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E-LEARNING COURSE DESIGN IN ADDIE METHODOLOGY AS A PROCESS IN BPMN 2.0

PROJEKTOWANIE KURSU E-LEARNINGOWEGO W METODYCE ADDIE JAKO PROCES W NOTACJI BPMN 2.0

Abstract: The aim of the article is to apply selected business processes modelling notation BPMN in e-learning design to enable the e-learning team to use ADDIE methodology decomposed as a process. In the first part of the article some basic issues of the educational and organizational context of the process are presented. The second part explains the ADDIE methodology. Next, BPMN implementation in designing the online course process is proposed. The article is an introductory part of research aiming to optimize e-learning creation processes in business.

Keywords: e-learning, ADDIE methodology, BPMN, process, instructional design.

Streszczenie: Celem artykułu jest zastosowanie w projektowaniu e-learningu wybranego sposobu modelowania procesów biznesowych. Użycie notacji BPMN umożliwia zespołowi e-learningowemu dekompozycję etapów metodologii ADDIE i przedstawienie ich jako procesu. W pierwszej części artykułu przedstawiono podstawowe zagadnienia opisujące edukacyjno-organizacyjny kontekst tego procesu. Druga część wyjaśnia metodologię ADDIE. Następnie zaproponowano przykładowe diagramy BPMN porządkujące proces tworzenia

kursu *online*. Artykuł jest wstępną częścią badań, których celem jest optymalizacja procesów tworzenia e-learningu w biznesie.

Słowa kluczowe: e-learning, metodyka ADDIE, notacja BPMN, proces, projektowanie e-learningu.

1. Introduction

Education, together with its related and accompanying disciplines, needs creativity from all its participants. Educators are expected not only to have the subject matter knowledge, but also the ability to engage and motivate. The students are to search for solutions, not just acquire knowledge and train for new skills. Information technology delivers tools to facilitate communication, allowing to focus more on creative activities. E-learning, becoming more common in schools, universities and business, can be a great way to enhance personal potential. It needs careful, deeply thought-through preparation, complying with all the participants' needs and abilities. It should be referred to as a process. Modelling has a great importance for better understanding and analysing (Azouzi, Ayachi Ghannouchi, & Brahmi, 2017). BPMN (Business Process Modelling Notation), designed to cover many types of modelling, can be applied to present the tasks, activities and communication flow in the e-learning process, considered a proper tool for any business project and much more promising and universal than e.g. Petri net (Chomiak-Orsa & Kołtonowska, 2018). To make the process even more orderly and adjusted to the educational context, ADDIE methodology can be used. It is well known in instructional design and even more common in e-learning objects development. Instructional design, which contains planning and delivering instruction as well as assessing student learning (Skowron, 1997), is a broader process than the instructional strategies that a teacher uses in the classroom (Hamdani, Gharbaghi, & Rio, 2011). In the literature, instructional design is viewed as a form of complex problem solving, not only as a visual representation or framework of the process. According to Merrill et al. (Merrill, Drake, Lacy, & Pratt, 1996), "*instruction is a science and instructional design is a technology founded in this science*". Its aim is to develop learning experiences and environments which promote the acquisition of specific knowledge and skill by students (ibidem). In the cited works there is an interesting definition of students and learners, showing the slight difference between these concepts. Students are specified precisely as those who "*submit themselves to the acquisition of specific knowledge and skill from instruction*", while learners "*derive meaning and change their behaviour based on their experiences*". Thus in this article, students are the target group to which the proposed model refers.

Various approaches applying both ADDIE methodology and BPMN diagrams, exist in the literature focusing on milestones (e.g. Vogelsang, Droit, & Liere-

Netheler, 2019), detailing the teaching and learning activities of participants in an e-learning course in the planning phase (Morais, Pedrosa, Fontes, Cravino, & Morgado, 2020). Other authors use BPMN to present the global e-learning process referring to the IMS Learning Design standard (Azouzi et al., 2020) in the context of cloud computing use for e-learning.

