

## **Inserting Educational Goals in the Evaluation Process in a Virtual Learning Environment: A Cognitive Classification**

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**Abstract:** *The growth of long distance education in Brazil along with the increasing number of online courses offered through Virtual Learning Environments (VLE) has raised a concern regarding the evaluation and usage of such methodologies. Each online course lectured through VLE present educational goals that must be defined by their respective professors. Aiming at helping professors to define these goals we implemented an activity module for the pedagogical tool Dependency Map. This module suggests the kinds of activities that can be performed by students so they can develop the skills demanded by the course or lecture in which they are currently enrolled. For this reason, we developed a cognitive taxonomy for the exercises available in the Moodle VLE by mapping the verbs in the description of the activities with representative verbs from the classes defined by the taxonomy.*

**Keywords:** *Distance Learning; Bloom's Taxonomy; Cognitive domain; Evaluative activities*

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### **I. Introduction**

Nowadays, with the increasing demand of courses offered through Distance Learning (DL), many questions have been arising regarding this form of knowledge acquisition.

One of them is how these students are evaluated, taking into account that the separation between educator and student happens in a direct way, thus making the evaluation process very subjective from the point of view of student-teacher interaction.

That is why there is a constant concern regarding the forms of evaluation and how they are applied, how to identify their final goal and what is the student's learning in the teaching-learning process.

The evaluation procedure in the teaching-learning process in distance learning, mostly done through tools provided in a Virtual Learning Environment (VLE) through online courses, has been bringing forth new paradigms through the DL methodology, in which the student, who takes a primordial part in this teaching methodology, has the flexibility both of studying and choosing the best day to do evaluation tasks made available in their VLE.

It is in this context of flexibility that many studies are being developed so that, the evaluation process of online courses, defined in a VLE, comes as a way to help the teacher in the development of this task with the purpose of enhancing the teaching-learning process.

This process, which happens through the teacher student interaction must be clear and objective, in this context the teacher needs to know how to well define the educational purposes proposed in the course or discipline being planned so that the student can identify what really must be learnt and what abilities they must develop so that the goal established by the teacher during planning actually is successful.

According to Bloom et al (1977), the educational purposes are manners or ways in which the students modify their thoughts, their feelings and their actions.

Or even, it can be conceptualized as expected goals or behaviors to be met, during a course or discipline, in which a cognitive hierarchy is obeyed where the student can only reach the domain defined by the teacher for the conclusion of their course or discipline, if he/she has inferior capacities or abilities.

A way to work with educational purposes is through Bloom's Taxonomy proposed by Benjamin Bloom in the fifties when, along with his collaborators, M.D. Englehart, E. J. Furst, W. H. Hill and D. Krathwohl created a task force to discuss, define and create a taxonomy of educational purposes, dividing the work according to the specific domain of development which can be cognitive, affective and psychomotor (Lomena, 2006 apud Ferraz & Belhot, 2010).

Thus, Bloom's Taxonomy allows the association of educational purposes to the student's planning and evaluation, however in case the student cannot reach the desired goal, it doesn't define the necessary mechanisms to identify where the problem lies. That can restrain the student's autonomy, a characteristic necessary to Distance Learning.

As an alternative to end this problem the Dependencies Map (Lima & Fialho, 2008) was developed. It allows the teacher to define, beyond the educational purpose to be reached, the behaviors necessary to reach such goal. Therefore, the Dependencies Map (DP) is a tool constituted of a set of educational goals related among each other, using a hierarchy defined in Bloom's Taxonomy (Lima; 2009).

Being so, the Dependencies Map presents the dependency relation of the intended educational purpose with the educational purposes of inferior classes as a way of contributing to the achievement of the educational purpose.

For the above mentioned, it is necessary to identify the student's previous behavior or behaviors that influence their achievement of the proposed educational purpose.

This entire relationship of dependency is generated through the Dependencies Map and this sequence of steps repeats itself up to the point in which the students' expected behaviors reach the lower level of taxonomy, or at least to a level where teacher thinks it is not necessary to go down any further.

However, the Dependencies Map works only with educational purposes in the planning level, but it does not define the evaluation elements that make possible to identify the attainment of such purposes.

