no-code development tools. In Central European Conference on Information and Intelligent Systems (pp. 97-103). Faculty of Organization and Informatics Varazdin.

Bommadevara, N., Del Miglio, A., & Jansen, S. (2018). Cloud adoption to accelerate IT modernization. McKinsey Digital.

Byrne, G., Lubowe, D., & Blitz, A. (2007). Using a Lean Six Sigma approach to drive innovation. Strategy & Leadership.

Cocco, S. (2006). Student leadership development: The contribution of project-based learning. Unpublished Master's thesis. Royal Roads University, Victoria, BC.

Coronado, E., Mastrogiovanni, F., Indurkhya, B., & Venture, G. (2020). Visual programming environments for end-user development of intelligent and social robots, a systematic review. Journal of Computer Languages, 58(June 2020), 100970.

Dias, G. K. A. (2017). Evolvement of computer aided software engineering (CASE) Tools: A user experience. International journal of computer science and software engineering, 6(3), 55.

Evgeniou, T. (2002). Information integration and information strategies for adaptive enterprises. European Management Journal, 20(5), 486-494.

Engelsrud, A. (2019). Moving to the Cloud: Lift and Shift. In Managing PeopleSoft on the Oracle Cloud (pp. 229-242). Apress, Berkeley, CA.

Gattiker, T. F., & Goodhue, D. L. (2005). What happens after ERP implementation: understanding the impact of interdependence and differentiation on plant-level outcomes. MIS quarterly, 29(3),559-585.

George, M. L., Maxey, J., Rowlands, D. T., & Upton, M. (2004). *Lean six sigma pocket toolbook*. McGraw-Hill Professional Publishing.

Glass, R. L. (2005). IT failure rates-70% or 10-15%? *IEEE software*, *22*(3), 112-110.

Hailpern, B., & Tarr, P. (2006). Model-driven development: The good, the bad, and the ugly. IBM systems journal, 45(3), 451-461.

Hyun, C. Y. (2019). Design and Implementation of a Low-Code/No-Code System. International journal of advanced smart convergence, 8(4), 188-193.

Jalinus, N., Nabawi, R. A., & Mardin, A. (2017, September). The seven steps of project-based learning model to enhance productive competences of vocational students. In International Conference on Technology and Vocational Teachers (ICTVT 2017) (pp. 251-256). Atlantis Press.

Jones, W. (2002). Case tool time. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C41&q=%22CASE+Tool+Time%22++MSIS+488+Fall+2002++Walt+Jones&btnG= Last accessed: June 2, 2022.

Kuhn, D. L. (1989). *Selecting and effectively using a computer aided software engineering tool* (No. WSRC-RP-89-483; CONF-891192-7). Westinghouse Savannah River Co., Aiken, SC (United States).

Larmer, J., & Mergendoller, J. R. (2010). Seven essentials for project-based learning. Educational leadership, 68(1), 34-37.

Madakam, S., Holmukhe, R. M., & Jaiswal, D. K. (2019). The future digital work force: robotic process automation (RPA). JISTEM - Journal of Information Systems and Technology Management, 16.

Peláez, A. L., & Kyriakou, D. (2008). Robots, genes and bytes: technology development and social changes towards the year 2020. Technological Forecasting and Social Change, 75(8), 1176-1201.

Porter, M. E., & Millar, V. E. (1985). How information gives you competitive advantage.

Primer, A. (2015). Introduction to Robotic Process Automation. Institute for Robotic Process Automation.

Schmidt, A., Otto, B., & Österle, H. (2010). Integrating information systems: case studies on current challenges. Electronic Markets, 20(2), 161-174.

Schmidt, D. C. (2006). Model-driven engineering. Computer-IEEE Computer Society, 39(2), 25.

Schmitz, M., Dietze, C., & Czarnecki, C. (2019). Enabling digital transformation through robotic process automation at Deutsche Telekom. In Digitalization Cases (pp. 15-33). Springer, Cham.

