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SOCIAL MEDIA AS A DIDACTIC STRATEGY FOR STRENGTHENING SCIENTIFIC COMPETENCE IN ENGINEERING EDUCATION: AN INTERVENTION STUDY WITH FACEBOOK

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ABSTRACT

This work examines social media as a didactic strategy to strengthen scientific competence in the General Electronics course of the Electromechanical Engineering program at Unidades Tecnológicas de Santander. A quantitative, descriptive, non–experimental design was applied with 15 fourth–semester students; combining a diagnostic test on circuit analysis with a structured Facebook–based academic space, governed by netiquette guidelines. Initial results revealed significant gaps in Ohm's Law application, measurement units and circuit operations. After the intervention, statistically significant improvements were observed across all four evaluated criteria (Wilcoxon, $\alpha = 0.05$): circuit identification (pre: 20, post: 25 pts, $d = 1.57$), electrical laws and devices (pre: 15, post: 25 pts, $d = 2.92$), circuit operations (pre: 15, post: 20 pts, $d = 3.22$) and electronic symbols (pre: 20, post: 25 pts, $d = 1.53$), with the overall score rising from 69.67 to 94.33 out of 100 ($d = 2.75$). Facebook promoted collaboration, motivation and responsible digital tool use; confirming that a structured social media integration can effectively develops scientific competence in technical engineering.

KEYWORDS: Scientific Competence, social media in Education, Collaborative Learning, Engineering Education, ICT-Based Teaching Strategies.

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1. INTRODUCTION

The technological advances of the 21st–century digital age, characterized by the massive availability of information and global interconnection through the Internet and broadband, have driven the proliferation of mobile devices and social media platforms (Yamin, 2019); reshaping almost every aspect of human life and interaction, including business (Imjai et al., 2025), medicine (Navarro et al., 2025), personal life (Aguilera-Mata & García Martínez, 2021) and education (Cadena González et al., 2019). Over the past decade, there has been growing interest in incorporating Information and Communication Technologies (ICT) into education and classrooms (Mayorga & Contreras, 2019; Poveda-Pineda & Medina, 2020; Rodríguez, 2018). In this context, it is common to find schools and higher education institutions with widespread access to and use of computers, aiming to facilitate teaching and learning processes both inside and outside the classroom (Greenhow et al., 2009; Odom et al., 2013; Toro Córdoba et al., 2018). As these technologies become more widely used (Jaimes et al., 2025; Navarro et al., 2021, 2024), new opportunities and challenges arise for students and teachers (Jenkins, 2006): students need to develop skills to create, communicate and learn digitally, while educators must design authentic and meaningful digital learning experiences.

Digital ecosystems offer new opportunities to foster intercultural understanding while bridging intercultural gaps; posing challenges for education systems, such as digital inequalities, ethical issues and user well–being (Gui et al., 2017). They also offer new learning opportunities, including improved access to information, student–centered pedagogy, interaction and collaboration (Hernández et al., 2025); offering flexible time and space and enabling the formation of heterogeneous groups that were previously not possible in traditional settings. Online work provides opportunities for collaborative learning in multicultural environments, where students from different cultures and countries interact, learn and form relationships. Research shows that these online encounters contribute to improving intercultural understanding compared to face–to–face meetings (Hoter et al., 2009).

Collaborative approaches to teaching and learning have been shown to reflect the skills required to use ICT tools (Harasim, 2017). In the education systems of various countries, these skills have been integrated into teaching and learning with a strong emphasis on their implementation. Collaborative learning involves interaction between students and social or professional communication, creating online learning communities that become an integral part of the school experience, allowing each student to participate in collaborative processes and benefit from the resulting outcomes (Greenhow et al., 2009; Rodríguez, 2018). Beyond the classroom, multicultural study groups have the opportunity to explore, develop and discover cultures that would not otherwise be available through traditional education. Consequently, educators must encourage students to build a collaborative culture supported by digital technologies (Shonfeld & Gibson, 2019).