To succeed in instructional design it is essential to use proper methods that provide the structure and guidelines. According to Grover and Kettinger (Grover & Kettinger, 2000, p. 167), a method, informally is almost equal to a procedure for doing something and may have a representational notation enabling better communication. In more formal terms, a method consists of definition, discipline and use, as shown in Figures 1. The definition includes the concepts, motivation and theory that support the method. The discipline covers the syntax of the method, a computer-interpretable format and a procedure giving information about why and how the process is meant to be done. The use means how the method will be applied in a specific context.
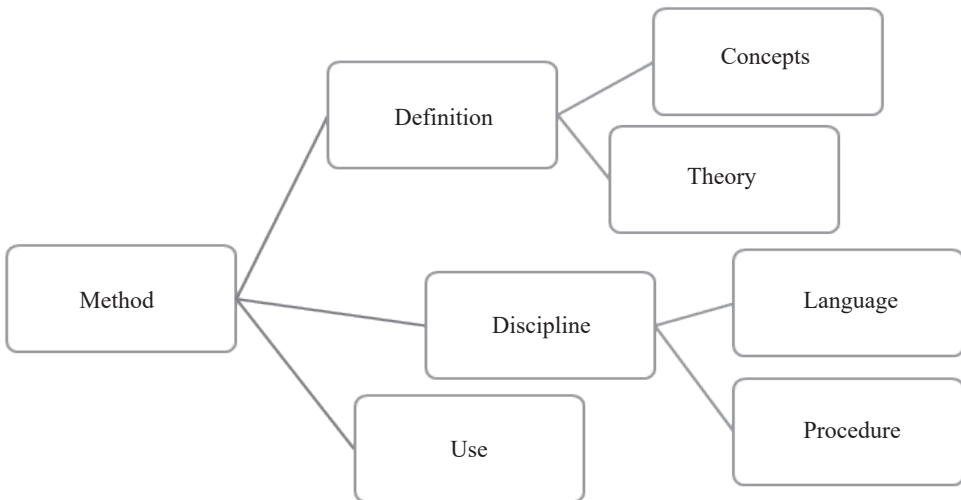

Fig. 1. Ideogram of a method

Source: (Grover & Kettinger, 2000).

A more detailed approach describing a conceptual framework devoted to creating learning objects, was proposed by Queiros et al. (Queiros, da Silveira, & da Silva Correia-Neto, 2016). Figure 2 shows a graphic scheme of this framework. It contains the concepts, tools and methods used in the process of a learning object development. One of its components is the Business Process Management with its notation BPMN. This notation will be discussed in a further part of this study.
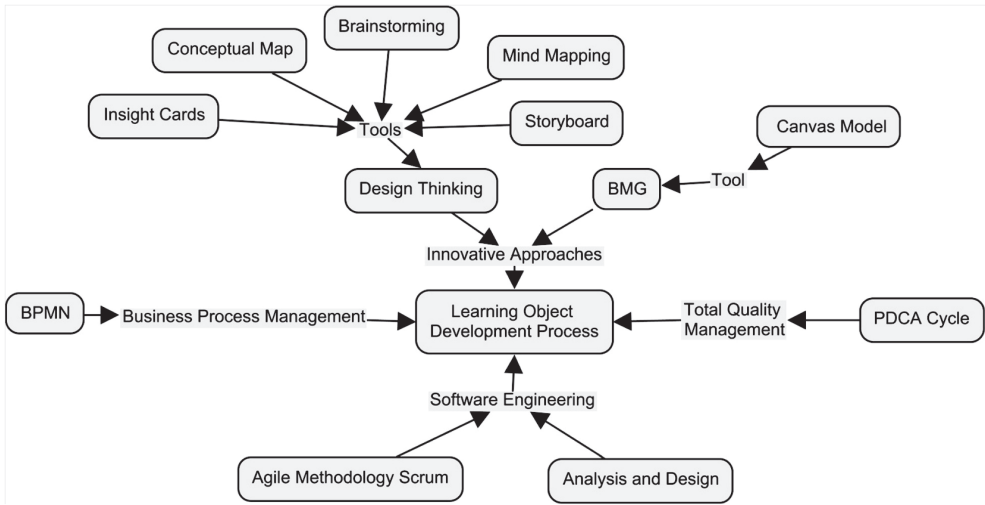
Fig. 2. Conceptual framework in LODPRO: learning objects development process
Source: (Queiros, da Silveira, & da Silva Correia-Neto, 2016).

