Assessing Argumentative Competencies using Forum Analysis Software for Systems Engineering Students

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Abstract

Argumentative competence is a key skill for Systems Engineering students. However, it has been observed that students at the University of Córdoba have deficiencies, according to internal and external test results. To address this problem, a virtual learning environment was implemented in the Moodle platform and software was developed to analyze argumentative forum responses. The research had a quantitative approach, with a sample of 20 students to whom a diagnostic test was applied. The results showed significant difficulties in their initial argumentative competence. After the analysis of the forum responses through the software, shortcomings were observed in the substantiation of arguments and logical reasoning. In view of this, strategies and educational resources were implemented in the virtual environment to strengthen skills such as the structuring of solid arguments and the use of convincing evidence. It is expected that the findings and the proposal will contribute to the effective development of argumentative competence in students, providing them with tools to communicate ideas and promote critical and analytical thinking in an innovative way.

Keywords: argumentative competence, virtual teaching and learning environment, systems engineering, Moodle platform, analysis software.

1. Introduction

Argumentative competence has become a primary aspect in modern higher education. According to Toulmin (2003), the ability to express ideas, evaluate perspectives, and build strong arguments is essential for professional training in any field. However, recent research points to significant deficiencies in these skills among college students(Armenta et al., 2017; Backhoff et al., 2013).

However, the assessment of this competence has become a significant challenge for teachers. The difficulty lies, in part, in the complexity inherent in this competence, which encompasses

aspects such as the logical structure of the argument, the coherence and cohesion of the discourse, the clarity of the presentation of ideas, the relevant use of evidence and examples, as well as the ability to refute potential objections (Fonseca, 2019).

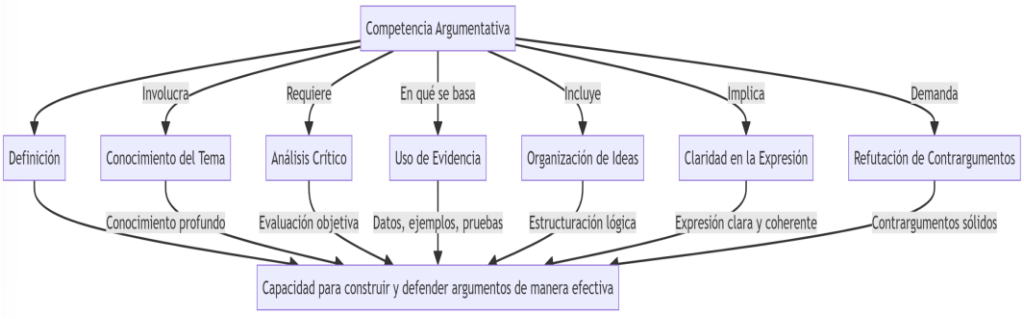


Figure 1. Key aspects of argumentative competence.

Note. This figure reflects the key aspects that are part of argumentative competence, as well as some key theoretical aspects that must be evaluated according to (Guzmán-Cedillo et al., 2013).

The multiplicity of criteria to be evaluated is aggravated by the abundance of responses generated in the forums, which demands meticulous attention to exhaustively analyze each student intervention (Santibáñez-Yáñez, 2015). This scenario poses a dilemma for teachers, who are faced with the dilemma of providing a fair and detailed assessment, while dealing with the time constraints imposed by the substantial amount of interactions in the forums (Da Silva, 2021). This obstacle highlights the prevailing need for an efficient solution that not only simplifies the evaluation process, but also guarantees quality and equity in the feedback provided to students.

Faced with this problem, this article presents the results of a research focused on evaluating argumentative competencies through software for the analysis of forums in Systems Engineering students at the University of Cordoba. This software is responsible for using the argumentative competence assessment rubric proposed by (Guzmán et al., 2012), receive the answers generated from the forum, evaluate them using Python with its NLTK library; which is used for natural language processing and assigns it an assessment resulting from the analysis of the response.

Criterios	Descripción del criterio	Niveles de desempeño			
		1	2	3	4
Vocabulario	Conjunto de palabras que el estudiante utiliza o conoce.				
Sintaxis	Manejo de conceptos propios de la temática.				
Disciplinarios	Parte de la gramática que enseña a coordinar y unir las palabras para formar oraciones.				
Postura	Posición, ya sea a favor o en contra, frente al tema.				
Estructura	Presencia de consistencia (habla alrededor de un tema), coherencia (muestra la secuencia de un hilo conductor en su discurso), y congruencia (no muestra contradicciones en su discurso).				
Transición	Secuencia ordenada de ideas en un discurso.				
Justificación	Manejo de evidencias alrededor de una afirmación.				
Contra argumentación	Réplica que hace referencia al comentario de otro(s) para comenzar un mensaje.				
Refutación	Entendida como la contestación de un mensaje, enumerando puntos que no se consideran bien argumentados por el compañero.				
Respetuosa	Manera en la que entiende que debe contribuir en la deliberación.				
Crítica	Consideración hacia la participación de sus compañeros.				
Colaborativa	Apertura hacia las ideas de los otros				
Flexible	Predisposición a cuestionar afirmaciones de manera reflexiva.				