One of the emerging technologies surrounding university students is social media. Among the wide range of technologies available on university campuses, students most frequently use social media, but not necessarily in formal learning contexts (Corredor et al., 2008). This gap between habitual use and academic application represents both a challenge and an opportunity. Given that the internet and social media constitute a hypermedia environment; it is not surprising that students are distracted by non–academic content. However, social media has proven to be a helpful tool, as younger generations are digital natives and have grown up in the digital landscape (Pérez Rubio, 2014). In particular, students need to manage digital stimuli effectively so that these tools can be channeled toward personal, professional and academic goals (Gui et al., 2017). Structured integration of social media into teaching is therefore necessary to harness the potential of ICT, as it offers options for enhancing creativity, developing digital and scientific skills, promoting communication and guiding students toward good study practices (Aguilera-Mata & García Martínez, 2021; Jiménez, 2021; Lugo-López & Pérez-Almagro, 2022; Miguélez Martínez, 2021).

For this reason, this work proposes the use of social media as a teaching strategy to strengthen the scientific competence of students in the General Electronics course of the Electromechanical Engineering program at the Unidades Tecnológicas de Santander (UTS). The intervention is grounded in the premise that the successful implementation of a teaching strategy based on ICT can enable students to develop scientific competence and skills in collaboration and lifelong learning through interactions with digital environments. The guiding research question of this paper is: How can social media be implemented in teaching to strengthen scientific competence in the General Electronics course?

1.1. Scope, Contributions and Structure

The scope of this work is descriptive, detailing the relationships and variables of the population group studied, specifically in relation to the experience of using social media as a teaching strategy to strengthen scientific competence in the subject of General Electronics. As noted by Hernández and Mendoza (Hernández-Sampieri, R. & Mendoza, 2018), the descriptive scope facilitates the specification of properties and characteristics of the concepts, phenomena and variables analyzed in the classroom context, while also allowing for the definition, measurement and characterization of the variables and the phenomenon studied (Díaz & Vélez, 2024; Fernández & Calderón, 2021; Limas & Vargas, 2020; Marín & Cabero, 2019).

The contributions of this work span three dimensions. At the competency level, the strategy documents the development of scientific communication skills, the formation and empowerment of learning communities and the promotion of student autonomy and responsibility in digital activities; strengthening the conditions for meaningful and self–directed learning. At the collaborative level, it encourages joint digital activities that enable communication, information exchange and the generation of shared outcomes regardless of physical distance; stimulating investigative curiosity and allowing real scientific processes to be visualized. At the institutional level, the work provides evidence that supports the identification of needs and opportunities for improvement; promoting the integration of multidisciplinary knowledge and the development of innovations in teaching methodologies and resources.

Finally, it is worth noting that the growing influence of social media extends beyond the daily lives of students, who have developed a high degree of interest in using these platforms as tool for information and research. Higher education students use them as mechanisms for scientific exploration and information gathering to fuel their learning process. In this context, Díaz and Vélez (Díaz & Vélez, 2024) note that the rapid development of social media as instruments for knowledge generation creates spaces through which students can explore various dimensions related to academic and scientific topics, thereby enriching their learning experiences.

The document is structured into five sections. The first covers the introduction, including the problem statement, objectives and theoretical framework of the research. The second describes background on studies conducted by different researchers on the subject. The third presents the methodological design. The fourth reports the results demonstrating the achievement of the proposed objectives. The fifth presents the conclusions.

2. BACKGROUND

ICT has transformed many aspects of everyday life, particularly teaching and learning processes. In the field of education, these technologies have established themselves as tools that foster meaningful learning experiences, promote collaborative learning and facilitate the inclusion of students with diverse needs (Shonfeld & Gibson, 2019). They also offer flexibility in terms of time and space, broaden access to information and reinforce student–centered pedagogy (Dabbagh & Fake, 2017; Hoter et al., 2009; Lanuza Gámez et al., 2018).

In this digital environment, there is a need to train students in skills that integrate knowledge, abilities, attitudes and values to solve problems in various life contexts. In particular, scientific competence occupies a central place in engineering education. Within the PISA framework (OECD, 2023), scientific competence is defined as the capacity to explain phenomena scientifically, evaluate and design inquiry and interpret data and evidence dimensions that, in technical education, translate into skills of observation, classification, measurement, communication, inference and prediction (MEN, 2022). In the specific context of electronics, this competence requires students to move between theoretical principles such as Ohm's Law and Kirchhoff's laws and their practical application through instruments and circuit interpretation (Trujillo-Segoviano, 2014). Its development requires, in turn, the implementation of relevant assessment tools, such as rubrics or checklists, to identify strengths and weaknesses in learning (Morales López et al., 2019).