Based on the conceptual framework, Queiros et al. (2016) propose a BPMN diagram for the learning objects development process, divided into four stages according to the PDCA (plan–do–check–act) iterative management method. This is a very interesting approach, referring to the ADDIE[1] model in the Analysis and Design part. The ADDIE methodology is presented in the next section of this article.

2. ADDIE methodology

Instructional designers often base their projects on the ADDIE methodology used in product development. This methodology describes a generic instructional design paradigm. The name of this concept is an acronym for: Analyse, Design, Develop, Implement, and Evaluate. ADDIE is a five-phase approach to building effective learning solutions (Branch, 2009). When applying ADDIE in education, one should have a special philosophy in mind: intentional learning should be studentcentred, innovative, authentic, and inspirational. The aim of applying ADDIE in instructional design is to generate episodes of intentional learning (Ghirardini, 2011).

Initially ADDIE was developed in Florida State University for military inter-service training purposes (Branson et al., 1975). Its aim was to explain "*the processes involved in the formulation of an instructional systems development (ISD) program (...) to adequately train individuals to do a particular job and which can also be applied to any inter-service curriculum development activity.*" ADDIE is the overall, general view of what is going on during the process and is in line with the concepts

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[1] ADDIE: Analyse, Design, Develop, Implement, and Evaluate.

of Inputs, Controls, Mechanisms and Outputs, known as ICOM model (presented in Figure 3), which is more generally put into the Input-Process-Output (IPO) paradigm (Figure 4) cited by Branch (Branch, 2009). The ICOM model assumes that each activity is covered by a verb-based label placed in a box. The idea of ICOM is a part of a broader concept of the IDEF0 Functional Modelling method which is designed in order to model the decisions, actions, and activities of an organization or system (Grover & Kettinger, 2000). In IDEF0 methodology there is only one type of box (representing a single process), conventional inputs and outputs, and two other types of arrow which represent "Controls" and "Mechanisms". To distinguish an input and control items, it should be verified whether they change; inputs are always modified, transformed in order to become the outputs. Controls come in the form of standards, plans, templates or checklists and are not often changed. Mechanisms include the resources (people with particular skills, machines) and tools that are required to complete the process.
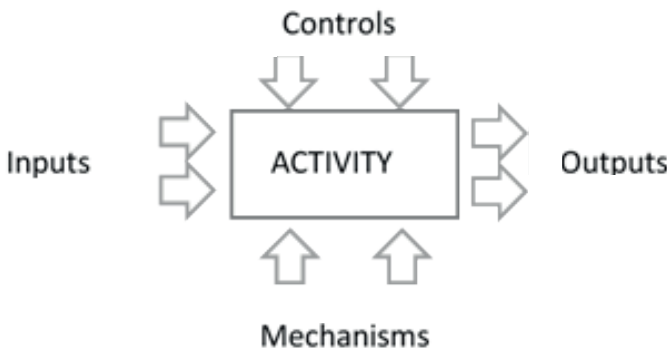

Fig. 3. IDEF0 ICOM notation

Source: (Grover & Kettinger, 2000).

Fig. 4. Input-Process-Output (IPO) paradigm

Source: (Branch, 2009).