Figure 2. Evaluation rubric used by the software to assess student participation in the forum.

Note. Based on (Guzmán et al., 2012).

This proposal represents a pedagogical contribution by exploring an innovative didactic strategy taking advantage of digital technologies so familiar to the new generations.

The use of ICT in education should always focus on solving the problems that afflict the education system, to the point that all types of software focused on teaching and learning must be contextualized to the needs of the context (Escobar et al., 2023), therefore the proposal presented in this paper also represents a technological contribution through the design of software specialized in natural language processing and the evaluation of argumentative texts through random regression. This tool allows the quality of arguments in discussion forums to be analyzed in an automated way according to previously established criteria.

Figure 3. Screenshot of the tool

Finally, in methodological terms, this study implements a rigorous quantitative process, which includes an initial diagnosis, an intervention proposal and a subsequent comparative analysis to evaluate the results of the diagnostic test and the analysis provided by the software designed for the evaluation of forums. This research model could be replicated in future studies on communicative competences and education mediated by digital technologies.

The multiple contributions of this article in pedagogical, technological and methodological matters seek to enrich the understanding of how to develop critical argumentative skills in engineering through educational innovation. The findings have relevant implications for both researchers and educators in this field.

2. Materials and Methods

The methodological design of this research responds to a quantitative descriptive model, based on the guidelines of (Hernández-Sampieri & Torres, 2018). Data collection was carried out in two phases, first applying a diagnostic test to determine the initial level of argumentative competence and then analyzing the answers in a discussion forum using the developed software.

The study population was made up of 20 students in the last semester of Systems Engineering at the University of Córdoba, Colombia, selected through a non-probabilistic convenience sampling. The instrument applied in the first phase was a diagnostic test validated by experts, composed of 15 multiple-choice questions to evaluate fundamental concepts about argumentation. In the second phase, the argumentative forum analysis software based on random regression was used, which processes responses in text format by assigning automated scores according to the criteria of a previously parameterized rubric.

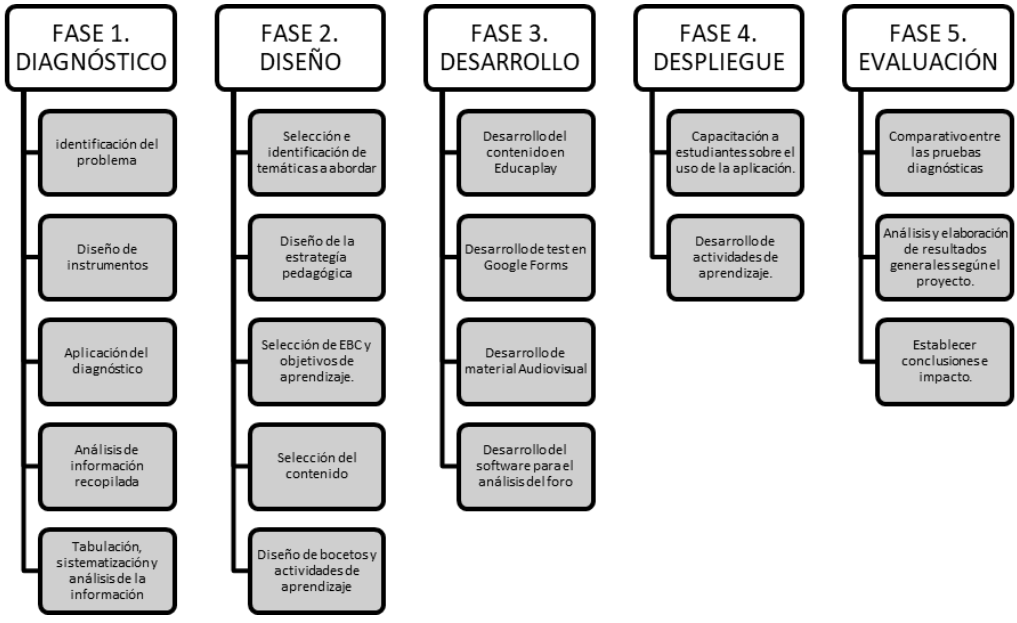
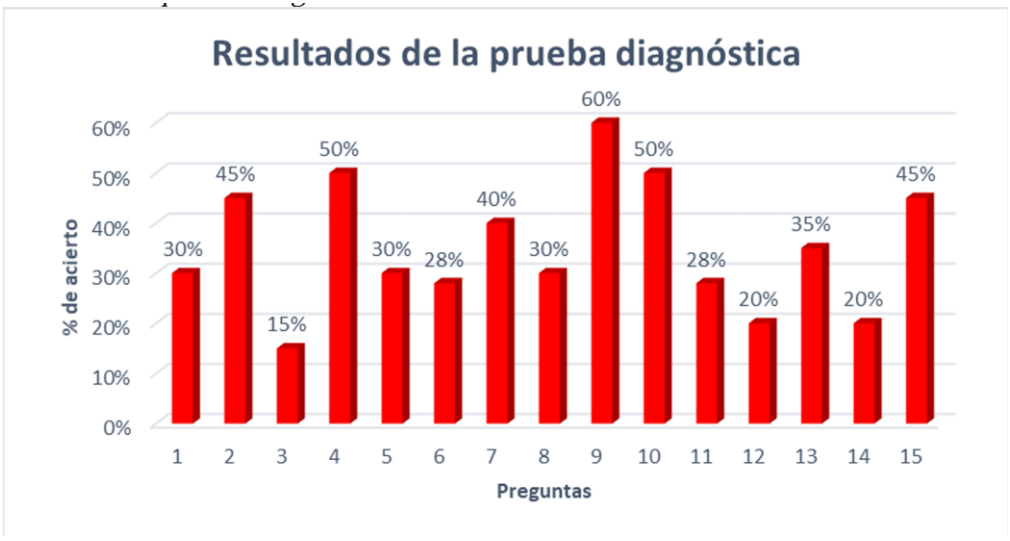


