Analysis of data typologies in virtual learning environments to define the variable catalog of resources and activities

Benjamín Maraza-Quispe[1], Nicolas Caytuiro-Silva[2]
[1]Universidad Nacional de San Agustín de Arequipa
[2]Universidad Católica de Santa María de Arequipa

Abstract

The objective of the research is to perform an analysis of the typology of data in virtual learning environments (VLE) in order to define the variables of resources and activities in virtual learning environments (VLE) in order to improve the management of resources and activities. The methodology applied consisted of the analysis of the resources and activities of the Learning Management System (LMS) Moodle of the Faculty of Education of the National University of San Agustin de Arequipa, the phases of data understanding and data preparation of the LMS were implemented, through the analysis of the management of resources and classroom activities, the results show that the data stored in the LMS can potentially be used to measure, inform and improve the participation of students in the teaching-learning processes. However, in order to perform a complete analysis, variables that are part of the research proposal were additionally included, these variables are identified as factors that influence student performance and their inclusion in data mining projects requires more detailed research, likewise, resources and activities, their simple and derived attributes of each of them were observed, to define the type of objectives, either descriptive or predictive about each of the activities and resources. The results were satisfactory since they allowed defining the objectives and the type of variables to measure the effectiveness of these resources and activities in virtual learning environments to be effectively applied by teachers through the different courses in Virtual Learning Environments (VLE). The conclusions allow offering a methodological proposal for a better management of resources and activities in VLE.

Palabras clave: Typologies; analysis; resources; activities; environments; virtual; learning; catalog

Introduction

Knowing and using a methodology to effectively manage resources and activities in LMS is very necessary, especially now that the use of virtual learning environments has become widespread [1]. The face-to-face educational system necessarily migrated towards virtual teaching-learning environments, which generated new ways of understanding the educational process. Integrating information and communication technologies (ICT) to the educational process implies changes in the forms of communication, in the contents and forms of evaluation, changes in the role of the teacher and students, ICT can be used by teachers as technical-pedagogical support and by students as a tool for autonomous learning [2].

Learning Management System (LMS) is an effective platform for communication and collaboration among teachers and students to enhance learning. These LMSs are now widely used in both conventional and virtual and distance learning paradigms. These LMSs have various limitations as identified in the existing literature, including poor learning content, use of appropriate technology and usability issues. Poor usability leads to the distraction of users [3]. In this context, it is necessary to propose a methodology that allows for the adequate management of the teaching-learning processes in virtual learning environments.

Moodle does not include some navigational factors and those are implemented requiring improvements. The navigation factors of proposed framework that are not provided in Moodle are back to top link, site map, proper help and documentation, powerful search function, and shortcut key facility. In addition, there are no highlighting techniques implemented in Moodle, which can direct the users to important information or events. These are all essentials for an efficient navigation. Furthermore, customizability is also an important aspect of good navigation, but Moodle still does not allow users to customize pages/courses according to their need and preference. Some of the users are not satisfied that links are still visible to them even though these are not relevant to them [3].

This research presents a proposal for a methodology to adequately manage the resources and activities in LMS in order to organize the learning activities of students, how to evaluate, the type and preparation of students and teachers and the types of subjects.

[1] **Correspondencia:** Benjamín Maraza Quispe, bmaraza@unsa.edu.pe

State of the art

Usability of E-Learning Systems

According to International Organization for Standardization (ISO) 9241 [11], usability is defined as the degree to which a particular product is used by particular users to accomplish specific goal with efficiency, effectiveness and satisfaction in a precise standpoint used. Majority of the past studies on the usability of E-learning systems have been on exploring the usability of interface of E-learning systems and the links between usability features and the E-learning success. Usability has been defined differently as specified in components that are more specific i.e. learnability, memorability, errors and efficiency. Nielsen gives attention to expert users when talking about efficiency though learnability is directly related to efficiency. Memorability mostly relates to casual users and errors deal with those errors not covered by efficiency, which have more disastrous results. A comparable definition is given by Shneiderman; while defining usability of e-learning system looks at it as five measurable human factors central to evaluation of human factors goals; speed of performance, time to learn, retention over time, rate of errors by users and subjective satisfaction. Dix defines concepts entailing system usability; learnability, flexibility and robustness signifying that those concepts are on the similar abstraction level [4].

E-Learning Processes

E-Learning is a revolutionary and very promising field that brings about a radical change in the field of learning. Web based technologies are used to create virtual classrooms with attractive materials and resources, and provides a wide range of solutions that support the learning process and services that are accessible anytime from anywhere. Interactions of students with an E-Learning platform often come in three forms: Learner-learner, Learner-instructor and Learner-content. Learning Analytics (LA) is a recent field of research and development of tools and technologies that help to analyze and understand the interactions of learners with educational resources. In the first international Conference on Learning Analytics and Knowledge (LAK 2011), it was defined as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" [5]. Electronic learning is defined by [6], as an innovative learning experience that can be synchronous or asynchronous using electronic devices such as laptops, tablets, and smartphones with Internet access. Learning Management System allows instructors and students to share classroom resources, tools, and activities. According to [7] online learning is defined as a platform that facilitates the delivery and management of teaching and learning practices. LMS has tools and functions that allow schools and universities to encourage instructors to utilize them for teaching and learning processes [8], and assist them in evaluating students' activities, allowing better collaboration and interaction [9].