Sharma, N. K. (2012). Management information system. International Journal of Management, IT and Engineering, 2(8), 553-570.

Sheik, P. A., & Sulphey, M. M. (2020). Enterprise Resource Planning (ERP) As a Potential Tool for Organizational Effectiveness. Webology, 17(2).

Villegas-Ch, W., García-Ortiz, J., & Sánchez-Viteri, S. (2021). Identification of the Factors That Influence University Learning with Low-Code/No-Code Artificial Intelligence Techniques. Electronics, 10(10), 1192.

White, R. E., & Pearson, J. N. (2001). JIT, system integration and customer service. International Journal of Physical Distribution & Logistics Management, 31(5), 313-333.

Yoshikuni, A. C., Galvão, F. R., & Albertin, A. L. (2021). Knowledge strategy planning and information system strategies enable dynamic capabilities innovation capabilities impacting firm performance. VINE Journal of Information and Knowledge Management Systems, 52(4), 508-530.

Yusuf, Y., Gunasekaran, A., & Abthorpe, M. S. (2004). Enterprise information systems project implementation: A case study of ERP in Rolls-Royce. International journal of production economics, 87(3), 251-266.

8. Product Appendix A

Product Exercise - Simple Exercise – Power Automate.

Tool Action Summary:

- Sign up and obtain Documentation. Sign up and sign in - Power Automate
- Power Automate, you can explore a diverse set of templates and learn about the key features for Power Automate. You can get a quick sense of what is possible and how Power Automate could help your business and your life.
- Analyze the desired process, to find an appropriate template (e.g., templates for sending you a text message, adding Twitter leads, backing up files...)
- Analyze the tasks and set conditions that trigger the flow and the action that result from that event (adjust, add, or delete actions).
- Select an appropriate flow type based upon the Lean Analysis (cloud flow, desktop, business process, etc.
- (Optional) Examine code by viewing code generated for all actions and triggers (for a clearer understanding of the data that's being used by triggers and actions) [Action or trigger > Peek code].
- Select a connector. Connectors are proxies or wrappers around an API that allows the underlying service to talk to Microsoft Power Automate. A user connects to build their app and workflow from software as a service (SaaS) connectors. This connects apps, data, and devices, etc.)
- Test and validate that the new actions and data were created.
- Execute or Run the new workflow. After creating and tested a desktop flow, run it from an event, schedule, or button.
- Manage the flow in Power Apps > select Flows in the left navigation pane

Product Exercise – Complex Exercise – Power Automate.

- Install the UiPath Studio (development tool) from UiPath, or local network.
- Enter required information (name device ID – if not present, > Activate
- 2. Open and select a project, activity (press a key, enter a number, etc.) and sequence (combined task) designation.

  >Choose from: Plan, Simple (template/flow hart – for different sequence of activates), Agent (shortcut for improvement), Transactional (uses states – e.g., loading, execute shut-does – not moving until all tasks for the project are completed

- Build the project. Create a name,

  Add a function (record, scrape, user event, value), >Run, test
  Scrape (screen or web), user event (keyboard or mouse entry). Set variables
  Create file (separate parts of the automation)
  Activity – drag and drop into the activity program (pane).
- Domains (7) – UI domain – keyboard, mouse. (drag/drop activates according to the project logic),
- User events (triggers); orchestrator – depending upon edition; system (delete, open); condition programs (fi. Else); workflow - sequencing
- Properties – set addresses, locations
- Control bar – Used to create the components for variables, arguments, imports.
- Create an automation.
- Test and install in production

9. Project Activity Appendix B

1. Create file output from Excel (Task assignment, Excel file, output required)

2. Create email upon task completion. (Task assignment, Excel (or other source file), email message - output required)

3. Create message of data arrival, update file. (Trigger for automation, Excel (or other record file), email message - output required)