Even though ADDIE is a universal and commonly used methodology in instructional design, it has some deficiencies when concerning todays requirements. Flexibility and adaptability to the needs of the target group of students may imply the presence of agile development principles (Drljača, Latinović, Stanković, & Cvetković, 2017). The solution may be SAM (*Successive Approximation Model*) including prototyping. In SAM, a more cyclical process, which is often considered as an alternative to ADDIE, collaboration, efficiency and repetition, are emphasized. Nevertheless, SAM is not a totally new approach that would replace ADDIE. It complements some areas, whilst not overwriting the whole methodology.

Determined and extracted tasks in e-learning process design could be presented in e.g. Gantt chart, but this would be a very flat solution due to some limitations of this tool. A Gantt chart is a perfect add-on in e-learning project management, showing how the tasks are spread out in time. However, when it comes to indicating the relationships between the actors of the process, one should use another tool. In considering e-learning design as a business process, one can use BPMN 2.0 in order to show the activities, their relationships and the flow.

3. Business Process Model and Notation (BPMN 2.0)

The process of e-learning course preparation can be very long and complex. Thus the role of a supervisor or even a project manager should be considered in the process to ensure its correct realization. When transforming a course into an online form or creating it from scratch, it is not enough to provide the materials (usually presentations or pdf files) and make them available on the Internet. The role of the teacher should be determined – whether he or she is to help the learners understand the subject, or to become more of a guide and mentor. Especially when a full online course is considered, without the presence of a teacher or moderator, each phase of the learning process should be deeply thought-out and discussed. Moreover, a series of scenarios should be prepared, including various paths that the learner can choose or which will be the results of the learners decisions and progress (Skowron, 2006). In this article the business roles present in the e-learning course creation process are included in a form of a BPMN diagram. This should facilitate teamwork, and communication as well as process management. Designing the e-learning process requires a lot of creativity, as nowadays it is not enough to transfer pieces of knowledge into a presentation and deliver it to the learners. E-learning can be a very empowering tool, depending on the e-learning team's approach. The main actors performing the tasks in the course creation process are (Bąkała 2018): Subject Matter Experts (SMEs), Instructional Designer (ID, E-learning Methodologist), E-learning Designer (Graphic Designer, IT specialist). Their creativity and customer knowledge determine the level to which the course can engage learners. In this model, the teamwork approach is proposed. The communication is the core of the idea.

The goals of an organization can be defined by a business process containing a set of activities to create a value for the customers (it can be a product or a service). To enable all business users (business analysts, technical developers as well as the managers) to properly understand the business processes, a graphic notation Business Process Modeling Notation (BPMN) was developed by the Object Management Group (OMG 2013a, 1). As it comes from OMG documentation, BPMN "provides business with the capability of understanding their internal business procedures and communicate these procedures in a standard manner" (OMG, 2013b, 2).

BPMN has become a standard for process modelling, it is mostly used to express the normal execution flow of business processes, without errors (Meland & Gjære, 2012). BPMN recently has also been accepted as an ISO standard ISO/IEC 19510:2013 Information technology — Object Management Group Business Process Model and Notation (Geiger, Harrer, Lenhard, & Wirtz, 2018) in order to "provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes" (OMG, 2013a).

In this article, a process diagram showing the activities and roles for e-learning design is proposed. To prepare this in BPMN 2.0, Bizagi Modeler (Software for Business Process Model and Notation, n.d.) software was used.

3.1. BPMN diagram of the e-learning design process

The e-learning design process usually engages a few entities and roles. BPMN enables to show various activities and their relationships in collaboration diagrams (Ladleif, Weltzien, & Weste, 2019). Presenting the activities, tasks and the process flow on a graphical scheme allows to visualize better. In this section, BPMN was used to present the relationships and interactions in the e-learning design process, and considered a scenario of preparing e-learning course with the use of the ADDIE methodology. The entities are shown in "pools" – the big rectangles which represent participants in the collaboration process. They can contain "lanes" with business roles. The interaction between participants is represented with message exchange, which is modelled with message flows that connect two pools. A pool may be empty or may show a process within. An empty pool is commonly known as a 'black box' and may be modelled as a simple rectangle. Interaction between two empty pools is shown with message flows which connect the borders of interacting pools. In this study there are basically two entities: the e-learning team and the client. The client's pool is shown as a black box and the e-learning team's pool is completed with the activities represented by rectangles inside the pools. In further process modelling there can be distinguished specified roles within the pool (e.g. SME, ID, Manager) in the form of lanes.