Behavioral Indicators in Virtual Learning Environments

The need to analyze student interactions in virtual learning environments (VLE) and the improvements this generates is an increasingly emerging reality in order to make timely predictions and optimize student learning. This research aims to implement a proposal of standardized learning behavior indicators in virtual learning environments (VLE) to design and implement efficient and timely learning analytics (LA) processes [10].

The methodology consisted of a data management analysis that was carried out in the Moodle platform of the Faculty of Education Sciences of the National University of San Agustin of Arequipa, with the participation of 20 teachers, where qualitative online questionnaires were used to collect the participants' perceptions. The results propose a standard in terms of indicators of behavior in the teaching-learning process in Virtual Learning Environments as they are: Preparation for learning, progress in the progress of the course, resources for learning, interaction in the forums and evaluation of resources. These were evaluated through learning analytics and show the efficiency of the proposed indicators. The conclusions highlight the importance of implementing standardized behavior indicators that allow us to efficiently develop learning analytics processes in Virtual Learning Environments in order to obtain better predictions to make timely decisions and optimize the teaching-learning processes [10].

Readiness of the LMS

The LMS readiness presents the readiness of all aspects that are part of the e-learning environment. There are number of factors might affect the readiness of LMS adoption in various dimensions e.g. technology, user proficiency, motivations, organization support. Factors can be based on behavioral patterns studying multiple

constructors of readiness to accept changes, to change beliefs and to resist changing [11]. Successfully preparing the technological requirements of LMS is essential in increasing its adoption [12]. Researchers have discussed the technical factors from different perspectives. A theoretical base based on the technology acceptance model (TAM) in [13], [14], where others from analyzing perceptive such as [12] focusing on the importance of user-support technical. Several characteristics can be considered to measure the quality of readiness software systems, especially in open-source systems such as the LMS Moodle system used for this case study [15]. However, we found that the usability characteristic as defined by [15] covers several important factors such as learnability, operability, accessibility, and user interface. Thus, we tailored our survey specifically to the usability factors that match our requirements.

Importance of implementing a resource and activity management methodology in a LMS

According to [16]. The results reveal the importance of providing the adequate training to faculty and LMS readiness in order to increase e-learning adoption. It confirms that the faculty's capabilities play a major role not only in provoking students' perceived benefits but also in overcoming challenges in LMS readiness. Although faculty members' capabilities were an essential factor that significantly affects all e-learning processes, some statistical uncertainties were found that might affect the reliability of the results. Indeed, the results of this study can be used to increase e-learning adoption specifically in Shaqra University and other universities in the region.

Researchers indicated that the concept of UX is subjective and holistic and therefore there are no specific user experience (UX) metrics to evaluate UX of e-learning systems [17], [18], [19], [20]. Some researchers have suggested models including UX metrics to evaluate UX for e-learning systems, while others have used existing proposed metrics to evaluate such systems. For example, Topolewski et al. [21] proposed a UX model which describes user experience in terms of 21 properties related to five categories that influence users‟ intention to use eLearning. The model was tested empirically by designing a survey which consisted of the identified UX properties. The survey was given to students who used a specific mobile application (Jaxber app) to evaluate their UX experience with this e-learning system. The results proved the reliability and validity of the proposed model; some properties were deleted so that the model finally consisted of 18 UX properties which can be used to evaluate the UX of e-learning systems.

According to research conducted by [22], examined the user experience (UX) of the Moodle e-learning system employed at the University of Technology Malaysia (UTM) from students‟ perspectives using comprehensive user experience (UX) criteria adopted from two criteria. The adopted UX criteria consist of teaching and learning, usability and hedonic metrics; these related to 8 categories and 29 corresponding sub-categories. Two methods were employed to investigate the UX of the e-learning system: semi-structured interviews and questionnaires. These were employed based on the UX criteria. A total of 20 students participated in the interviews and a total of 120 students responded to the questionnaires. The results showed that the students were satisfied with the e-learning system and they had positive user experiences while interacting with it through their learning. However, several issues relating to aspects of the UX criteria were identified by the students; these need to be considered in order to improve the UX of the e-learning system.

Methodology

Description of the context and the participants

The present research conducts an analysis of the management of resources and activities in the platform of the Faculty of Education of the Universidad Nacional de San Agustín de Arequipa. Since 2012, the University has been using a virtual support platform based on the Moodle LMS. Under this platform, the subjects that are managed in virtual modality that allows, on the one hand, teachers to maintain a repository of information and record of academic activities; and, on the other hand, for students this platform allows them to have a practical view of the learning activities that are programmed in the syllabi of the subjects. The research has been developed by analyzing the general subjects in order to propose a methodology for analyzing the management of these resources and activities.

