MODEL FOR DETERMINING PEDAGOGICAL FACTORS AFFECTING
THE RETENTION RATES OF FIRST-YEAR ENGINEERING
STUDENTS

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Abstract

The low academic performance of students is a problem of concern to the Higher Education Institutions (HEI) worldwide. The quality of education is mainly measured by the academic performance, which is directly related with the grades. The grades obtained by students are translated into the number of passed and failed subjects. Students who fail one or several subjects in their first attempt have to decide either to repeat the course or dropout their studies. In the case of student retention, several previous studies have shown that students entering a career are not graduated in the established times. These results undoubtedly reflect an education problem that affects the development of society. Therefore, this issue needs to be investigated.

Because of the importance of this problem, some HEI have conducted studies about the causes for low academic performance. In general, the authors of these investigations agree that the causes are multi-factorial and they may be related with education institutions, students or teachers.

Several studies have proposed some variables to consider in assessing academic performance. However, the evaluation tools used to measure this variable have not been shown. In the present work, the objective is to develop a model that allows to identify the pedagogical factors directly influencing on the retention of subjects in the first-year engineering students. This study is founded on the hypothesis that the responsibility of teachers in the classroom significantly influences in the academic success or failure.

The main result from this research is the approach of a unified model, which constitutes a compilation and a combination of pedagogical factors considered on investigations carried out previously in some countries. The model is based on two questionnaires, the first one for teachers and the second one for students. These questionnaires contain similar questions that collect information from different points of view. The opinion collected from both teachers and students is to be compared and contrasted, with the purpose of identifying the factors directly affecting student retention.

The research certainly presents a contribution with regard to the previous work carried out. The results will help both teachers and academic authorities to raise awareness and decisions to improve the teaching-learning process and decrease student repetition rates.

Keywords: Academic performance, Higher Education Institutions, pedagogical factors, student retention.

1 INTRODUCTION

One of the main problems that the higher education institutions (HEI) currently have is the student dropout because of his low academic performance [1]. The retention and dropout have important personal, institutional, social and economic implications [2]. In the personal aspect, it implies a condition of failure that emotionally affects the student and it also affects his occupational trajectory. From the institutional point of view, it affects its university ranking, reputation and financial well-being [3]. In social terms, it contributes to generate inequity, social instability and detract from the goals that society expect from HEI. In the economic issue, the investment made by the state, university and family constitutes an unsuccessful expense and a waste of time.

One of the main indicators of the education quality is the academic performance, which is directly related to grades obtained by students. These grades are translated in the number of subjects passed and failed. In the case of students who fail, they have to decide whether to repeat the course or drop out their university studies [4]. Additionally, the reiterated retention may lead students to their definitive drop out.
The retention student has become one of the most important priorities for the HEI authorities [3]. Therefore, this topic should be investigated. Some HEIs have conducted studies on the causes of low academic achievement. In general, the authors of these investigations agree that the causes are multifactorial and involve aspects related to education institutions, students or teachers [5].

Several studies have been presented considering economic aspects, leadership, student mobility, institution image, pedagogical factors. Some articles display the results which determine factors oriented to teachers [6], students and institutions, however they do not present the models developed.

Despite several studies have been conducted, the problems of retention and dropout have not been solved; for this reason in the present study, we develop a model that allows to identify the pedagogical factors that directly influence the retention of first-year engineering students.

This study proposes the hypothesis that the responsibility of teachers in the classroom significantly influences in the student academic success or failure. The main result of this research is the approach of a unified model that constitutes a compilation and a combination of pedagogical factors considered in previous research in some countries.

Two questionnaires containing similar questions for teachers and students were developed in this model. The purpose of the questionnaires is to collect information about pedagogical aspects from different points of view. The opinion obtained from both teachers and students should be compared and contrasted in order to identify the factors that directly affect student retention.

The results will help to identify the pedagogical factors that influence the teaching-learning process and may affect the student retention. With this information, teachers and academic authorities may increase awareness and make decisions to decrease student retention rates.

1.1 Definition of terms

First-year engineering student: a student who has approved the credits corresponding to the subjects of the first and second semester of their careers, approximately 20% of the credits of the engineering career.

Retention, percentage retention rate: Parameter of the educational institution, corresponds to the number of students who fail the subjects corresponding to the first year of their career with respect to the students enrolled in the first year [7].

Student at risk: A student who presents factors that risk his permanence in the educational career, and allows to predict a higher dropout rate at some point in the future [7].

Cognitive factors: Factors related to the academic environment, intelligence, knowledge, related to educational variables [7].

Non-cognitive factors: Emotional or affective factors, personal values, social skills [7].

1.2 Related work

Previous studies consider retention student as a social problem. Some of these works are described below and presented in chronological order.

Roos conducted a study of Dixie State College freshman students, the primary goal of this study was to explore the relationship between retention and exposure to non-cognitive risk factor information for students and counselors [7]. Mbuva, presented a study of student retention in HEI, the studied areas included: student retention definition and student success, factors that affect the graduation rates of minority populations [8].

