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Systematization of an Assessment Proposal in Theoretical - Practical Subjects for a Teachers' Training Program in Electronics, Technology and Computer Science

Hugo D. Marín-Sanabria , Jimmy W. Ramírez-Cano and Diego M. Rivera-Pinzón

Universidad Pedagogica Nacional, Bogota, Colombia; hmarin@pedagogica.edu.co, jwramirez@pedagogica.edu.co, dmrivera@pedagogica.edu.co

Abstract

Objectives: To propose and systematize an alternative assessment for 4 disciplinary areas that link the theoretical - practical character of a training program addressed to electronics, technology and computer science teachers. **Methods**: A descriptive study was used as methodology in this work. In that way, the instruments used to collect information are data formats and reports submitted by the students who belong to the areas of study. The information collected is qualitative. The systematization considered the alternatives of assessment used by teachers in the areas of Electronic Design, Digital Design, Circuit Analysis and Mechanical Physics. **Findings**: The proposed assessment option for these areas, involves three training sections: 1. The theoretical orientation which is mediated by questions that guide the student learning process, 2. Some virtual laboratory practices are proposed to connect the theoretical orientation. These practices are supported with new guiding questions, giving depth to the topics in development. 3. The real laboratory, which complements the theoretical and the virtual laboratory. Each laboratory activity is supported with new questions that guide the learning process and return to the items which are expected to be discovered by the student in the two previous activities. **Application:** To articulate the activities, a methodology of teaching by oriented research is used. This type of research is strengthened under the guidance of the learning. This orientation is mainly done throughout questions that are originated in each activity for the areas and the topics proposed in the research. It is important to highlight that the results can be generalized in other areas that keep relation with the investigation, as well as to other fields and disciplines related to the engineering.

Keywords: Assessment Practices, Education, Electronics Teaching, Learning, Teaching Strategies

1. Introduction

The treatment and the intentions of the evaluative activity in the classroom, a few times, is subjected to the reflection and analysis as it has been cataloged as a symbolic act that plays the role of facilitator for the knowledge measurement, abilities, skills and on many occasions, learning opportunities[1,2]. A study that links the learning assessment and improves the processes of teaching the learning leads us to reflect on the evaluative activity. Thus, the results will allow a strengthening, not only of the evaluative activity within each academic space, but they may be used, modified and adapted in programs and areas that are related to the study.

In this research process, it is of vital importance to give meaning again to the evaluative practice, claim it as a concerted process where each one of the experiences of the student and the teacher are involved[3]. Consequentially, it is intended to identify how these experiences contribute to the structuring and generation of knowledge itself, a

*Author for correspondence

process that is based on a feedback model in which the teacher plays a predominant role, which claims that the individual achieves his goals by correcting and analyzing their own mistakes in the teaching-learning processes[4–6].

2. Discussion

Nowadays, the results of the assessment in higher education, high and elementary school, do not contribute a structured sense to the learning process of the student, in addition, they are not consistent with social needs. For this reason, it is necessary to make changes within the evaluation strategies to improve the following items:

- The tests are diagnostic.
- They do not consider the difficulties and individual differences of the evaluated individual.
- It becomes an iterative process and at the same time technical, because it is the expected response.
- It is a purely unilateral process.
- It becomes a means of control.
- It is often a casual situation, since it does not follow a plan within the program exposed to the student, for example, the quiz.

In accordance with these elements, the evaluation does not allow a concerted process, by contrast, it focuses attention on quantify a process that should be qualitative[7,8]. The problem is accentuated when we analyze the relations between the concepts of a subject that is strengthened by the technical contents and that are supported with laboratory practices that sustain the results obtained in the lecture sessions.

It is important to note that these problems are common in the evaluation for subjects of theoretical – practical order, for the areas of Digital Design, Physics and Circuits. These areas are common in professional training programs for teachers of electronics, technology and computer science, and some engineering programs.

3. Methodology

The methodology used was a descriptive study that used the instruments to collect information the data formats and reports submitted by the students of the mentioned areas. The analysis of the information focuses on analyzing the responses to the planned activities in terms of logic, language, argumentation and analysis of the situation presented in each of the reports. The academic sessions and the most representative topics of the study are:

- Physics I: Mechanical physics – laws of motion – Coordinate Systems – Energy of a system – angular movement.
- Circuits I: Response of resistive circuits and first-order circuit analysis.
- Circuits II: Analysis of second-order electrical systems. Phasor analysis in electrical circuits.
- Digital Design I: Numeric representations – logic functions using logic gates – combinational and sequential logic.

This study is based on a preliminary investigation that sought to determine the perception of students towards the assessment practices that occur in these areas. That research starts with the analysis of the survey conducted to 155 students. The questions were: 1. Has someone ever made clear to you: what is the aim of the evaluations that you write?, 2. Are the percentages of evaluation in each subjects of each area shared on time?, 3. How deep, your consider, are addressed the topics in each area in relation to the level proposed during the assessment?, 4. Do you find any aspect that relates the results of the laboratory practice to the theoretical assessment?, 5. On what scale do you relate the assessment practices in each area to the practical problems of your life?