That is why, in this paper, we inserted the evaluation process attached to the Dependencies Map, which will give subsides to the teachers, during the planning of their course or discipline, to define what evaluation activity or activities they will be able to use so that the student can develop their cognitive process aiming to reach the expected learning which was outlined by the teacher in his/her planning.

## **II. Educational purposes and Bloom's Taxonomy**

According to Bloom et al (1977) the educational purposes are manners or ways in which the students modify their thoughts, their feelings and their actions. Through Bloom's Taxonomy it is possible to classify the purposes of the educational system, facilitating, even, the exchange of information about the curricular developments and the evaluation plans.

As written by Esteves, (1968), the teacher must know how to define his/her educational purposes so that the students do not have to guess what is expected of them.

So that doesn't happen, the teacher needs to observe two primordial elements when developing these goals, which are clarity of communication and observable behavior of the student.

The clarity of communication is directly related to the transmission of the purpose defined by the teacher that must be assimilated by the student, so, for Esteves (1968), the educational purpose is a description of the behavior that one expects to observe in the student after the educational experience that is provided to him/her.

As such, the entire teaching process – teaching material, methods, activities, evaluations, among others – must be directly linked to the students' learning purposes observed through the change in their behavior according to the development that is desired of him.

As for the observable behavior, the purpose is identified through the verification of repetitions made by the student after learning something. This verification can occur through practical or theoretical activities that are developed through clear visualizations of what must be developed and then transcribed in a precise and objective manner.

A way to work with educational purposes is through Bloom's Taxonomy proposed by Benjamin Bloom in the fifties when, along with his collaborators, M.D. Englehart, E. J. Furst, W. H. Hill and D. Krathwohl created a task force to discuss, define and create a taxonomy of educational purposes, dividing the work according to the specific domain of development which can be cognitive, affective and psychomotor (Lomena, 2006 apud Ferraz & Belhot, 2010).

This taxonomy was established through the classification of a group of educational purposes formulated by several North-American teachers, whose purpose was to create a model so that all teachers from that country could assume the same homogenous a practical comprehension, and one that was also liable of generalization regarding evaluation and planning.

For Silva et al (2012), the use of Bloom's Taxonomy allows that the planning of the discipline has as base the definition of the capacities and abilities that are expected of the student and not only the content that will be given.

Bloom's Taxonomy has divided the educational purposes into three classes: cognitive, affective and psychomotor. Each class presents peculiar concepts of that taxonomy. The cognitive domain involves the acquisition of a new knowledge, of intellectual development and of skills and attitudes. The affective domain is related to aspects related to feelings and postures. It involves categories connected to the development of the

emotional and affective area, which include behavior, attitude, responsibility, emotions and values. The psychomotor domain is related to specific physical abilities (Ferraz & Belhot, 2010).

The cognitive domain of Bloom's Taxonomy is a classification structured in levels of growing difficulty that go from the simplest to the most complex understanding, in which the student, in order to develop a certain skill at its highest level, must have the domain of abilities of inferior levels to the one he/she wishes to achieve.

This hierarchical classification of cognitive processes is divided into six levels of complexity, structured in descending order which are: Evaluation, Synthesis, Analysis, Application, Understanding and Knowledge.

As seen in Table 1, for each category of the presented taxonomy there is a list of related verbs that are used as support to the systemic planning of courses of disciplines when structuring its purposes, strategies and evaluations.

In the hierarchic way in which it was built, the cognitive classification of this taxonomy favors the disposition of the educational purposes that belong to a class in a certain way that will always be based on the behaviors included in the consequent classes of the scheme. (Bloom et al 1977)