Yonghong Jade Xu performed a bibliographic study on student retention conducted through the last 40 years stated that, in the USA, 48 percent of undergraduate students and 69 percent of students in science, technology, engineering and mathematics (STEM) between 2003 and 2009, had dropped out [9]. However, Willis A. Jones indicated that HEI have not conducted studies on student retention in HEI, besides little effort has been made to systematically establish the institutional activity that deals with student retention. In this study, the institutional activity related to student retention was cataloged and compared [10].

Tejedor manifested that researching works tend to use eclectic models of interaction, which take into account some of the aspects (psychological, social, pedagogical) that can determine or affect academic performance. The causes for a poor performance have been classified into three categories:
institutional, teacher-related, and student-related. The author concluded by offering various performance guidelines to improve student performance, which can be taken into account in the planning and management of institutions within the framework of the European Higher Education Area (EHEA) [11]. According to Jacob D. Pleitz, it has been shown that those students who did not feel that their social or institutional expectations were achieved accurately had less possibilities to return to the institution than their peers [12].

The objective of this study is to define a model to determine the pedagogical factors affecting the retention rates of first-year engineering students.

At the same time it is intended to answer the following research question:

RQ. What researched pedagogical factors have been tackled in the relevant studies? What is the most researched pedagogical factor?

The rest of the article is structured as follows. The section 2 of this article refers to the method used for the development of this research, in section 3, the results are presented. Finally, the conclusions and recommendations obtained are shown in section 4.

2 METHOD

The method used to propose a model that allows to determine the pedagogical factors affecting retention rates of first-year engineering students, consists of four steps shown in Fig.1.

2.1 Step 1: Search for models based in pedagogical factors.

This step consisted in determining models developed in previous studies in the field of student retention and pedagogical factors. The search was supported by academic databases, such as Scopus, Web of Science (WOS), ACM Digital Library and Dialnet.

2.2 Step 2: Search of pedagogical factors.

This step consisted in identifying pedagogical factors which affect student retention based on a systematic mapping carried out in a previous study. This mapping was conducted by means of a systematic review, literature selection and a matrix construction that consolidate the pedagogical factors considered in most of former researches.

Table 1. Mapping of relevant studies about pedagogical factors.

<table>
<thead>
<tr>
<th>Pedagogical Factors</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study short references</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tejedor, García-Valcárcel, Muñoz-Repiso, 2006.</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Montero, Villalobos, Valverde Astrid, 2007.</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Pérez Cristian, 2016</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fincher Mark, 2010.</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>García Ortiz, Cruz, 2014.</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Castro, Paternina, Gutiérrez 2014.</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Garbanzo Guiselle, 2007.</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

A: Lesson planning  
B: Lesson organization  
C: Student - teacher relationship  
D: Teaching methods  
E: Teaching techniques  
F: Types of exams  
G: Academic autonomy  
H: Use and quality of didactic resources  
I: Tutoring  
J: Academic updating // Pedagogical training
2.3 **Step 3: Definition of the model.**

This step consisted in defining a model to identify which of the pedagogical factors affect the student retention of first year students of engineering.

2.4 **Step 4: Instruments supporting the model**

The model is based on two questionnaires, one is oriented for students and another for teachers as shown in Fig. 1.

![Figure 1. Steps for the model construction.](image)

3 **RESULTS**

This paper presents a model for determining pedagogical factors affecting the retention rates of first-year engineering students. This descriptive study was conducted from March 2016 to February 2017.

3.1 **Search for models based in pedagogical factors**

In the step 1, we found three models related with student retention, corresponding to the years 2010 and 2013. Three models were reviewed to check if they explicitly considered pedagogical factors. In the first study [1], the author presented several analytical models with data mining techniques to explain the reasons why students drop out. These models revealed that the most important predictors of the student dropout phenomenon are in general the educational and financial variables. In the second study [2], the authors showed a model to determine how the image of the institution influences the institutional commitment and the student intention to drop out his studies. Additionally, a student retention model including system and institutional dropout as outcome variables was developed. In the third study [3] the authors showed an application conceptual model of Six Sigma quality improvement methodology to the problem of undergraduate student retention in a business university. The three models do not consider pedagogical factors in their studies, therefore these ones were not considered to develop this research.

3.2 **Search of pedagogical factors**

The pedagogical factors that have been considered in this study are the result of a previous investigation that we have carried out, which were determined through a systematic mapping. This mapping constitutes a compilation of pedagogical factors considered on investigations carried out previously in some countries. In Table 2, a description of each of the 10 identified factors is shown.

With the information shown in Table 1 and Table 2, we answered the research question posed in this study.

RQ. What researched pedagogical factors have been tackled in the relevant studies? What is the most researched pedagogical factor?
The researched pedagogical factors that have been tackled in the relevant studies are: lesson planning, lesson organization, student - teacher relationship, teaching methods, teaching techniques, types of exams, academic autonomy, use and quality of didactic resources, tutoring teachers, academic updating // pedagogical training. The most investigated pedagogical factors is student - teacher relationship as shown in the Fig. 2. This one was considered in all the studies taken as basis for the study.