In the example below a collaboration diagram is proposed, representing interactions between two processes. Each individual process can represent a person,

role, or system, in this case the e-learning team collaborates with a client when the first (upper) path is triggered. Collaboration diagrams are quite commonly used and are easy to recognize due to consisting of more than one pool. A pool may be in the form of a black box, or may show a process within. The process can be instantiated with the use of an Exclusive Event Gateway. When the first event of the gateway's configuration is triggered, the process starts.

In Figure 5 there are two events that can initiate the process: receiving a request from a client, and receiving a signal about a training demand. The signal may come from outside of the organization, it can also be a result of a survey. For example, when Covid-19 restrictions changed the educational landscape in March 2020, it was natural and obvious that many teachers would need some training in e-learning tools enabling them to teach online. There were a lot of e-learning training providers who reacted to this demand and prepared valuable courses. Depending on the marketing strategy, the course can be sent to the customer or available for sale in various distribution channels. The marketing strategy is a subprocess in the presented diagram and can be expanded to show some details, however these are not the topic of this article. The alternative path goes through the message event with the request from a client. This means a situation when the client triggers the process and his/her request needs further arrangements shown in the next subprocess. In this stage, as well as in the marketing strategy, a documentation should be prepared that will be used for the distribution plan when the course is already prepared. The process ends with a message sent to the client, or a signal sent, for example, as an announcement. The activities on the client's side are put into the black box and not presented in detail. Only the communication in the form of message flows is shown between the pools.
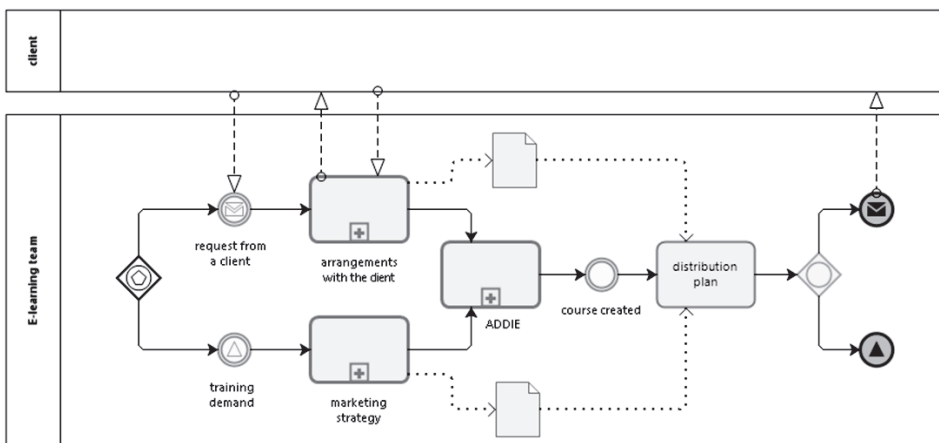

Fig. 5. E-learning course preparation process diagram

Source: own elaboration.

The idea presented above can be referred to as the ADDIE methodology. General areas of responsibility for key roles in the ADDIE process are presented in Figure 6. The abbreviation SME means Subject Matter Expert and ID stands for Instructional Designer. The whole process should be supported, and monitored by the HR manager and technical specialist.
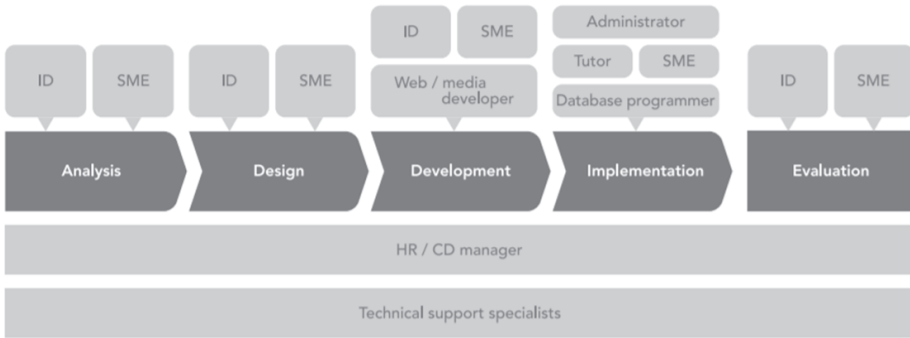