**Table 1: Structuring of Bloom's Taxonomy of the Cognitive Domain**

Category	Description
<b>1. Knowledge</b>	<b>Definition:</b> The student will recognize information, ideas in the (approximate) form in which they were learnt.
	<b>Verbs:</b> Write, list, label, show, number, copy, select, name, say, define, reproduce, relate, identify, quote, collect, evoke. N
<b>2. Comprehension</b>	<b>Definition:</b> The student understands or interprets information based on previous knowledge.
	<b>Verbs:</b> Explain, associate, deslangua, understand, stimulate, group, summarize, convert, discuss, translate, assort, differentiate, resume, paraphrase, describe, interpret, illustrate.
<b>3. Application</b>	<b>Definition:</b> The student selects, transfers and uses data and principles to complete a Problem or task with minimal supervision.
	<b>Verbs:</b> Use, compute, solve, apply, calculate, finish, experiment, demonstrate, discover, determine, take, establish, articulate, transfer, teach, prepare, built.
<b>4. Analysis</b>	<b>Definition:</b> The student distinguishes, classify and relates assumptions, hypothesis, evidences or structures of a statement or question.
	<b>Verbs:</b> Analyze, classify, categorize, compare, contrast, deduct, arrange, connect, divide, prioritize, indicate, diagram, discriminates, focus, separate.
<b>5. Synthesis</b>	<b>Definition:</b> The student creates, integrates and combines ideas into a product, plan or proposition that is new to him/her.
	<b>Verbs:</b> Create, propose, formulate, modify, plan, elaborate, create a hypothesis, create, design, develop, connect, compose, generalize, substitute, integrate, rearrange, rewrite, adapt, anticipate, compile.
<b>6. Evaluation</b>	<b>Definition:</b> The student appreciates, evaluate or criticizes based on specific standards and criteria.
	<b>Verbs:</b> Judge, evaluate, recommend, critique, justify, decide, test, convince, conclude.

### 1. Mining the verbs used in the descriptions of the activities

In Bloom's Taxonomy, each cognitive domain class brings with it a relation of imperative verbs that express an action and are used in the definition of educational purposes (Lima & Fialho, 2011). These verbs are widespread in several academic papers. In this paper, we used the verbs shown in (Lima, 2009).

In this sense, we developed a work methodology that would lead us to define in which cognitive classification, according to Bloom's Taxonomy, the evaluation activities available in Moodle could be applied to.

For that, it was taken into account that at the VLE Moodle, in order to use the tools as an evaluation element, it is necessary an enunciation that presents a verb describing the action that the teacher expects from the student.

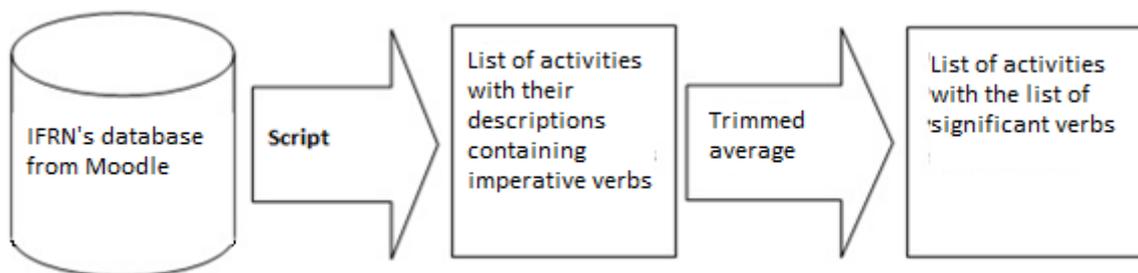
Therefore this work makes an analysis of the verbs utilized in the descriptions of the evaluation activities seen in Moodle with the purpose of identifying to which cognitive domain class of Bloom's Taxonomy these activities are inserted.

With that in mind, we developed a quantitative analysis methodology related to the use of evaluative tools of distance learning courses of the Federal Institute of Education, Science and Technology of Rio Grande do Norte (IFRN) that works with this type of teaching since 2006. Picture 1 illustrates the steps of the analysis methodology developed.

The information used for the quantitative analysis were the tables related to the activities of Moodle's data bank used by IFRN when developing their distance learning courses. This database is composed of more than 48.000 entries.

As seen in Picture 1, the first part of the methodology is to obtain, for each evaluative tool, a list of the verbs used by teachers when describing the tasks to be developed by the students. For such, we developed a

script, presented through Alg. 1, which captures the verbs used by teachers in the descriptions of the activities performed.



