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Rule-Based Automation in Moodle for Self-Instructional Learning

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ABSTRACT

The design and development of a self-instructional course within a Moodle learning management system (LMS) requires consideration of various elements and operational definitions to achieve effective implementation. This study aims to specify, in a practical way, procedures and automation guidelines in Moodle based on the experience of instructional design; and the structuring of online activities through the programming of automated flows by configuring conditional rules and the integration of a virtual assistant to attend general queries with a Chatbot tool named Dialogflow from Google.

The instructional organization has been validated with a design-based research methodology through an iterative development model involving analyzing practical problems, evaluating, testing solutions, documenting, and reflecting on the implemented design principles. This experience proposes in its development three successive versions with continuous improvements of a self-instructional course, with the participation of 300 teachers, who tested the training itinerary, advancing through the sequence of resources and activities according to the programmed conditions.

A method of successive validation with continuous improvements allows identifying elements susceptible to be changed and restructured and analysis tools according to metrics provided by Moodle, verifying the users' participation and tracking progress based on learning automation processes.

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Keywords:
Instructional Design, Online Education/Virtual Education, Self-Learning

INTRODUCTION

Proposing a self-training course development requires didactic considerations in its initial design and planning process since the structure of resources and activities must be aligned with an instructional model that consistently guides the organization of the course, intuitively facilitating the navigability and autonomous participation of students. This way, the virtual courses must be organized based on a design proposed from previous theoretical-pedagogical models, with precise guidelines for implementing resources, activities, and evaluative actions.

The pedagogical action in a self-instructional format must be specified in the design, mediation, monitoring,g and feedback around the learning activities (Debattista, M. 2018). We understand that in a traditional training process, the tutor accompanies their students, facilitating guidelines for workshops, giving instructions, presenting and analyzing cases or situations in authentic contexts, ultimately mediating and strengthening a virtual space as a learning community. However, in a process without a tutor or teacher support, the role of monitoring, feedback, communicative mediation, and guidance of the learning process; must be provided by automated means.

This substitution of the teaching role, by structured means based on predetermined responses or decision adjustments in progress, with information and emerging activities based on conditionalities and rule-based systems, is assumed as a primary element in a self-instructional virtual training process. From the point of view of instructional design for virtuality, this automation must combine instructional dynamics with social dynamics (De Oliveria, 2016), understanding that the access, review, and guide or feedback of the content must focus on communicative instances, both with the other participants and with a tutor or assistant who is capable of resolving doubts, queries or concerns.

METHODOLOGY

This study is a design-based research model with repetitive tests applied in the design, development, and implementation

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stages. This strategy is appropriate for creating didactic curricular materials, going from an initial version to a refined model after reiterative changes made during piloting, and continuously delivering improved versions.

This methodology allows narrowing the gap between research models and educational practices, feasibly carrying out permanent innovation proposals from a more dynamic perspective than traditional research, as a process focused properly on developing and validating curricular products. (Joyce. Et al. 2014).

LITERATURE REVIEW

Virtual platforms and their online development

Virtual education is the natural heir to traditional distance education, where units of study, initially based on paper or printed material, were transformed into a digital format. The first programs were defined under an e-reading model. They advanced to online environments with the ability to interact with a tutor, and resources such as videos and audio tapes transformed physical support towards digitization. These new formats allowed access from limited print editions and video recordings to unlimited digital items with online updating, universally shared through Internet networks. The changes and impact on education are remarkable, from the development of multimedia-hypermedia, to what we know today as web 4.0, and already appearing overwhelmingly, virtual and immersive reality propose new resources for the educational process. (Rosyadi, B. R., Nisa, K., Afandi, I., Rozi, et. al; 2021, February).

From a functional point of view, education with support media or online technology platforms, thanks to the e-learning model, can safeguard complex pedagogical processes that allow different access problems to be solved, such as non-attendance of students for health reasons, complexities of labor, commuting time problems, and others. In this sense, e-learning becomes an ally of personal and professional development by allowing continuing education and training processes with the facilitation of ubiquitous participation anytime, anyplace, with the option of revising recordings of synchronous activities such as video classes and conferences.