Fig. 6. Areas of responsibility for key roles in the ADDIE process

Source: (Ghirardini, 2011).

These areas allow to assign the roles, however they do not show the interactions and details essential for the Project Manager (PM) to plan the communication and schedule. In the proposed process diagram the detailed tasks are included as well as the events that influence the stages of the process, complying with the interdependence of certain activities. The general linear form of the Analysis process is shown in Figure 7. The owner of the process is the PM, but each of the activities presented in the rectangles requires other actors, performers, and partners.
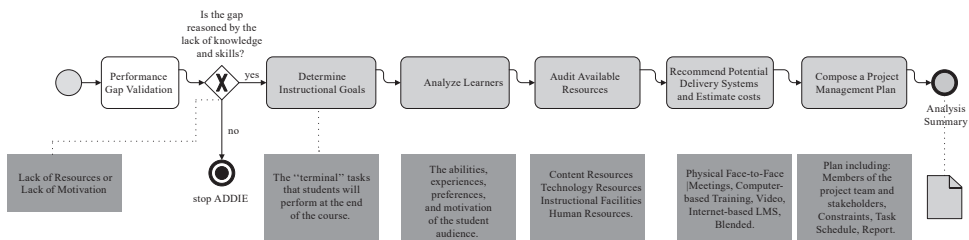

Fig. 7. The analysis phase of the ADDIE methodology in BPMN 2.0 standard

Source: own elaboration.

The first task in the above diagram (Figure 7), "Performance Gap Validation", means the necessity to conduct the needs analysis first. In this step there are two issues: the reason of the gap which is validated, and determining whether e-learning is the best solution to deliver the training. In this article the lack of knowledge and skills is assumed as the reason of the performance gap and e-learning is indicated as an appropriate training delivery solution. If the performance gap is of another nature, it is advised to stop the ADDIE process. Otherwise one can start the *Analysis phase*.

4. Conclusion and future work

In this article, a diagram of the Analysis phase in the ADDIE model is presented. The proposed solution consists of several stages and shows what business roles should be engaged to manage the process effectively. With the use of BPMN 2.0 the activities to undertake after the task "performance gap validation" are shown. BPMN, designed to cover various types of modelling, does not fully address the time dimension so far. As the systematic literature review shows, there are some compliant extensions proposed (Cheikhrouhou, Kallel, Guermouche, & Jmaiel, 2013), other extensions have also been formulated such as the one for risk handling (Marcinkowski & Kuciapski, 2012; Sameh, Ghannouchi, & Brahmi, 2017). The possibility to develop the standard shows its potential to be adapted to various requirements. To help practitioners better learn, understand and use BPMN, and a technique that supports the evolution of BPMN diagrams and on learning BPMN notation can be proposed (Campos, Lopes, Gadelha, Conte, & Oliveira, 2019).

As the article shows, e-learning design can be presented as a process diagram which helps the entities engaged in the process to better understand the roles and interactions. Additionally, from the project manager's point of view this kind of graphic representation of the process flow allows for the subsequent optimization of the process.

In some cases multi-instance collaboration appears, making the BPMN diagram ambiguous. This can be improved by adding some artefacts explaining the cases, and adding Gantt's charts will also be helpful. In future work, sequential tasks can be analysed and decomposed in order to show the responsibility details and enable the PM to prepare the project management plan regarding the partners, business roles and communication.

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