Population and Sample

The total population is made up of 100,000 thousand records obtained from the database of the content management system (LMS) of the Faculty of Education of the UNSA. From these data, 9,250,000 records were extracted through simple random sampling using the IntelliBoard tool [23].

Research design and procedure

An exhaustive analysis of the data that could be used as a source for this study has been carried out, which meets the objectives of the project and, in addition, the analysis has been approached in two aspects:

- Moodle: the structure of document organization in the platform has been analyzed, as well as all the available resources and activities [24].
- IntelliBoard: the structure of the reports generated has been analyzed with the idea of aligning the objectives to be addressed in the following phases of the research with the information provided by this platform [1].

Definition of the catalog of variables

There is a wide range of variables associated with an educational environment, and of different typology. A correct definition of objectives for the identification and calculation of indicators of interest to the educational community requires an exhaustive cataloguing of all the resources and activities provided by a virtual learning environment, that is. a technological platform such as Moodle. There are two broad categories of elements available in the teaching technology platform.

Definition of objectives

Objectives are categorized into two groups defined according to their informative nature [25]

- Descriptive: they report the statistical properties of simple variables, as well as composite indicators calculated from several involved.
- Predictive: they make prospections on simple or composite variables.

See the table I.

Table 1

Definition of objectives

Target group	Target type	Acronym
Descriptive	Resource targets	ODR
	Objectives on activities	ODA
	Targets on resource/activity use per teacher	ODP
	Resource/activity use targets per student	ODE
	Student Performance Objectives	ODB
	Objectives on course	ODC
	Faculty Objectives	ODF
Predictive	Resource targets	OPR
	Objectives on activities	OPA
	Targets on resource/activity use per teacher	OPP
	Resource/activity use targets per student	OPE
	Student Performance Objectives	OPB
	Objectives on course	OPC
	Faculty Objectives	OPF

Results and Analysis

In order to propose the methodological proposal, a series of descriptive objectives are analyzed, which are detailed below.

Resource analyzed

The following tables II and III summarize all the resources with which we work in the Content Management System. (LMS) of the faculty considering the percentage of use, the attributes of element, attributes of student and attribute of professor, it can be analyzed that some resources are quite used, while other resources little used.

Table 2. *Resource targets*

Element	% Usage	Id element	Description	Element attributes	Teaching attributes	Student attributes
Archive	95	ARC	The File module allows teachers to provide a File as a course resource.	Owner	Date and time of creation	Date and time of download
				File name	Competences	Number of comments to the content of the element
				File description	Date and time of creation	Use the file
				Access Restrictions	Date and time of creation	Use the file
				Uploaded file type	Date and time of creation	Use the file
Folder	90	CAR	The folder allows a teacher to display multiple course files together.	Owner	Date and time of creation	Date and time of download
				Folder name	Competences	Number of downloads
				Folder description	Competences	Number of comments to the content of the element
				Folder size	Date and time of Creation	Use the folder
URL	95	URL	This resource allows us to add and give access to different websites with contents of interest for our students in a quick way.	Owner	Date and time of creation	Date and time of visit
				URL Name	Competences	Number of comments to the content of the element
				URL Description	Embed URL	Use the URL
				Display type	Select the type	Use the URL
Label	90	ETI	A tag serves as a spacer within a Moodle page.	Owner	Date and time of creation	Date and time of first click
				URL Name	Competences	Number of click on label
				URL Description	Enter the URL	Label content review time
				Access Restrictions	Place the restrictions	Number of comments to the content of the element
				Attachment type in each tag	Set the file type	
Book	10	LIB	The book module allows you to create multi-page study material in book format, including multimedia content.	Owner	Date and time of creation	Date and time of download
				Name of the book	Competences	Display date and time
				Book Description	Details contents	Display time
				Book Availability (From - To)	Details start and end date	Number of views
				Access Restrictions	Details restrictions	Number of downloaded chapters
				Number of chapters	Details number of chapters	Revise chapters
Website	10	WEB	Allows teachers to create a web page using the text editor.	Owner	Date and time of creation	Date and time of visit to the website
				Name of the website	Competences	Number of repeat visits
				Description of the website	Number of updates	Average web page review time
				Website Availability (From - To)	Details start and end date	Number of comments to the content of the element
				Access Restrictions	Details restrictions	Revise restrictions