Strengthening these competencies requires teaching strategies that provide structured guidance for the teaching process; serving as a bridge between the use of technological tools and the attainment of meaningful learning. Integrating ICT through well–planned and evaluated experiences ensures that its use is not limited to the transmission of information; guaranteeing a tangible impact on the development of competencies (Carrillo Valdez, 2018; Sarmiento & Ojeda, 2018).

Among the many digital tools available, social media stands out for its capacity for interaction and collaborative knowledge building; positioning platforms such as Brainly, Edmodo, Facebook and RedAlumnos as viable tools for sharing resources, facilitating discussions and fostering academic

communities (Manca & Ranieri, 2016; Sobaih et al., 2016). Facebook, in particular, has demonstrated significant potential for encouraging teamwork, sharing experiences and enhancing student motivation (Mazman & Usluel, 2010). More recently, research conducted during and after the COVID–19 pandemic confirmed that social media platforms can sustain academic engagement and peer interaction even outside formal classroom settings (Fardoun et al., 2020; Manca, 2020); reinforcing their value as complementary tools for strengthening scientific competencies in technical subjects such as General Electronics.

3. METHODOLOGY

The work employed a quantitative and descriptive approach, utilizing a non–experimental design. Specifically, a pre–post single–group design was used, in which the same instrument was applied before and after the intervention to measure changes in scientific competence; enabling the collection of objective information from the participating population and the analysis of results without manipulating the variables, thereby answering the research question and evaluating the impact of the implemented teaching strategy (Cubo Delgado, S., Martín Marín, B., García Ramos, 2011).

The population consisted of fourth–semester students in the Electromechanical Engineering program at the Unidades Tecnológicas de Santander in Bucaramanga, Colombia. From this population, an intentional sample of 15 volunteer students (11 men and 4 women) aged between 18 and 24 was selected. Inclusion criteria were: being enrolled in the General Electronics course for the first time, having completed the Circuit Analysis prerequisite courses and providing voluntary informed consent to participate. Students who had previously taken the course or were repeating it were excluded. These students had begun their training online before transitioning to face–to–face classes, a context that had already familiarized them with digital learning environments prior to the intervention.

Various tools were used to collect data (Morales López et al., 2019). First, an online diagnostic test, designed in Microsoft Forms, was administered to identify weaknesses in electronic circuit analysis; evaluating performance through a rubric that measured circuit recognition, application of Ohm's Law, interpretation of symbols and basic circuit operations. The diagnostic instrument was validated through expert judgment by two Electric Circuits instructors with a minimum of five years of teaching experience; reviewing each item for relevance, clarity and content coverage relative to the course prerequisites. Adjustments derived from this review ensured content validity before administration. To further support the reliability of the instrument, inter-rater agreement between the two expert evaluators was assessed using Cohen's kappa coefficient, yielding a value of $\kappa = 0.82$, which indicates strong agreement (McHugh, 2012). Although internal consistency metrics such as Cronbach's alpha are less applicable to rubric-based diagnostic instruments of this nature, the combination of expert validation and inter-rater agreement provided sufficient evidence of instrument quality for a descriptive pilot study of this scope. Subsequently, a survey was administered to select the preferred academic social network; resulting in Facebook being chosen as the implementation platform (Zambrano-Álava, 2020).

The teaching strategy involved creating an academic space on Facebook, developed over a two–week period (August 20 to September 1), where students engaged through posts, discussions, exercises and feedback from the teacher. To ensure responsible use of the platform, netiquette guidelines were established, understood as standards of courtesy and behavior in digital environments; regulating interaction and promoting respectful academic communication. During the intervention, theoretical content, practical exercises and audiovisual resources were shared; enabling a collaborative learning process both inside and outside the classroom (Mazman & Usluel, 2010).