**Picture 1:** Selection process of the significant verbs by activity

After executing the script, then we have a list with the verbs and the amount of times they appear in the descriptions of the activities proposed by the teachers in the database. With that, it has been identified the verbs associated to one or more activities.

However, in this part of the work, we came across a disparity of occurrence, with some verbs presenting insignificant values in regards to the total amount of verbs related to a determined activity. These disparities come from possible mistakes when using the verbs in the descriptions of the activities proposed by the teachers.

**Algorithm 1:** Used to recover the verbs described in activities

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1. Beginning
2. For each type of activity do;
3.   For each verb from Bloom's Taxonomy verb table do;
4.     Search the verb in Bloom's taxonomy verb table, in the description of each activity;
5.     If the verb is found do;
6.       Storage the verb and type of activity
7.     End of if;
8.   End of for;
9. End of for;
10. For each type of activity do;
11.  Print current type of activity;
12.  For each verb in Bloom's Taxonomy verb table do;
13.  Print the amount of verbs related to each type of activity, the name of the verb;
14.    Activity, name of the verb;
15.  End of for;
16. End of for;
17. End.
  
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To eliminate this disparity, we used the statistic method of trimmed average, as seen in Picture 1, which consists in discarding the discrepant values, both maximum and minimal of an initial classification (Lopes, 2008).

In this paper we discarded only the minimal values, with a 10% rate of elimination. This percentage was chosen after observing that the verbs classified as insignificant presented an incidence with values below de average of other verbs that were more used.

The next section describe the steps followed to utilize the trimmed average applied to select the verbs classified as significant which were collected from the description of Moodle's evaluative activities.

*1.1. Statistic method of trimmed average*

The trimmed average is the same arithmetic average calculated with the exclusion of elements that are discrepant from the group. Generally, they are really high or really low elements that clash with the others.

This statics methods has the purpose of trimming the extremes, thus avoiding unadvisable effects of possible extravagant values, bringing to the aforementioned values a small incursion in a more modern domain when treating the samples (Lopes; 2008).

For the execution of this statistic methods the work was divided into three steps:

**First step:** We calculated the relative frequency (FR) for each verb through the formula:

$$FR(a) = \frac{FA(a)}{S} \tag{1}$$

**In which:**

FA(a) → Absolute frequency of the treated verb in the evaluated activity

(a) → Occurrence of a verb in a activity.

S → Sum of the incidence of all the verbs from that activity.

**Second step:** We calculated the discard with the verbs with FR(a) < 10%

$$d = FA(ak1) + FA(ak2) + \dots \tag{2}$$

**In which:**

d → Sum of incidence of the discarded verbs (discard).

ak → Verbs that present an FR(a) smaller than 10%

FA (ak) → Absolute frequency of the verbs with FR(a) below 10%

**Third step:** We calculated the new relative frequency line (F'R) through the formula:

$$F'R(a) = \frac{FA(a)}{S - d} \tag{3}$$

**In which:**

F'R(a) → Relative frequency of the verbs that were not discarded.

These calculations were made for all evaluative activities available at Moodle.

For such, we put together a table of content with all the verbs found in the description of the evaluative activities of VLE that were being studied along with the amount of occurrences of the verb in the description of the activity that would be analyzed.

After putting together the table with the collected data, which came as result of performing algorithm 1, it was possible to find the sum (S) that corresponds to the Sum of FA(a) of the verbs found in that specific activity.

Soon after, we perform the calculation of the relative frequency FR (a) of each verb found in the referred activity. In order to do that, we must divide the FA(a) of the verb by the sum (S) of the verbs' FA(a) found previously. (Formula 1).

The next step corresponds to the elimination of the insignificant verbs that appear with an incidence rate of FA(a) smaller than 10%. This rate was chosen due to the fact that the values found grouped in this percentage represent the verbs with least repetitions in the description of the activities, having as basis the values of error in descriptions, i.e., verbs used inappropriately in the description of the activity.

After finding the FA(a) of the verbs to be discarded, and also after doing their total sum represented in the table by the field "Discard (d)", which will serve to find the new sum of the FA(a) of the verbs that obtained an incidence rate over 10% for the referred activity (Formula 2).