Moodle and features for the design of virtual courses

In recent decades, various technological solutions have been developed to manage training processes over the Internet. Various platforms have been positioned internationally with considerable acceptance and validation of educational processes. One of the most used platforms to manage online learning is Moodle, which facilitates the construction of participatory spaces mediated by resources and activities, incorporating tools for management, automation, monitoring, and feedback (Satriani, E., Zaim, M., & Ermanto, E. 2021).

Moodle is a platform created in 2002 as a free and open source proposal to develop learning on the Internet. This way, it is defined in the LCMS (Learning Content Management Systems), learning management solutions, or platforms. Its creator, Martin Dougiamas, proposes a virtual space capable of managing constructivist learning activities, with a wide variety of tools for teaching and synchronous and asynchronous communication. Moodle offers a flexible space that proposes much more than a simple repository of resources, facilitating easy participation and monitoring of actions. It is proposed as a digital context focused on the student, mediating cooperative learning, which in generic terms allows interactivity, flexibility, participation, and continuous tracking.

Automated didactic design according to the rules system in Moodle

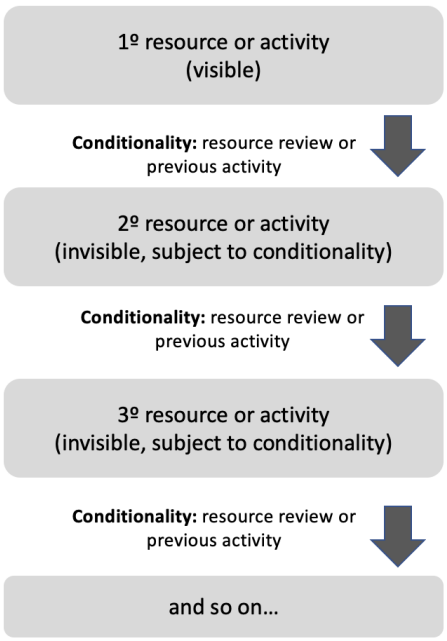
To automate self-instructional training processes, Moodle allows access to both resources and activities according to the conditionality of previous actions; in such a way, the flow of actions can be automated depending on whether the student goes through content review and achievement of activities.

PROCEDURES

Organization of conditionality route for the automation of the advancement process in Moodle

The access to each resource can be conditioned based on a previous situation; the student progresses and achieves the activities, visualizing the contents and subsequent actions. In Moodle, the conditionality system to configure access to resources or activities is defined in terms of adding a restriction to such objects (resources and activities) to create a learning sequence that can be automated.

Fig. 1 Conditionality path between content and activities in Moodle



Typology of restrictions to automate conditionality of access to resources and subsequent activities in Moodle

Moodle allows the management of the conditionality of access to resources and activities through the restrictions of activity completion, date, grade, and user profile, in such a way. Access to subsequent activities or resources may be based on compliance with previous fulfillment of requirements.

Fig. 2. Types of restrictions to access content or activities in Moodle

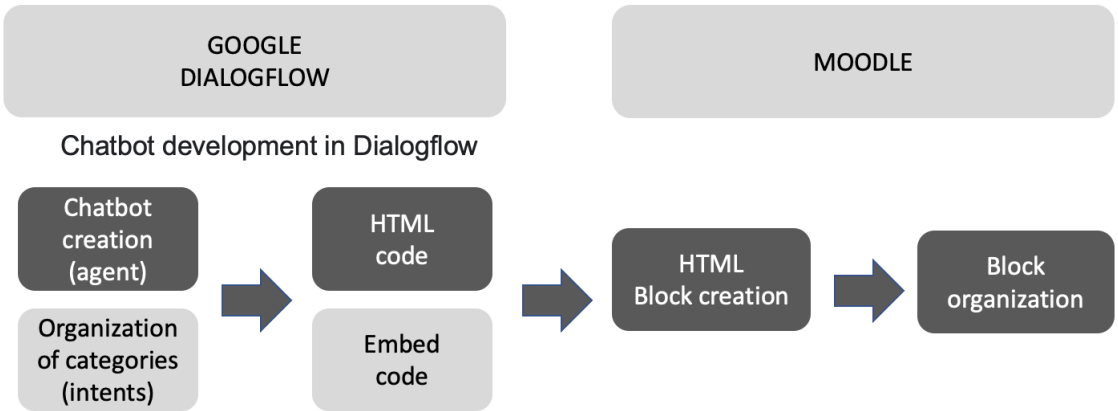
The virtual assistant as a means of interaction in virtual classrooms