Figure 4. Research phases.

Statistical analysis was performed using central tendency measures and specialized software such as SPSS. The results of both tests were contrasted to evaluate the evolution in argumentative skills before and after the pedagogical intervention in the virtual teaching-learning environment. In this way, it was possible to determine the impact of the strategies implemented in the selected sample.

3. Results

The results of this research provide evidence on the difficulties faced by Systems Engineering students in relation to argumentative competence, as well as the positive impact that educational strategies mediated by virtual teaching-learning environments can have to strengthen these critical communication skills.



Specifically, the initial diagnostic test applied to the 20 participating students showed important gaps in terms of basic concepts about argumentation. 75% scored less than 60% of correct answers, indicating a performance well below expectations. In particular, shortcomings were identified in distinguishing a solid argument, recognizing the purpose of a rebuttal, and detecting common logical fallacies.

Subsequently, the automated analysis of the responses of the argumentative forum using the software developed in Python yielded worrying findings regarding the structure and coherence of the arguments. Approximately 80% of the participants demonstrated predominantly linear reasoning, with little use of relevant evidence and no approach to opposing perspectives or counter-arguments.

4. Discussion:

The results of this study support previous research that has shown important deficiencies in argumentative competence among university students. The low average score obtained in the initial diagnostic test is indicative of insufficient development of skills to formulate solid and coherent arguments (Otálora Rodríguez, 2016).

Likewise, in the analysis of the responses of the argumentative forum, it was observed that most of the students based their approaches on opinions without a basis in facts, data or relevant evidence. This finding is consistent with the study of (Armenta et al., 2017), where students were found to have difficulty identifying and using reliable sources to support their arguments.

The detected predominance of logical fallacies and superficial reasoning in the responses of the forum has also been reported in other educational contexts (Chávez & Caicedo, 2014; Montero

Cano, 2020). These argumentative errors can be attributed to a lack of specific training in argumentative competence within the engineering curriculum.

Similarly, Valdés-León et al. (2022), reinforces this concern by highlighting the importance of addressing argumentative competence in educational settings, especially in technical disciplines such as engineering. Likewise, authors such as (Alsina et al., 2021; Damascene-Morais, 2021; Miralda Banda, 2020) They underline how the lack of adequate argumentative skills not only affects the quality of interactions in forums, but can also have broader implications on the professional development of higher education students and future professionals, who require solid skills in the construction and evaluation of arguments in their work practices.

It is alarming to note that, even in higher education programs such as Systems Engineering, most students fail to construct informed, coherent and critical arguments. The predominance of logical fallacies and superficial reasoning found is consistent with the research developed and reflects a clearly insufficient preparation in essential critical thinking and persuasive communication skills (Cornejo-Morales et al., 2021). This leads to difficulties when it comes to building scientific knowledge (Uskola et al., 2021).

Therefore, the results obtained in this study ratify the need to implement pedagogical strategies explicitly aimed at strengthening argumentative skills. Although the sample was limited to students from one university, it is feasible that the findings will be extrapolated to other higher education institutions in the country, given the historically low results in generic competencies evidenced in external tests such as Saber Pro (OECD, 2019).

In conclusion, these findings have important implications for the training in communication competencies within Systems Engineering programs and higher education in general. Through the design of practical argumentation and debate activities, as well as effective feedback from teachers, the development of critical thinking and argumentative skills that currently present significant deficiencies can be promoted.

5. Recognitions:

State in the form of gratitude, the contribution made by people other than the authors or institutions that, in some way, contributed to the development of the study.

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