Table 3. *Activities*

element	% Usage	Id element	description	element attributes	teaching attributes	student attributes
Assistance	95	SIS	The attendance activity module allows a teacher to take attendance in class and students to view their own- attendance record.	Owner	Date and time attendance was created	Number of attendances
				Name of assistance	Competences to be developed in the assistance	Number of absences
				Description of assistance	Date and time of attendance review	Number of delays
				File Availability (From - To)	Details start and end date	Number of excused absences
				Access Restrictions	Details access restrictions	Accumulations of lag times
				Total number of fixed attendances	Add assistance	Rating
Questionnaire	95	CUES	The Quiz activity allows the teacher to design and set quizzes with multiple choice, true/false, matching, short answer, and numerical response questions.	Owner	Date and time the questionnaire was created	Date and time of realization
				Name of the questionnaire	Date and time of questionnaire review	End date and time
				Description of the questionnaire	Date and time of completion of the questionnaire	Date and time when the appraisal is displayed
				Questionnaire Availability (From - To)	Number of additional files uploaded by the teacher	Rating
				Access Restrictions	Types of feedback (Comments, pdf annotation)	Time Spent
				Types of deliverable formats	Competences to be developed in the questionnaire (rubric)	Number of hits
				Number of questions	Details number of questions	Questions where the student needs feedback
				Maximum number of attempts	Enter number of attempts	Performs attempts
				Passing grade	Enter the passing grade	Answer questions
				Duration of the test	Set the time	Takes into account the time
Task	95	TAR	The Assignments module allows a teacher to assess student learning by creating an assignment for students to complete which they can then review, assess, grade and give feedback on.	Owner	Date and time of task creation	Date and time of task display
				Name of the task	Date and time of task review	Date and time of submission
				Description of the task	Competences to be developed in the task (rubric)	Attached file type
				Task Availability (From - To)	Number of additional files uploaded by the teacher	Number of task submission attempts
				Access Restrictions	Types of feedback (comments, pdf annotation)	Grade obtained in the task
				Types of deliverable formats	Revision of the task in groups or individually (1, 2, ...)	Choose the format type

				Deadline for submission of the task	Set the deadline	Delivery according to the deadline
Chat	90	CHAT	The chat activity allows participants to have a discussion in text format synchronously in real time.	Owner	Date and time the chat was created	Number of chats participations
				Chat name	Date and time of chat review by teacher	Date and time of chat participations
				Chat Description	Number of additional files uploaded by the teacher	Rating obtained in the chat
				Chat Availability (From - To)	Types of feedback (comments, pdf annotation, videos, ...)	Performs queries
				Access Restrictions	Competences to be developed in the chat (rubric)	Make comments
Forum	90	FOR	The forum activity module allows participants to have asynchronous discussions, i.e. discussions that take place over an extended period of time.	Owner	Date and time of forum creation	Number of accesses to the forum
				Forum name	Types of feedback (Comments, pdf annotation)	Number of posts reviewed in the forum
				Forum Description	Competences to be developed in the forum (rubric)	Number of replies to the forum
				Forum Availability (From - To)	Number of questions posed by the teacher in the forum	Time spent on the forum
				Access Restrictions	Forum revision date and time	Rating obtained in the forum

Observed activities

The following table IV summarize all the activities with which we work in the Content Management System (LMS) of the faculty considering the percentage of use, the attributes of element, attributes of student and attribute of professor, it can be analyzed that some resources are quite used, while other resources little used.

Table 4. *Activities*

element	% Usage	Id element	description	element attributes	teaching attributes	student attributes
Database	5	BD	The database activity module allows participants to create, maintain and search for information Records. The structure of the entries is defined by the teacher according to a list of fields.	Owner	Date and time of database creation	Number of searches in repositories or records
				Database name	Date and time of database revision	Date and time of searches performed
				Description of the database	Number of additional files uploaded by the teacher	Number of comments on posts
				Database Availability (From - To)	Types of feedback (Comments, pdf annotation)	Rating obtained in each entry
				Access Restrictions	Competences to be developed in the chat (rubric)	Takes into account the number of accesses
Survey	5	ENC	The Survey activity module allows a	Owner	Date and time the survey was created	Date and time you answered the survey