By proposing 100% online self-instructional training spaces, it is essential to facilitate communicative and expressive strategies of opinion and interaction with others. It is an innate act to look for spaces or instances of communication to carry out an educational activity so that, if there are no options for participation and intercommunication, the degree of discouragement and desertion increases drastically. Faced with this reality of self-instructional training practices, all instances of communicative participation that Moodle facilitates should be taken advantage of, including incorporating other tools by embedding external resources that facilitate the possibility of attending to queries, doubts, or requirements by students (Gamage, D., Fernando, S., and Perera; I., 2015)

Virtual assistant implemented in Moodle.

One of the actions for assistance with emerging queries without requiring the participation of a tutor or pedagogical mediator is implementing automated tools to answer questions through virtual assistants or Chatbots (Shilowaras, M., & Jusoh, N. A. 2022). Every day, the use of intelligent systems with the use of programming based on natural language management by chat becomes more common and easier to implement, understanding that the programming of frequently asked questions is an actual situation to get good results of interactions between the students and the automated machine. The integration of virtual assistants or chatbots in Moodle is achieved by using HTML code with external tools, as in this specific proposal, inserting an assistant created with the Google © DialogFlow tool.

Fig. 3. Chatbot development process in Dialogflow and its integration in Moodle



Didactic model for virtual course design

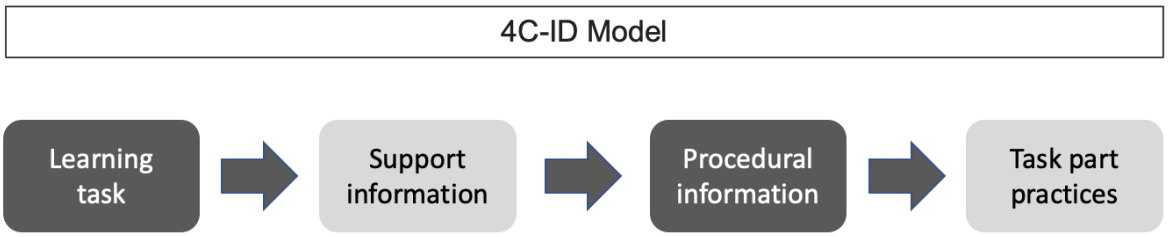
When speaking of a model, it refers to a framework that gives meaning and coherence to all teaching actions based on the didactic, evaluative, methodological, and execution elements of teaching. In this way, the development role of a teaching action always entails identifying which will be the teaching

model to be implemented in coherence with a common thread to all educational actions. In this way, proposing a didactic model as a structuring element of a virtual training program refers to the ability to discriminate the most appropriate instructional tool according to the situation or learning activity, determining relevance, availability, and technical-technological feasibilities. Nevertheless, the most important thing is to give a sense of didactic coherence based on an educational model; for example, if the instructional model is proposed from a competency-based framework, the activities and contents must be aligned with the disaggregation in knowledge, procedures, and attitudes. (Ghirardini, B. 2011).

Based on the didactic models for the training support of self-instructional courses, the international experience in MOOCs formats (massive open online courses) originated from extensive research and modeling from the Zero project at Harvard. This initial experience supports teaching with a focus on understanding, which refers to delimiting the focus of content and online activities to the minimum elements.

All activities, tasks, and contents must be short and focused on the specific learning objective and present information in multiple ways supported by multimedia, promoting interaction with other participants to create a collaborative virtual learning community, considering the lack of a teacher, mediator, or tutor. These elements on a virtual platform must be broken down into three essential components: resources, activities, and evaluation. In this way, a didactic model refers to constructing a virtual course that can be organized on a path between various resources and activities sequentially.