Finally, the impact assessment was conducted by reapplying the diagnostic test at the end of the intervention; allowing for a comparison of the initial and final results. To determine whether the observed differences were statistically significant, a Wilcoxon signed–rank test for paired samples was applied, given the non–parametric nature of the data and the small sample size ($n = 15$), with a significance level of $\alpha = 0.05$. Effect size was calculated using Cohen's d; quantifying the magnitude of the observed change beyond statistical significance. The data were analyzed using the defined rubric; making it possible to establish the level of improvement in scientific competence and assess the effectiveness of the teaching strategy (Carrillo Valdez, 2018; Sarmiento & Ojeda, 2018).

4. RESULTS AND DISCUSSION

This section presents the results of the research process and discusses the findings. The results are organized sequentially: first, the diagnostic assessment of prior knowledge; second, the

description of the Facebook–based teaching strategy; and third, the comparative evaluation of pre– and post–intervention outcomes. The discussion interprets and contextualizes the findings in relation to prior research, evaluating their contribution, limitations and implications.

4.1. Works Results

The work results are presented in the sequential order in which the process of collecting and analyzing information was carried out to achieve the objectives proposed within the framework of the problem studied.

4.1.1. Diagnostic Test for the Analysis of Electronic Circuits

The diagnostic test, designed to identify students' weaknesses in electronic circuit analysis, was administered using Microsoft Forms to determine the level of prior knowledge required for the General Electronics course. This instrument was designed based on the topics covered in the Circuit Analysis courses, which are considered prerequisites for taking General Electronics and is presented in Table 1. The test consisted of 18 questions distributed across four criteria: 1) series, parallel and mixed circuits; 2) current and voltage laws and the behavior of electronic devices; 3) operations with electronic circuits; and 4) symbols used in electronic devices.

Table 1: The Diagnostic Test.

N	QUESTION	ANSWERS CORRECT	ANSWER INCORRECT
1	What type of circuit is characterized by the same current flowing through all its elements? a) Series b) Parallel c) Mixed d) None of the above	15	0
2	Indicate the unit of measurement used to quantify electric current. a) Ohm b) Watt c) Volts d) Amperes	8	7
3	Indicate which characteristic defines a parallel circuit. a) The current is the same in all elements. b) The voltage is the same across all elements. c) The total resistance is the sum of all resistances. d) None of the above	12	3
4	Indicate the unit of measurement corresponding to the electrical resistance of an element. a) Ohm b) Watt c) Volts d) Amperes	13	2
5	Indicate a characteristic of a parallel circuit. a) The current is the same in all elements. b) The voltage is the same in all elements. c) The total resistance is the direct sum of all resistances. d) None of the above.	15	0
6	Indicate the unit of measurement corresponding to the electrical power of an element. a) Ohm b) Watt c) Volts d) Amperes	11	4
7	Indicate which particles must move to generate an electric current. a) Electrons b) Neutrons c) Protons d) None of the above	15	0
8	Indicate the unit of measurement corresponding to the potential difference present in an element. a) Ohm b) Watt c) Volts d) Amperes	12	3

9	Indicate the law that states that the electric current flowing through a conductor is directly proportional to the applied voltage and inversely proportional to the resistance of the conductor. a) Ohm's Law b) Faraday's Law c) Watt's Law d) None of the above	12	3
10	Indicate a distinctive feature of a series circuit. a) Electric current flows through a single path. b) Electric current flows through multiple paths. c) Answers a and b are correct. d) None of the above.	14	1
11	Indicate the type of circuit obtained when series and parallel connections are combined. a) Series b) Parallel c) Mixed d) None of the above	11	4
12	Indicate the type of circuit whose equivalent resistance is determined by directly adding the resistances of all its elements. a) Series b) Parallel c) Mixed d) None of the above	15	0
13	Indicate the type of circuit whose equivalent resistance is determined from the inverse of the sum of the inverses of each resistance. a) Series b) Parallel c) Mixed d) None of the above	14	1
14	Indicate the electronic component that is used as a power source in a circuit. a) Resistor b) Capacitor c) Coil d) Power supply	10	5
15	Indicate the electronic component whose primary function is to oppose the passage of electric current. a) Resistor b) Capacitor c) Coil d) Power supply	11	4
16	Indicate the electronic component whose primary function is to store electrical charge in an electric field. a) Resistor b) Capacitor c) Coil d) Power supply	13	2
17	Indicate how an ammeter should be connected to measure the current in a circuit. a) In series with the circuit element. b) In parallel with the circuit element. c) Diagonally with respect to the circuit element. d) None of the above.	7	8
18	Indicate how a voltmeter should be connected to measure the voltage in a circuit. a) In series with the circuit element. b) In parallel with the circuit element. c) Diagonally with respect to the circuit element. d) None of the above.	8	7