To conclude it we performed the calculation of the new relative frequency F'R(a) that corresponds to the occurrence of the verbs with a rate over 10%. This calculation is made through the division of the FA(a) of each verb by the new total found through the subtraction of the original sum (S) minus the discard (d) (Formula 3).

After applying the statistic method of the trimmed average it is possible to identify the verbs with incidence over 10%, i.e., the verbs that are more significant foe each type of evaluative activity available at Moodle as presented in Table 2.

### 1.2. Result of the trimmed average application

Table 2 shows the results of the applicability of the methodology developed in the study, through the execution of the script represented by Alg.1 along with the statistic method of trimmed average applied to each evaluative activity available in the study environment, aiming to select the most significant verbs used in the descriptions of the activities proposed by teachers when developing their courses or disciplines through a Virtual Learning Environment (VLE)

**Table 2:** Main cognitive verbs used in descriptions of Moodle's activities

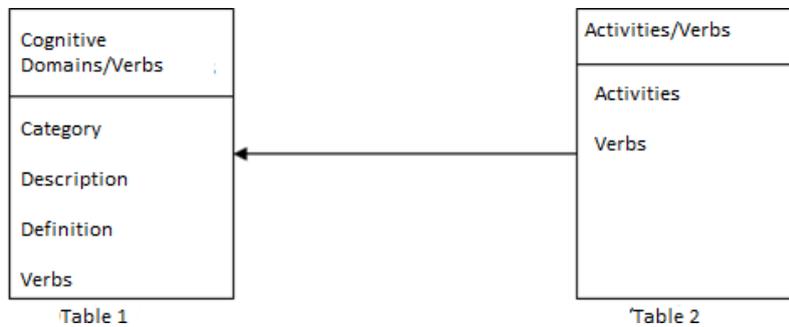
Activities	Verbs
Database	Classify, connect.
Diary	Paraphrase, experiment.
Questionnaire	Paraphrase, experiment, articulate.
Glossary	Convert, paraphrase, experiment, articulate compare.
Lesson	Connect,.
Evaluation research	Articulate, classify.

Wiki		Quote, paraphrase, experiment, articulate, classify
Choice		Paraphrase, experiment.
Chat		Paraphrase, experiment.
Forum		distinguish, paraphrase, experiment, articulate.
Task	Advanced type of loading archives	Quote, take.
	off-line activity	Paraphrase.
	Online Text	Experiment, connect.
	Sending a single file	Experiment, articulate.

**2. Cognitive classification of the evaluative activities**

After bringing up all the data, which came from the results presented in Picture 1, we realized that some of the verbs are a part of more than one activity, this means that one activity can be used in more than one cognitive classification of Bloom’s Taxonomy.

This situation was possible to see after crossing the verbs shown in Tables 1 and 2. In this association, for each verb associated to an activity, data shown in Table 2, we made the search for its homonym in the list of verbs shown in Table 1 and in the end we made the association of the activity to the cognitive domains(s) related according to the scheme shown in Picture 2.



**Picture 2:** Relationship between Cognitive Domains/Verbs with the Activities/Verbs

Through all this sequence of actions, graphically described through Picture 1, it was possible to identify a list of significant verbs for each evaluative tool of the environment used as object of this paper.

**Table 3:** Activities and their cognitive domain classes

Activity		Cognitive domain classes
Database		Analysis
Diary		Comprehension, application.
Questionnaire		Comprehension, application.
Glossary		Comprehension, application, analysis.
Lesson		Analysis
Evaluation Research		Application, analysis.
Wiki		Knowledge, Comprehension, Application, analysis.
Choice		Comprehension, Application.
Chat		Comprehension, Application.
Forum		Comprehension, Application.
Task	Advanced type of loading archives	Knowledge, Application.
	off-line activity	Comprehension.
	Online Text	Application, analysis.
	Sending a single file	Application.

When relating the verbs described in Table 1 with the verbs identified in Table 2 we are able to associate each evaluative tool to a cognitive classification of Bloom’s Taxonomy as shown in Table 3.