Fig. 4. Resources for implementing the 4C-DI Didactic Model



The 4C-ID didactic model

This model is proposed as a structural framework for instructional design, facilitating the development of educational programs through specific guidelines to strengthen the development of complex skills within an online training process under a framework of competencies. Its structural elements define four fundamental components: learning tasks, support information, procedural information, and information referring to parts of some task (Van Merriënboer, J. J. G., & Kirschner, P. A; 2018)

4C-ID: Learning Tasks

The initial component based on the learning tasks is the nuclear axis of the instructional design based on this didactic model, proposing a diversity of options in the presentation of the tasks through the use of cases, requirements and project development, proposals of tasks based on problem-solving, simulation actions in authentic contexts. Learning tasks must be considered in a context of complexity, subtracting knowledge, skills, and attitudinal elements, referring to a training framework under a competency approach. Thus, it requires integrating skills based on knowledge, procedures, and attitudes.

Another exciting element that this model poses is organizing the presentation of learning tasks based on a scaffolding structure through the variability of complexity, proposing gradualness and progress in the variability of practice through inductive learning proposing concrete learning experiences

4C-ID: Supporting information

The second component of this instructional model proposes that support information should be presented in a way that facilitates the development of learning tasks for students, traditionally going beyond a simple complement of conceptual or theoretical content, for example, representing information through graphic organizers, cognitive schemes in association with mental models underlying the proposed information, structural models.

In short, complementary information provides a link between previous knowledge and new information to be able to carry out learning tasks. This data should make it easier for students to establish significant relationships between the various concepts or elements of information presented and structure their previous knowledge in cognitive conflicts to reconstruct and develop new learning and restructure new mindsets. It is essential to promote access to complementary information based on the demands of the complexity of a task in such a way that the need for a more complex activity necessarily requires more significant support from additional resources to facilitate the proposed learning.

4C-ID: Procedural information

This third component of the instructional model refers to giving guidelines for the development of procedures by the student, for example, tutorials with instructions on how to do the activities or step-by-step guides to solve the demands of the tasks correctly. It is also essential to approach the

presentation and gradually access procedural support information to disaggregate the guidelines to solve a complex task in various processes.

This method is a fundamental component in transferring skills that have to do with applications or software, where the manuals have become a reference as an instructional resource for procedural support.

4C-ID: Practicing a part or specific tasks

This fourth component is the space where actions are proposed that require practice by students, in such a way that in an approach based on a competency approach, knowledge not only remains in the conceptual declarative, but there must be a transfer and application toward practical elements of doing. The learning tasks must propose options of activities necessary for the students to master the skills and procedures proposed in the learning goals.

This instructional model defines the obligation to subdivide practical activities into various actions that progressively and sequentially facilitate the complex mastery of a task so that it is proposed to specify practices for parts of a task. In this way, facilitating actions based on exercising practices in partial tasks support the learning of more complete and significant tasks. The achievement of a complex task must be built on a progressive scaffolding subdivided into partial practices.

Course design in a virtual platform

For the specific implementation of the micro-course on a virtual platform, the previous elements are designed as a reference for ideation and planning for its subsequent development, considering a learning route as navigation and graphic organizer before presenting at the beginning of each unit and subsequently the various elements that build the learning experience for students, which is evidenced in content and activities. (Suartama, I. K., Setyosari, P., & Ulfa, S; 2019). The learning route is the first edition of specifying the fluidity of the micro-curricular course, which allows solving the previous path to organize the sequence of elements and its programming based on the conditionality of progress and define the transit of review of both content and student participation in activities.

The potential of the training activities on virtual platforms and the benefit of their records

Understanding that participation in educational action mediated by technological environments records behaviors and actions that participants perform, an ideal environment is identified for data collection to propose analysis and study models on this new learning reality. Therefore, the use of online platforms facilitates the recording of metrics with indicators and the definition of interaction between various factors, allowing the validation of analytical models by verifying the causal effects, also guaranteeing clarity in the measurement and identification of specified variables and in this way, advance the understanding of student performance (Dondorf, T., Pyka, C., Gramlich, R., Sewilam, H., & Nacken, H. 2019).

New analysis procedures are proposed for educational research based on this excellent opportunity to have records of actions and evidence of participants' behavior on online platforms. There are several technological resources for monitoring referred to the analytical management with student data, records, and analytics on the behavior of users in digital marketing or management of sales and purchases online; in such a way, those same procedures and techniques of registration or analysis, are being transferred to the educational field. There are applications and management of user behavior analysis systems with metrics and review of objectives to be met, such is the case, for example, of the Google Analytics © tools, which can be associated with Online Learning Management systems (LMS) like Moodle (Romero, E., Artal-Sevil, J. S., Mainar, E., & Rubio, B; 2018).