The diagnostic test indicated an acceptable level of proficiency in identifying basic circuits; however, 53% of students did not clearly recognize the characteristics of a parallel circuit and 27% struggled to identify a mixed circuit. Performance was higher in terms of electronic device symbols, although between 13% and 33% of students still confused some components. Significant gaps were found in the understanding of Ohm's Law, with 20% answering incorrectly; particularly in the recognition of units of measurement for electrical quantities, where 47% did not identify the unit of electric current and 27% were mistaken about electrical power. The most critical weaknesses were found in practical circuit

operations: 53% of students did not know how to connect an ammeter correctly and 47% did not know the proper connection for a voltmeter; confirming that students possessed the minimum conceptual base to begin the course but lacked the procedural fluency required to progress without structured support.

Based on the diagnostic test results, an evaluation rubric was developed to assess the level of scientific competence in electronic circuit analysis. Table 2 presents the consolidated scores by criterion, calculated as group averages across the 15 participants.

Table 2: Results of the Rubric for the Diagnosis of Competence.

Criteria Of Evaluation	Scores				
	25 Points	**20 Points**	**15 Points**	**4 Points**	**0 Points**
Series, parallel and mixed circuits. (Questions: 1, 3, 5, 7 and 11)	Clearly identify and interpret different types of electronic circuits.	Identify and interpret some types of electronic circuits.	Partially identifies and interprets types of electronic circuits.	Does not clearly identify or interpret the different types of electronic circuits.	Does not identify types of electronic circuits.
Laws of current, voltage and behavior of electronic devices. (Questions: 2, 4, 6, 8 and 9)	Clearly understands Ohm's Law, the behavior of different electronic devices and units of measurement.	Understands Ohm's Law, the behavior of different electronic devices and units of measurement.	Partially understands Ohm's Law, the behavior of different electronic devices and units of measurement.	He does not understand Ohm's Law, the behavior of different electronic devices and units of measurement.	Does not understand Ohm's Law or the use of electronic devices.
Operations with electronic circuits. (Questions: 10, 12, 13, 17 and 18)	Performs operations with electronic circuits clearly and understands the behavior of electric current.	Performs operations with electronic circuits and understands the behavior of electric current.	Performs some operations with electronic circuits and understands the behavior of electric current.	Does not perform operations with electronic circuits and understands the behavior of electric current.	Does not perform operations or understand electric current.
Symbols used in electronic devices. (Questions: 7, 9, 14, 15 and 16)	Clearly identifies how electronic devices are represented within a circuit.	Identify how electronic devices are represented within a circuit.	Partially identifies how electronic devices are represented within a circuit.	Does not partially identify how electronic devices are represented within a circuit.	Does not recognize or represent devices in a circuit.

Note: Prepared Based on the Results of the Diagnostic Test Administered Using the Microsoft Forms Tool.

The rubric results revealed a clear pattern across the four criteria. Recognition tasks scored higher: circuit identification reached 20/25 points; indicating that students could differentiate series and parallel configurations but struggled with mixed circuits; electronic symbol recognition also reached 20/25 points, though mastery was not uniform across all components. Application tasks scored lower: understanding of electrical laws and devices reached only 15/25 points; reflecting conceptual gaps particularly in measurement units despite a basic grasp of Ohm's Law; while circuit operations also reached 15/25 points; confirming that students could perform isolated calculations but failed in practical instrument use, specifically ammeter and voltmeter connections. Overall, the group achieved an average score of 70 out of 100; consistent with an intermediate competence level and a pattern documented in technical education research: declarative knowledge develops ahead of procedural fluency (Trujillo-Segoviano, 2014).