			teacher to create a custom survey to obtain feedback from participants using a variety of question types, such as multiple choice, yes/no, or text.	Survey Name	Number of questions posed by the teacher	Number of questions answered
				Survey Description	Types of feedback (Comments, pdf annotation)	Time spent in the activity
				Survey Availability (From - To)	Date and time of survey review	Takes into account the availability
Glossary	5	GLO	The glossary activity module allows participants to create and maintain a list of definitions, similar to a dictionary, or to collect and organize resources or information.	Owner	Date and time of glossary creation	Date and time you viewed the glossary
				Glossary name	Types of feedback (comments, pdf annotation)	Date and time you updated the glossary
				Glossary description	Competences to be developed in the glossary(rubric)	Number of terms entered by the student
				Glossary Availability (From - To)	Number of terms entered by the teacher	Time spent reviewing the glossary
External tool	5	HEX	The external tool activity module allows students to interact with educational resources and activities hosted on other websites.	Owner	Date and time of creation of the external tool	Date and time of review of external activities
				Name of the tool	Types of feedback (comments, pdf annotation)	Number of iterations in the external activities review
				Description of the tool	Competences to be developed in the external tool (rubric)	Time spent in the activity
				Tool Availability (From - To)	Time spent checking the external tool	Rating
Lesson	5	LEC	The lesson activity allows a teacher to present content and/or practical activities in an interesting and flexible way.	Owner	Date and time the lesson was created	Date and time of the activity
				Lesson Name	Proposed competencies to be developed in the lesson	Qualifier obtained in the lesson
				Lesson appearance (progress bar, slide, menu, ...)	Number of feedbacks comments	Use the lesson
SCORM Package	5	SCO	A SCORM package is a set of files that are packaged according to a standard for learning objects.	Owner	Date and time of creation of the SCORM package	Date and time of review of package contents
				SCORM package name	Proposed competences to be developed with the activity	Qualification obtained
				SCORM package description	Type of file uploaded by the teacher (XML or AICC)	Number of attempts made
				Package Availability	Enter the start and end date	SCORM package usage time
Workshop	5	TAL	The workshop activity module allows for the collection, review, and peer assessment	Owner Name of the workshop	Date and time of creation of the workshop	Date and time of participation in the workshop
				Workshop description	Workshop evaluation date	Qualification obtained in the workshop

			of student work.		and time	
WIKI	5	WIK	The wiki activity module allows participants to add and edit a collection of web pages.	Owner	Date and time of creation of the WIKI	Date and time of participation in the WIKI
				WIKI Name	Competences to be developed in the WIKI	Number of comments on the WIKI
				Description of the WIIKI	WIKI Revision Date and Time	Number of replicas on the WIKI
				WIIKI Availability (From - To)	Comments and feedback from the WIKI	Rating obtained in the wiki

Descriptive objectives on resources and activities

Tables IV and V detail the descriptive objectives on the resources and activities indicating the type of visualization of each of them.

An enumeration was made to differentiate the groups of objectives, and from the blocks, to select which objectives are from the blocks, to select which objectives are plausible given the information existing information on IntelliBoard.

Table 5. *Descriptive objectives on resources*

id	target name	objective description	display type
1	Student delay in accessing a teacher-activated URL.	Calculate the difference between the date and time of astudent's visit to a teacher-activated URL and the date and time of activation by the teacher.	Bar chart where the students are represented on the X-axis and the differences (URL_DIF) on the Y-axis. The X-axis will be ordered from highest to lowest by the URL_DIF value.
2	Average time taken by all students to access a teacher-activated URL.	Calculate the average of the differences between the dateand time of a student's visit to a teacher-activated URL and the date and time of activation by the teacher.	Real number referred to the average time. E.g. 1h 24m.
3	Average number of URLs activated by a teacher in a course.	Calculate the average dilations associated with each URL Contained in a course, so that the teacher can analyze which URL might be of more or less interest to students.	Bar diagram where the URLs are represented on the X Axis, and on the Y axis the average dilations associated with each one. The X axis would be ordered from highestto lowest.
4	Average time of use or interactivity with the tag.	Calculate the average interaction time of the students inthe tags, of inserted or embedded material such as: videos, slides, texts,	Actual number.
5	Relationship between the availability time of each resource and its proper use.	Calculate the ratio between the time a resource isavailable and the time it is used by students.	Percentage.
6	Ratio of the number of files uploaded to the number of resources used.	Calculate the ratio between the amount of files uploadedand the amount of resources used.	Percentage.
7	Average number of file views by students.	Calculate average number of file views by students	Percentage.
8	Average number of URL views by students.	Calculate the average number of URL views by students	Percentage.
9	Measure average label display by students.	Calculate the average number of label views by students	Percentage.

Table 6. *Descriptive objectives on activities*

id	target name	objective description	display type
1	Average turnaround time from taskproposal.	Calculate the average time of the student's submission ofthe assignment and the time since the assignment was created.	Bar chart showing the mean by time interval for eachstudent.
2	Average time of participation inthe forum.	Calculate the average time spent on the forum and the average time spent on the forum and the average time spent on the forum.	Bar chart showing the mean by time interval for eachstudent.
3	Relationship between attendance and student academic performance.	Calculate the mean between the student's averageattendance and the average total attendance.	Bar chart showing the mean by time interval for eachstudent.
4	Relationship between the numberof completed questionnaires and the student's academic performance.	Calculate the average between the number of questionnaires solved and the average obtained in thecourse.	Bar chart showing the mean by time interval for eachstudent.
5	Relationship between the numberof tasks developed and the student's academic performance.	Calculate the average between the number of assignments completed and the average obtained in thecourse.	Bar chart showing the mean by time interval for eachstudent.
6	Intensity of collaborative learningthrough the use of wikis.	Calculate the average number of participations in thewikis by students.	Bar chart showing the mean by time interval for eachstudent.
7	Average number of questionnairescompleted by the student	It consists of calculating the average number of quizactivities completed by students.	Show in percentages the calculations in time periods perstudent.
8	Average number of assignmentscompleted by the student	It consists of calculating the average number of activitiescompleted by students.	Show in percentages the calculations in time periods perstudent.