Tools and strategies for the implementation of a registration system in Moodle

In Moodle, the core of available tools allows the collection of records for analysis of actions and student participation, but as an open system, it accepts the integration of external plugins that facilitate the identification of metrics. In this proposal, data is collected from the participation registration report and the use of the complement of the analytical graph, which allows analyzing dedication times, achievements, and overcoming activities, as well as qualifying results and participation in general Kuo, R., Krahn, T., & Chang, M; 2021).

Add-on analytics tools for web action logging

When considering content implemented on the Internet, there are tracking and reporting tools that facilitate the identification of specific behavioral actions and records of browsing and participation in these online environments; in this specific project proposal, a code has been implemented to raise reports from Google Analytics (Papanikolaou, K., & Boubouka, M. 2020).

Google Analytics as registration support in virtual learning environments.

Google Analytics is a tool that allows general analysis of various actions from the records that the system makes based on the behavior of the participants in Web content. Although this platform was initially proposed to collect information associated with the development of digital marketing, its records and reports facilitate the understanding of some technical elements, such as the identification of technologies used by students on the Moodle website (Álvarez Méndez, A., Angulo Carrere, M. T., Cristobal Barrios, J., et. al. 2020).

Unfortunately, for a couple of years, Google has not provided individualized information due to policies on the use and management of data. However, all the reports are records based on collective behavior. However, even so, it yields valuable information that allows identifying characteristics such as geographical, positioning, access technology, navigation flow, and permanence, and built from these records, various graphic panels as a data summary. Then Google Analytics, from the educational point of view, provides us with global context information to assume an understanding of the participants' behaviors and actions in a generic way.

Development and implementation of the course

After the design and planning, the self-instructional course is implemented on the Moodle platform, considering the programming of activities, the uploading of resources, and the automation of the navigation flow based on overcoming conditionalities.

The implemented course has been subdivided into two units, organizing three participation and access cohorts, which allow successive validation instances to review iteratively with each cohort adjustment and improvement options.

Creation of sections and graphic support content

The structuring and organization of visual aids, such as section identification buttons, unit headers, and resource or activity icons, are essential elements to facilitate navigation and understanding of the flow of navigation through the course.

Development of instructional resources and implementation in the virtual classroom

The contents that facilitate the learning and development of proposed objectives are based on the instructional resources published sequentially in Moodle; then, the participants review the instructional resources to strengthen the acquisition of information, practice guidelines, and identification. Of procedures for carrying out the required activities.

In this course, video tutorials, procedural instructional resources, and content for review in digital lessons have been developed.

Scheduling activities on the platform and implementation

The flow of navigation in the course is open for students as they sequentially review proposed resources and overcome micro-assessment activities such as lessons, posts in forums, and homework submissions. Completing part or all of them is a condition to continue advancing or “unlocking” the following contents.

CONCLUSIONS

In the training processes mediated by virtual spaces in education, various studies have focused their interest on virtual actions as a complementary role to the formal training function and other associated elements, both technical, communicational, and practical. In this way, the self-instructional online training process as a complex construction of the teaching function and technological mediation implies a context of various elements or factors involved in the participants' learning. Before that, it becomes relevant to develop interactive design proposals for improvement and advance in realizing effective programs.

Today, the potential of data recording facilitates the Integration of behavioral analytical systems, and web analysis facilitates a new framework for educational research development known as learning analytics. This registration method allows the use of tools and complements for educational platforms, such as plugins that enrich registration options, analytics, and monitoring of their students in these digital training contexts.

This facilitation of the enormous amount of data from these online behavioral records proposes a new area of research and specific analysis to propose improvements based on virtual learning. The data records provided by various technological tools associated with the participation of students in these virtual environments allow: a) to analyze various evidence from the activities and participation of students, b) to associate these records based on the modeling of defining factors and interveners for the achievement of learning, c) to validate these previously proposed models, And in a practical way, give feedback to the participants in an automated and training process.

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