To address the gaps identified in the diagnostic assessment, Facebook was selected as the implementation platform for the teaching strategy, a choice made by the students themselves through a survey administered after the diagnostic test (Zambrano-Álava, 2020). Students expressed confidence that social media could enhance their learning process and support the development of scientific competence in circuit analysis. To formalize this commitment, students agreed to dedicate a minimum of one hour per day to the academic space, engaging with the content, discussions and activities proposed by the instructor.

4.1.2. Implementation Of the Teaching Strategy

In accordance with the characteristics of the chosen platform, a teaching strategy was designed to enhance the learning process and develop scientific competence in circuit analysis. The intervention was structured in three phases. First, an onboarding phase established the academic space: a welcome message was posted as shows in Figure 1 and netiquette guidelines were defined as seen in Figure 2 to regulate interaction and ensure responsible use of the platform. These guidelines covered aspects such as respectful communication, timely participation and appropriate use of academic language in digital environments.

Figure 1: Welcome Message to the Facebook Social Network.

Figure 2: Netiquette Guidelines for Use of the Social Network.

In the second phase, consistent teaching materials were designed and shared, including an illustrative video on semiconductor diode theory covering operating principles, practical applications and everyday examples as shows in Figure 3. The video generated six comments and was shared beyond the enrolled group, extending the reach of the academic content to the broader community. During this phase, the instructor conducted feedback activities through a roundtable dynamic in which students shared concepts they had developed, which were then supplemented with additional information and industry–based practical examples. This format encouraged dialogue and debate while simultaneously addressing unresolved questions that students had not raised during face–to–face sessions (Mazman & Usluel, 2010).

Figure 3: Theory of Semiconductor Diodes.

In parallel with the online activities, the proposed circuit was developed in the classroom as a practical exercise targeting the specific weaknesses identified in the diagnostic test particularly ammeter and voltmeter connections and the practical application of Ohm's Law as seen in Figure 4. This combined approach was deliberate; integrating digital content on Facebook with hands–on laboratory practice, given that procedural skills require physical repetition that digital mediation alone cannot provide (Manca & Ranieri, 2016).

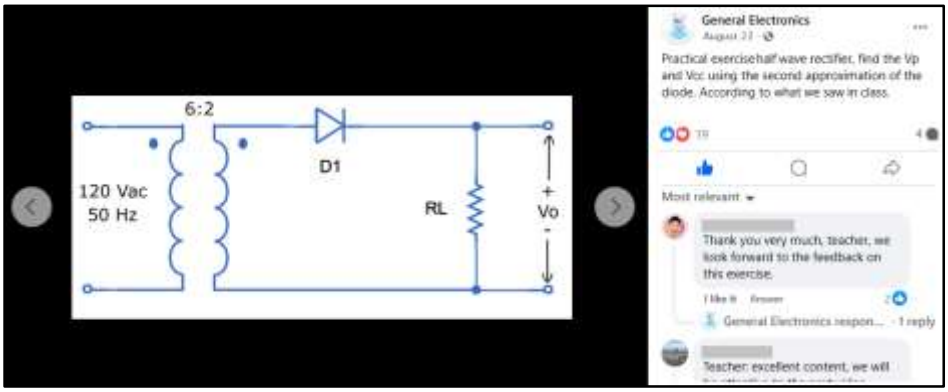

Figure 4: Practical Exercise Using Rectifier Diodes.

As the intervention progressed, an unexpected outcome emerged: the friendly environment generated by the platform reduced the social inhibition that some students experienced in face–to–face settings; motivating them to engage more actively and experiment with new learning approaches. This increased confidence led students themselves to create and publish a list of tips for learning more effectively on the platform as shown in Figure 5 an initiative that was not planned by the instructor but arose organically from student interaction; signaling genuine learning community formation (Harasim, 2017).

In the third phase, audiovisual material was shared on the operation of half–wave and full–wave rectifiers and their industrial applications, complementing the practical circuit design exercises previously developed in the classroom. Expanding this content through Facebook proved particularly effective for students who were reluctant to participate openly in face–to–face sessions: the digital environment lowered the affective barrier to asking questions and sharing difficulties, making conceptual gaps visible that would otherwise have gone unaddressed. The motivation generated throughout the intervention was reflected in a closing message shared with the group as seen in Figure 6, which students responded to with comments expressing both satisfactions with their learning progress and willingness to continue using the platform in future courses.