Descriptive objectives on resources and activities

Table 7. *Objectives on resources or activities per teacher*

id	target name	objective description	display type
1	Average time for teacher grading of homework assignment	Calculate the average time of the teacher's grading of theassignment.	Bar chart showing the mean per time interval for eachtask.
2	Average time of the Forum grading by the teacher	Calculate the average time the teacher uses to grade theproposed forum.	Bar chart showing the average per time interval for each performance.
3	Relationship between the date and time of creation of the questionnaire by teachers and the date and time of uploading the content.	Calculate the average between the dates and times of creation of the questionnaire and the date and time ofcreation of the contents.	Bar chart showing the mean of the differences for eachquestionnaire.
4	Competences raised by the teachers in relation to the tasks posed	Calculate the average between the number of competencies set and the number of tasks set.	Actual number.
5	Identify the type of feedback given by the teacher.	Calculate the type of feedback provided by the teacher,be it video, text, link, pdf, etc.	Fashion.
6	Determine the number of replies raised in the forums by the teacher.	Calculate the average time spent by the teacher reviewing forums	Actual number.
7	Determine the teacher's time spent reviewing activities.	Calculate the average time spent by the teacher checkingthe assignments	Actual number.
8	Determine the number of activities planned by the teacher during the	Calculate the number of activities planned by the teacherduring the whole semester.	Integer.

semester.

Descriptive objectives on resources and activities

Table 8. *Objectives on students*

id	target name	objective description	display type
1	Average of the entries to the assignment to review thegrade and/or comments.	Calculate the average of the entries to the assignment to review the grade and/or comments.	A bar chart showing the mean for each task.
2	Average revenue to this activity after forum participation.	Calculate the average income to this activity afterforum participation.	A bar chart showing the average for eachforum participation.
3	Correlation between attendance and the number of tasksperformed.	Calculate the average between the number of attendances during the semester and the number ofassignments completed.	Actual number.
4	Relationship between the number of completedquestionnaires and student attendance.	Calculate the average between the number ofsolved questionnaires and the number of attendances during the semester.	Actual number.
5	Relationship between the number of tasks developedand the time used for their resolution.	Calculate the average between the number of tasks developed and the time used by the student tosolve them.	Actual number.
6	Number of replies made by students in the forums andtime spent.	Calculate the average number of replies made bystudents in the forums during a semester.	Actual number.
7	Time spent by students in the development of tasks andtheir relationship with the date and time of their uploading to the platform.	Calculate the average time spent by students in thedevelopment of tasks and their relationship with the date and time of their upload to the platform.	A bar chart showing the mean at differenttime intervals.
8	List of file views by students and completedassignments.	Calculate the number of files downloaded by students and the grade earned on the assignment.	Actual number.
9	Ratio of URL displays by students and the grade of theassignment.	Calculate the number of url viewed by the students and the grade obtained in the assignment.	Actual number.
10	Relationship of label visualizations by students andassignment grading.	Calculate the amount of label visualized by thestudents and the grade obtained in the task.	Actual number.
11	Relationship of glossary creation and grading in thequiz.	Calculate the number of terms created by the teacher in the glossary and the grade obtained in the questionnaire by the students.	Actual number.

Descriptive objectives on resources and activities

Table 9. *Descriptive objectives on students' performance*

id	target name	objective description	display type
1	Main statistics of the grades per student (grades).	Calculate statistics such as mean, median, mode, variance, max value and min value of the gradesper student.	Table showing key statistics
2	Correlation between attendance and student academicperformance.	Calculate the ratio between the number of attendances during the semester and the total grade obtained for the activities.	Actual number.
3	Relationship between the number of completed questionnaires and the student's academic performance.	Calculate the ratio between the number of quizzes completed during the semester and the total grade obtained from the activities.	Real number.
4	Relationship between the number of tasks developedand the student's academic performance.	Calculate the ratio between the number of assignments developed during the semester and the total grade obtained from the activities.	Actual number.
5	Relationship between the date and time of resolution ofa questionnaire by students and its relationship with their academic performance.	Calculate the average of the date and time of solving a quiz during the semester and the total grade obtained from the activities.	Actual number.
6	Number of replies made by students in the forums andtheir relationship with their academic performance.	Calculate the ratio between the number of replies made in the forums during the semester and the total grade obtained from the activities.	Actual number.
7	Time of permanence of students in the development ofactivities and their relationship with academic performance.	Calculate the average time spent by students in the development of activities during the semester and the total grade obtained from the activities.	Actual number.
8	Relationship between abandonment and delays inactivities or resources.	Obtain a relationship between the abandonment and procrastination that a student presents in eachof the resources and activities.	Influence of each of the resources and activities on the fact of quitting, measured quantitatively in [0,100] %.