**3. Data validation**

With the purpose of legitimating the results obtained in the methodology that was described and imposed in section 3 and applied to Moodle’s database of IFRN, we sent Alg.1 to be implanted and executed in Moodle’s database of the Corporative University of the Federal Service of Data Processing (UNISERPRO), with the purpose of validating the data reached.

The result of the execution of the algorithm has generated raw information regarding the activities and their descriptions, used in the evaluative activities used by UNISERPRO, which had to be polished through the application of the work methodology developed.

After working with the data from UNISERPRO, whose result is presented in the attachments, we crossed the gathered information with the ones obtained through IFRN and we came to the conclusion that there

is the occurrence of other verbs that were not worked with in IFRN’s activities, however they were classified within the same Bloom’s taxonomy class, like the case of the verb “apply” with belongs to the application class. This verb was not found in the descriptions of the activities analyzed from the database of IFRN, however, it was highly repeated in the analyzed activities of UNISERPRO’s database (Tab. 4).

Another particularity identified in UNISERPRO’s database in that they work with the description of activities in a slightly different manner than IFRN, presenting in many of them, long texts to be analyzed and other activities that did not represent descriptions.

Due to these particularities, the classification ended-up being very restricted, but even then it did not escape the classification standard already made with the data from IFRN.

**Table 4:** Cognitive verbs used in descriptions of the activities from UNISERPRO/Moodle

Activities		Cognitive verbs
Database		We did not find this activity in the database
Diary		apply
Forum		apply, compare
Questionnaire		resolver
Glossary		apply, use
Lesson		analyze, compare
Evaluation Research		indicate
Wiki		use, write
Choice		discuss, apply, determine, calculate
Chat		classify
Task	Advanced type of loading archives	analyze, apply, compare
	Online Text	analyze, apply, compare, discuss, illustrate
	Sending a single file	apply, compare, determine, report
	off-line activity	discuss, report

#### 4. Final regards

The evaluation in the distance learning mode is of extreme importance during the teaching-learning process, due to that many works have been developed with the purpose of identifying the Best way to work with evaluations in this teaching methodology.

Courses made available in the online manner, developed through VLEs are planned with the purpose of providing the student the ability to keep up with their evolutionary process of this educational process as well as their cognitive development of the content approached during the course or discipline worked.

In order for this process to occur in a practical manner, it has been found that it is not enough only to plan the evaluative activities that will define if whether or not the student has reached the purpose defined by the teacher.

To fill this gap, this work was developed with the purpose of including in the planning process of a course or discipline, through the tool Map of Dependencies, the evaluation process through suggestions of evaluative activities that the teacher may define according to the cognitive domain that he/she desires his students to have. This domain is defined in the planning of the course or discipline taught by him/her.

Through the obtained results, labor from this scientific paper, it was possible to verify the existing relationship between Bloom’s taxonomy and the evaluative tools of a VLE. Thus it is found the possibility of working the evaluation in a VLE through the use of educational purposes.

As such, with the list of verbs available and associated to the evaluative activities set in the environment, the teacher will be able to program in a more objective manner their assignments that will be used in their courses or disciplines taught through online teaching courses in the distance learning mode, according to the cognitive domain that the teacher wishes for the student to reach.

##### 4.1. Academic contributions reached

It was found the importance of adopting pedagogical theories such as Bloom’s Taxonomy that is nothing more than a hierarchic organization structure of educational purposes divided into three classes. In this paper we used the cognitive domain that corresponds to the student’s intellectual learning that may be developed through a study of contents set through a virtual learning environment and the resolution of assignments with the purpose of reaching the traced goal.

Through this study, we observed that it is also necessary to evaluate the reach of this goal. Therefore, this paper has reached the conclusion that the evaluation is of the highest importance in this process. For the educational purposes defined by the teacher to be reached it was necessary to define which evaluative activities set in the VLEs provide a greater development of the student’s cognitive domain, reaching a cognitive classification of the evaluative activities available in a VLE.

It has been concluded that the cognitive classification of the evaluative activities set in a VLE will be of great contribution for the teachers during the planning of their disciplines or their courses through the use of the tool Dependencies Map, because now the teacher can follow the evolutionary process of their students through the evaluation of each educational goal defined by him/her.

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