Figure 5: Eight Tips for Learning Better.

Figure 6: Shared Message to Motivate the Experience.

The development of content was monitored through the design of a practical exercise on full–wave rectifiers, which is shown in Figure 7.

Finally, it should be noted that the teaching exercise yielded significant results, among which the following stand out:

- Frequent use of the Facebook platform encouraged students to connect to the fan page, to improve and strengthen the learning process.
- Students were able to interact with the teacher in a more direct and personalized way, overcoming difficulties that some had in regular class due to embarrassment, fear of criticism, or not understanding the subject.
- The organization of published material using

tags allowed students to easily locate photos, links, videos and documents that facilitated the preparation of assessments for each academic term.

- Students developed knowledge about netiquette guidelines and strengthened their responsible use of social media. Instead of prohibiting its use during class, it was used as a practical learning tool.

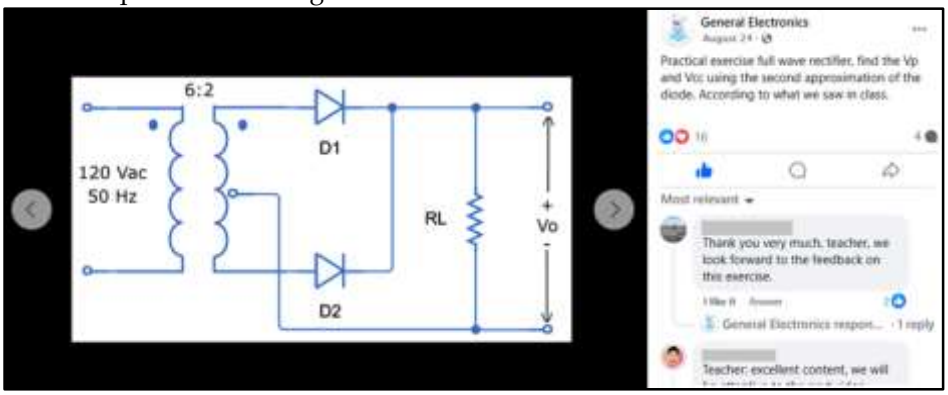

Figure 7: Full–Wave Rectifier Circuit.

The use of Facebook facilitated learning and peer collaboration by providing strategies, resources and information sources that supported effective learning. It also made it easier for the teacher to document and monitor the learning process.

During the two–week intervention period (August 20 to September 1), the Facebook page recorded 161 visits, 19 reactions, 20 followers, a reach of 106 people and 181 interactions on posts. The ratio of interactions to followers (9:1) is particularly telling: it indicates that students returned to the content repeatedly rather than viewing it once; suggesting active and sustained engagement rather than passive consumption. The reach of 106 people five times the enrolled sample indicates that content spread organically beyond the course; reflecting voluntary sharing behavior that is difficult to replicate in traditional classroom settings. Overall, these indicators confirm that the strategy enhanced motivation, fostered collaborative learning and extended the visibility of academic content beyond the boundaries of formal instruction.

Beyond the learning outcomes, this experience demonstrated that ICT–supported environments offer practical advantages for documentation and monitoring: content is automatically timestamped, interactions are traceable and participation records are available without additional administrative effort. These features make Facebook a useful tool not only for students but also for instructors seeking to track engagement and adjust their teaching strategy in real time.

4.1.3. Evaluation Of the Teaching Strategy Implemented

To evaluate the impact of the teaching strategy, the diagnostic instrument was reapplied at the end of the two–week intervention. To control for memory effects, students were not informed of their initial scores or the correct answers before completing the post–test. Table 3 presents the post–intervention rubric results, which are compared against the baseline scores from Table 2.

The results obtained are presented in Table 3, which displays the average outcomes achieved through the use of Facebook as a teaching strategy to enhance scientific competence in the General Electronics course for students in the Electromechanical Technology program at UTS.

Table 3: Results of the Evaluation of the Teaching Strategy Used.