Descriptive objectives on resources and activities

Table 10. *Descriptive course objectives*

id	target name	objective description	display type
1	Main statistics of the qualifiers by course.	Calculate statistics such as mean, median, mode,variance, max value and min value of grades by course.	Table showing the main statistics.
2	Number of activities and resources planned in a givencourse.	Count the number of activities and resources.	Actual number.
3	Competences to be developed in a given course.	Count the number of course competencies.	Percentage of skills covered.
4	Number of general and specialty courses by educationalprogram and their relationship to the number of resources and activities.	Establish the number of general courses, specialtyand make a relation with the number of resources and activities.	Diagram with the number of activities thatmake up the course.
5	Visualizations to make comparisons with other coursesin order to improve the implementation of a course.	Establish comparisons of course visualizationstructures to improve their implementation.	Comparative diagram between courses expressed in percentages above or belowthe average.

Proposal

After having analyzed all the descriptive objectives that correspond to the activities and resources that correspond to the students and teachers in the learning management system, we proceed to propose the objectives that will serve as a starting point to perform the predictive and descriptive analysis of the management of resources and activities in the LMS.

Selected objectives for Teacher

- Identify the effectiveness of some resources and activities, through the relationship between activities viewed, activities completed, tasks performed and the average obtained in the course.
- Establish actions for the improvement of teaching-learning based on the proposal of a personalized Dashboard according to the educational context where the student develops.

Selected objectives for Students

- Track the learning process of students in order to identify students at risk of dropping out in order to provide them with personalized tutoring and assistance.
- Analyze and compare the prediction of students' academic performance using data from a Learning Management System (LMS). Identifying students at academic risk at the beginning of a course in order to generate timely and targeted interventions.
- Identifying observable behavioral patterns through the relationship between the times spent in a course and the time dedicated to the development of activities.
- Identify indicators of academic performance towards the achievement of success and underachievement, through the relationship between the activities completed and their grade.
- Track student activities and interactions through the relationship between time spent in a course and the average grade received.
- Compare the development of activities with other students through the relationship between time spent on courses and time spent on activities.
- Identify the activities that students prefer the most through the relationship between the activity developed and its respective grade.
- Identify the resources most preferred by students through the relationship between the resource used and the time used for its review.

Conclusions

The results of the analysis of the activities and resources of the content management system made it possible to propose a catalog of resources and activities with their respective variables in order to standardize indicators for an adequate management of resources and activities.

The set of variables associated with an educational environment is very broad, and of different types. A correct definition of objectives for the identification and calculation of indicators of interest to the educational community requires an exhaustive cataloguing of all the resources and activities provided by a virtual teaching environment, that is a technological platform such as Moodle.

In particular, targets were identified that were well supported by data, both in quantity and quality, and that supported by data, both in quantity and quality, and that were of scientific interest from the perspective of scientific interest from the perspective of publishing research results.

The set of hypothetical objectives is very broad, and criteria of data quality and interest of the results have been used to make a selection in accordance with the interests of the project.

All the objectives derive from the definition and implementation of the design of the models developed in the KNIME software.

References

Maraza-Quispe, B., Alejandro-Oviedo, O. M., Choquehuanca-Quispe, W., Caytuiro-Silva, N., & Herrera-Quispe, J. Towards a Standardization of Learning Behavior Indicators in Virtual Environments. International Journal of Advanced Computer Science and Applications (IJACSA), 11(11), 146-152. https://doi.org/10.14569/IJACSA.2020.0111119, 2020.

I. Martí Castro, "Aprendizaje-Virtual". En Diccionario Enciclopédico de Educación. Grupo Editorial Ceac S.

A. (LEXUS), 2003.

Arshad, Raheela & Majeed, Awais & Afzal, Hammad & Rahman, Arif Ur. Evaluation of Navigational Aspects of Moodle. International Journal of Advanced Computer Science and Applications (IJACSA). 7. 10.14569/IJACSA.2016.070342, 2016.

Kiget, Nicholas & Wanyembi, Gregory & Peters, Anselemo. Evaluating Usability of E-Learning Systems in Universities. International Journal of Advanced Computer Science and Applications (IJACSA). 5. 10.14569/IJACSA.2014.050815, 2014.

Chaffai, Abdelmajid & Hassouni, Larbi & Anoun, Houda. Real-Time Analysis of Students' Activities on an E-Learning Platform based on Apache Spark. International Journal of Advanced Computer Science and Applications (IJACSA). 8. 10.14569/IJACSA.2017.080715, 2017.

V. Singh and A. Thurman, "How Many Ways Can We Define Online Learning? A Systematic Literature Review of Definitions of Online Learning (1988-2018)," American Journal of Distance Education. Volume 33, Issue 4, pp. 289-306. https://doi.org/10.1080/08923647. 2019.1663082, 2019.