For this research, it is taken the results that show students perception: 1. The surveyed students considered the evaluation as "a filling-in and monitoring to measure quantitatively" and a large percentage believe that it is "a tool that allows the feedback of the teaching-learning process". 2. Students relate the theoretical elements with the development of laboratory practices, particularly in the digital design area. 3. Students perceive that the evaluation using ICTs requires wider dissemination and is considered a relevant factor in the teaching-learning processes of the electronics, technology and computer science. 4. The most commonly evaluation strategies are the develop of exercises, workshops, work by real problematic situations, projects, quizzes, laboratory reports, participation in presentations, online debate (the less frequent) and tests (the most used). 5. The percentages and evaluation agreements are shared on time. 6. The projects that are more related to aspects of everyday life are seen mostly in the digital design area, while in physics it is not

clear this relationship, except in the electromagnetism and mechanics topics.

The project was divided into two phases, each one of a semester-long course. The first phase was focused on designing the activities and the assessment strategies to implement, for the implementation of the model in a second phase. In the second phase, the first thing to be done is the presentation of one of the topics to the students in the classroom. This presentation has a holistic assistance of the phenomenon and it is supported with some questions about the activity. This first activity is referred to, as the "theoretical" activity. Subsequently, the activity relates to new virtual laboratory activities. These activities are carried out with simulation and/or programming, in addition, they are mediated with questions that guide the student learning process and the progress and complexity in each "virtual" activity. Finally, following a similar procedure, some "real laboratory" activities are proposed, in which the student can interact with the phenomenon and responds to new guiding questions that are asked to connect the "theoretical activity" and the "virtual activity"[9–11]. Completed this cycle, a new topic is presented and it is followed by virtual and real laboratory activities, hereinafter is considered a cyclical process.

In the application of the model, the first phase presents the aim of the research and the process to be developed in the future. The invited members were the students of the program, specifically, the students of the academic spaces to study. Subsequently, we proceed to analyze the concerns and contributions of this meeting, thus allowed to fit the methodological proposal of the first phase. These processes guided the activities to be carried out for the second semester and added elements for the design of the formats that would allow the presentation and criteria unification to present the activities of the different groups. This application is considered vital for the development of the second stage. The formats designed were focused on the following aspects:

- Format for presentation of the laboratory activities from the teacher to their students. This format divided the activity into theoretical work, virtual laboratory and laboratory practice stages, which included guiding questions of the teaching process and strategies to be used for each performance area.
- Format of student results presentation. This format is divided into two parts: The preliminary report and the final report. It takes as a reference the previous format and allows the material organization. In addition, it focused the teacher's interest on the practice objectives during the assessing time.
- Evaluation Matrix. This format linked six categories to be considered in the process: Fulfillment and timeliness; preliminary report; report, teamwork; presentation and under pin. As transversal elements, four categories of evaluation of performance are proposed, followed by the criteria to be considered for each of the categories of the evaluation process and they will define the final evaluation. The given criteria make clear to the students the expected objectives in the assessment, so that the student will be more organized and purposeful related to his work. In addition to the categories, there is a valuation and a comments section.

After defining the way in which the work will be organized, we proceeded to define the pilot activities, based on the topics to develop from the area documents. So, the activities of real and virtual laboratory are planned in parallel to the time that the model is deployed To start up the second phase, the suitability of each proposed formats is done, to adapt them to the dynamics agreed by the group. This is in accordance with the criteria for each of the specific areas of work of the project and we proceed to the construction of the laboratories in each of the areas of work, in order to be implemented with each of the working groups in the academic spaces. Students get the format in which they will present their reports. It has all the possible specifications so that students can complete the format looking for the uniformity in the presentation and, in the same way, the facility for the review done by the research team.

To carry out the assessment process, an evaluation matrix was developed which presents the different items of the laboratories and the corresponding weighting. Co-researchers students and teachers from the research team focused their attention on the report answers submitted by the students specifically on logic, language, argumentation and analysis, as well as other aspects such as presentation and spelling. An important aspect that needed special attention was the conclusions which show if the student submitted a proper analysis. In addition, it reveals if the students achieve the conceptualization and how the theoretical funding contributes to the learning process.

As a parallel activity of the project development, a literature review was carried out. It generated a document in relation to the argumentative - reflective practice, a based model that supports the evaluative work in the theoretical-practical areas. The gathered material contributed elements that defined the purpose at work in addition these items were related to issues such as knowing, doing and being. The material, in turn, allowed the discussion on the need to develop three types of competences to attain the goals, the cognitive, socio-emotional and communicative competences. The described model allows a feedback from the Metacognition and the learning process analysis, useful in the process of assessment that aims to study the group.