**Table 2.** Mapping of relevant studies about pedagogical factors.

<table>
<thead>
<tr>
<th>No.</th>
<th>Pedagogical factors</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lesson planning</td>
<td>Class content planning, preparation of materials, activities and practice.</td>
</tr>
<tr>
<td>2</td>
<td>Lesson organization</td>
<td>Organize class content, didactic resources and activities.</td>
</tr>
<tr>
<td>3</td>
<td>Student - teacher relationship</td>
<td>Use of motivation techniques and strategies directed to students.</td>
</tr>
<tr>
<td>4</td>
<td>Teaching methods</td>
<td>Procedure or activities to develop the teacher and student in the teaching-learning process.</td>
</tr>
<tr>
<td>5</td>
<td>Teaching techniques</td>
<td>Use of teaching techniques.</td>
</tr>
<tr>
<td>6</td>
<td>Types of exams</td>
<td>Exams according to the subjects and level of difficulty treated in class.</td>
</tr>
<tr>
<td>7</td>
<td>Academic autonomy</td>
<td>The teacher applies remediation measures.</td>
</tr>
<tr>
<td>8</td>
<td>Use and quality of didactic resources</td>
<td>Use and quality of didactic and technological resources.</td>
</tr>
<tr>
<td>9</td>
<td>Tutoring</td>
<td>The teacher performs tasks of control, follow-up, orientation and support to learning difficulties.</td>
</tr>
<tr>
<td>10</td>
<td>Academic updating // Pedagogical training</td>
<td>Teacher academic updating and pedagogical training.</td>
</tr>
</tbody>
</table>

**Figure 2. Most investigated pedagogical factors.**

### 3.3 Definition of the model

Based on the pedagogical factors identified in the systematic mapping, we propose a model shown in Fig. 3, it will allow us to determine the pedagogical factors that affect student retention.
3.4 Instruments supporting the model

The model is based on two questionnaires designed by considering the literature selected in the systematic mapping. The opinion collected from both teachers and students is to be compared and contrasted, with the purpose of identifying the factors directly affecting student retention.

These questionnaires contain similar questions that collect information from different points of view. These ones contain two sections; the first section contains four questions that collect personal data from respondents.

In the case of teachers the information in the first section is: gender, level of academic, career in which he taught classes, relationship dependence with the institution. In the case of students the personal data collected are: gender, career in which was enrolled in the period analyzed, whether or not repeated a subject and if applicable the name of the subject that was repeated. Section two contains 22 questions that collect information that will determine the pedagogical factors affecting student repetition as shown in Table 3.

The questionnaire oriented for teacher is presented in detail in the accompanying digital dataset.

Table 3. Pedagogical factors and questionnaire questions

<table>
<thead>
<tr>
<th>Pedagogical Factors</th>
<th>Questions collect information about</th>
<th>Number of question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson planning</td>
<td>Delivery of the syllabus</td>
<td>5,6,20,22</td>
</tr>
<tr>
<td></td>
<td>Punctuality of the teacher</td>
<td></td>
</tr>
<tr>
<td>Lesson organization</td>
<td>Knowledge of the subject</td>
<td>10,22</td>
</tr>
<tr>
<td>Student - teacher relation</td>
<td>Student Motivation</td>
<td>9,14,15,16</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>Activities to develop the teacher and student in the teaching-learning process.</td>
<td>17,26</td>
</tr>
<tr>
<td>Teaching techniques</td>
<td>Use of teaching techniques</td>
<td>19</td>
</tr>
<tr>
<td>Types of exams</td>
<td>Exam according to the subject addressed in classes</td>
<td>25</td>
</tr>
<tr>
<td>Academic autonomy</td>
<td>Academic autonomy of the teacher in his class</td>
<td>21,23,24</td>
</tr>
<tr>
<td>Use and quality of didactic resources</td>
<td>Use of teaching materials and technological resources of quality.</td>
<td>11,12,13</td>
</tr>
<tr>
<td>Tutoring</td>
<td>Personal attention to students</td>
<td>7</td>
</tr>
<tr>
<td>Academic updating / Pedagogical training.</td>
<td>Academic update and teacher training</td>
<td>18</td>
</tr>
</tbody>
</table>

1 http://hdl.handle.net/10045/66067
4 CONCLUSIONS

Given the limited research on the possible pedagogical factors that influence student retention in the first year of engineering students, the present research designs a model which is intended to be a contribution in order to improve both teaching practices and student academic performance and decrease student retention.

The plan of a model that determines the pedagogical factors that influence student retention involves a conceptual complexity due to the great quantity of variables implicated in the teaching-learning process. The results of the model application in different higher education institutions may be analyzed and contrasted to determine the effectiveness of the proposal.

REFERENCES