E. Dahlstrom, D. Brooks and J. Bichsel, "The Current Ecosystem of Learning Management Systems in Higher Education: Student, Faculty, and IT Perspectives," ECAR, 2014.

E. Dahlstrom, D. Brooks and J. Bichsel, "The Current Ecosystem of Learning Management Systems in Higher Education: Student, Faculty, and IT Perspectives," ECAR, 2014.

N. Emelyanova and E. Voronina, "Introducing a Learning Management System at a Russian University : Students' and Teachers' Perceptions," The International Review of Research in Open and Distance Learning, 15(1), p. 272–289., 2014.

Benjamin Maraza-Quispe, Olga Melina Alejandro-Oviedo, Walter Choquehuanca-Quispe, Nicolas Caytuiro-Silva and Jose Herrera-Quispe, "Towards a Standardization of Learning Behavior Indicators in Virtual Environments" International Journal of Advanced Computer Science and Applications (IJACSA), 11(11), 2020. http://dx.doi.org/10.14569/IJACSA.2020.0111119

Mohammed Ilyas. Investigating readiness for acceptance of change for the adoption of blackboard lms at prince sattam bin abdulaziz university, saudi arabia. International Journal of Education and Practice, 6(4):216–226, 2018

Fezile Ozdamli and Nadire Cavus. Knowledge sharing technologies in higher education: Preferences of cis students in cyprus. Education and Information Technologies, 26(2):1833–1846, 2021.

Muyesser Eraslan Yalcin and Birgul Kutlu. Examination of students' acceptance of and intention to use learning management systems using extended tam. British Journal of Educational Technology, 50(5):2414–2432, 2019.

Shamsul Anuar Mokhtar, Hamidon Katan, and Imdadullah Hidayat-ur Rehman. Instructors' behavioural intention to use learning management system: an integrated tam perspective. TEM Journal, 7(3):513, 2018.

Mohamed Sarrab and Osama M Hussain Rehman. Empirical study of open source software selection for adoption, based on software quality characteristics. Advances in Engineering Software, 69:1–11, 2014.

Asma Hassan Alshehri and Saad Ali Alahmari, "Faculty e-Learning Adoption During the COVID-19 Pandemic: A Case Study of Shaqra University" International Journal of Advanced Computer Science and Applications (IJACSA), 12(10), 2021. http://dx.doi.org/10.14569/IJACSA.2021.0121095.

S. J. Mtebe, "Examining user experience of eLearning systems implemented in two universities in Tanzania", Interactive Technology and Smart Education, vol. 17, no. 1, , pp. 39-55, 2020.

W. T. Nakamura, E. H. T. de Oliveira, and T. Conte, "Usability and user experience evaluation of learning management systems – a systematic mapping study", In Proceedings of the 19th International Conference on Enterprise Information Systems (ICEIS 2017), pp. 97-108, 2017.

V. Roto, H. Rantavuo, and V.V.M. Kaisa, "„Evaluating user experience of early product concepts", International Conference on Designing Pleasurable Products and Interfaces, pp. 1-10, 2009.

L. Shi, "Defining and evaluating learner experience for social adaptive E-Learning", The 4th Imperial College Computing Student Workshop (ICCSW 2014), pp. 25-26, 2014.

M.Topolewski, H. Lehtosaari, P. Krawczyk, M. Pallot, I. Maslov, and J. Huotari, "Validating a UX model through a formative approach: an empirical study", 2019 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), IEEE, pp. 1-7, 2019.

Layla Hasan, "Examining User Experience of Moodle e-Learning System" International Journal of Advanced Computer Science and Applications (IJACSA), 12(11), 2021. http://dx.doi.org/10.14569/IJACSA.2021.0121141.

J. E. . Ninasivincha-Apfata, R. C. . Quispe-Figueroa, M. A. Valderrama-Solis, and B. Maraza-Quispe, "Dashboard proposal implemented according to an analysis developed on the KNIME platform", WJET, vol. 13, no. 4, pp. 816–837, Oct. 2021.

B. Martín Galán, & D. Rodríguez Mateos, "La evaluación de la formación universitaria semipresencial y en línea en el contexto del EEES mediante el uso de los informes de actividad de la plataforma Moodle". RIED.

Revista Iberoamericana De Educación a Distancia, 15(1), 159–178. https://doi.org/10.5944/ried.1.15.782, 2012.

Benjamín Maraza-Quispe, Ashtin Maurice Sotelo-Jump, Olga Melina Alejandro-Oviedo, Lita Marianela Quispe-Flores, Lenin Henry Cari-Mogrovejo, Walter Cornelio Fernandez-Gambarini and Luis Ernesto Cuadros-Paz, "Towards the Development of Computational Thinking and Mathematical Logic through Scratch" International Journal of Advanced Computer Science and Applications (IJACSA), 12(2), 2021. http://dx.doi.org/10.14569/IJACSA.2021.0120242