4. Results

A total of 5 complete activities were applied and 68 reports were received from each of the groups with the formats of evaluation matrix, which were observed from two perspectives: The first one, on the part of the research monitors that focused their attention on topics of form (presentation, spelling, writing and fulfillment of the practice objectives) and an analysis of the findings. To support the pedagogical processes, the monitors linked to the research project belong to training programs in humanities, specifically of Bachelor's degree in Psychology and Pedagogy, and Bachelor's degree in Special Education. This point is important because it exposes a different perspective than the one from the teacher, since the monitors belong to training areas different from engineering and they do not have training in science. The second view is developed by the teachers. They undertook a review of all the works and focus the attention on the arguments, the conclusions and the students' performance in carrying out the activity.

After having a material review report and the characterization of the information by the research team, the views were confronted and the information analysis was received, concluding the following results:

- Even when the group of students has material that would help them to organize the presentation of their results in the written form and it has been delivered in formats, a large number of groups did not use this material which denotes lack in the preparation of tasks in the written report achievement. In parallel, in most of the pieces of work presented, it was evident the division of the task into the members instead of a team work. This result was frequently visualized in the ideas linking, presentation of the text without width justify and different fonts and letters sizes.
- Congruent bibliographic references are missing, it is clear that the groups wish to comply with the requirements that were included in the evaluation matrix, however, in the document is only visible the name of texts that are followed on the subject or a web page, without following referencing rules for written documents. In addition, there are some sections which are literally copied in the theoretical framework stage that would become its result the same as a plagiarism.
- In most of the documents, a description of the methodology used by the group to achieve the objectives could not be found. The alternatives proposed by the team are important while in the reading of the document it can make visible the reasons for non-targets achieving, or highlight the reasons why they were reached.
- It is remarkable in the document the way in which the groups presented the final results. The proposed charts clearly differentiate the theoretical data from the virtual and the real ones; however, there are some instances in which the data were manipulated with the aim to strengthen conclusions of experiences developed in class. With the obtained data and using a spreadsheet program or similar, the group could have built graphs that show cut-off points or significant divergences. That kind of graphics were used only by a small number of groups and therefore the lack of analysis of the results found. It is important to highlight that the attached figures to the report were not referenced within the document and in the other hand, most of cases they were not considered to be a significant contribution to the analysis process of results, a situation which directly affects the conclusions of the written document.
- One of the most relevant points in the evaluation process was the analysis of the conclusions presented by the students. It was found that the level of arguments was very low at this point. It was clearly an effort to develop the proposed activity but not an analysis that would allow a comparison and correlation of the data obtained which would be reflected in better conclusions. It is as well that students did not consider the results of the virtual laboratory with those obtained in the practice, considering the first relevant element to reckon. These

results lead to think about: How can we promote a better argumentation level to the students? And, how do we generate higher levels of reading - writing?

- It was a recurrent issue that a large part of the conclusions sought to reinforce what has been said in class, so new alternatives were not explored, and in most cases, there was no relationship among the proposed objectives, the work performed and its conclusions.
- The use of the evaluation matrix made possible to organize the work, in addition, it was possible to have a clearer view of the assessment process. This allowed that the attention was focused on specific points so the practice development was faster. At the same time, it was clear that the student knew in advance the points on which it was expected to pay more attention, which brings that in practice, the student should take a more positive attitude, feeling part of the process. This response of a new alternative assessment showed great motivation and willingness to improve upon what already exists.
- In relation to the way in which the work was presented, it was frequent the personal writing or in first person, the problems of punctuation marks use, spelling, and in many cases, some ideas were exposed without a clear guiding theme between them.
- An important aspect in the project is focused on that the evaluative strategy proposed allows the assessment of 3 areas with different objectives. However, in practice some evaluative regular spaces are generates, which can be very useful at the time of initial assessment processes for other areas that may or may not share common goals from the ones that were implemented.
- The students of the group of Digital Design showed to be very familiar with the proposed model.
- In the laboratory practice session and at the time of requesting answers to the suggested guiding questions, there was a clear intention of the groups to show the achievement of the stated aim and the topic comprehension, space that makes possible to determinate that the proposed model allows them to think of argument alternatives.

5. Conclusions

To use the argumentation as an integrator element among theory, simulation and practice, has motivated the use of communicative skills, which are useful when assessing the practices developed by the students. However, these skills neither transcend the laboratory space nor were reflected in the written reports.

There is a clear lack of written communication tools, as well as information presentation mechanisms. These elements are considered priority to establish any kind of metric evaluations to be performed.

The time given to teachers for the preparation of teaching is reduced in most of the institutions. However, to get better results, it is necessary to spend more time in the guiding questions development process. These questions guide the teaching-learning process, therefore, are essential to the suggested model.

It is clear that the evaluation process is reversed mainly on the student who should reach the learning goals proposed, however, it is the teacher who knows the process, controls the elements of the subject to be taught and assessed, a part of the skills required by the research-oriented teaching methodology. So recognizing its importance becomes the regulatory element of the teaching-learning process. Consequently, if the teacher does not change its assessment structure linked to a grade, the teaching and learning processes will be disconnected and will not be meaningful in terms of improving results semester to semester.

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