Criteria Of Evaluation	Scores				
	25 points	20 points	15 points	4 points	0 points
Series, parallel and mixed circuits. (Questions: 1, 3, 5, 7 and 11)	Clearly identify and interpret different types of electronic circuits.	Identify and interpret some types of electronic circuits.	Partially identifies and interprets types of electronic circuits.	Does not clearly identify or interpret the different types of electronic circuits.	Does not identify types of electronic circuits.

Laws of current, voltage and behavior of electronic devices. (Questions: 2, 4, 6, 8 and 9)	Clearly understands Ohm's Law, the behavior of different electronic devices and units of measurement.	Understands Ohm's Law, the behavior of different electronic devices and units of measurement.	Partially understands Ohm's Law, the behavior of different electronic devices and units of measurement.	He does not understand Ohm's Law, the behavior of different electronic devices and units of measurement.	Does not understand Ohm's Law or the use of electronic devices.
Operations with electronic circuits. (Questions: 10, 12, 13, 17 and 18)	Performs operations with electronic circuits clearly and understands the behavior of electric current.	Performs operations with electronic circuits and understands the behavior of electric current.	Performs some operations with electronic circuits and understands the behavior of electric current.	Does not perform operations with electronic circuits and understands the behavior of electric current.	Does not perform operations or understand electric current.
Symbols used in electronic devices. (Questions: 7, 9, 14, 15 and 16)	Clearly identifies how electronic devices are represented within a circuit.	Identify how electronic devices are represented within a circuit.	Partially identifies how electronic devices are represented within a circuit.	Does not partially identify how electronic devices are represented within a circuit.	Does not recognize or represent devices in a circuit.

Post–intervention results showed improvement across all four criteria. Students clearly identified and interpreted all types of electronic circuits, including mixed configurations that had presented difficulty in the diagnostic test. Their understanding of Ohm's Law, electrical quantities and measurement units reached the maximum rubric score (25/25); resolving the conceptual gaps identified in the baseline assessment. Circuit operations improved significantly; with students demonstrating the ability to perform calculations and interpret current behavior, though instrument connection particularly ammeter and voltmeter use remained the weakest procedural skill. Recognition of electronic device symbols also reached the maximum score; with uniform mastery across all components evaluated.

Comparing the initial assessment with the final evaluation, improvement was observed across all four criteria. As shows in Table 2 and Table 3, the most substantial gains occurring in the understanding of electrical laws and devices (pre: 15, post: 25 pts) and electronic symbol recognition (pre: 20, post: 25 pts), both reaching the maximum rubric score. Circuit operations showed meaningful progress (pre: 15, post: 20 pts) but did not reach the maximum level; reflecting the procedural nature of instrument connection skills that require sustained hands–on practice beyond what a two–week digital intervention can fully address (Manca & Ranieri, 2016). Table 5 summarizes these pre– and post–intervention scores for direct comparison and Table 6 presents the corresponding statistical analysis.

Beyond scientific competence, the quality of students' participation in the social network was assessed independently using the rubric summarized in Table 4. This rubric evaluated four dimensions of digital academic performance: timeliness and consistency of participation, quality of published information, grammatical correctness and adherence to netiquette guidelines. Assessing these dimensions separately from content knowledge allowed for a more complete picture of how students engaged with the platform as an academic tool, not only whether they learned the subject matter.

Table 4: Results of the Evaluation of Students' Academic Performance.

Criteria Of Evaluation	**Scores**				
	25 Points	**20 Points**	**15 Points**	**4 Points**	**0 Points**
Participation in social media.	Participation in publications is timely and activities are submitted within the established deadlines.	Participation in publications is adequate, but lacks consistency and activities are submitted within the established deadlines.	Participation in publications is inconsistent and activities are often submitted late.	Participation in publications does not comply with the defined structure and activities are submitted late.	Does not participate or submit late.
Quality of published information.	Keywords, terms and images are used appropriately. The organization of information allows for discussion of the concepts learned.	Keywords, terms and images are used correctly. The organization of the information does not allow for discussion of the concepts learned.	Terms and images are used. The organization of the information does not allow for discussion of the concepts learned.	The published information lacks proper grammatical structure, with spelling and punctuation errors. Furthermore, it uses imprecise	The information lacks structure and contains numerous errors.

				vocabulary.	
Use of grammar.	The published information exhibits adequate grammatical structure, spelling and punctuation, facilitating the understanding of ideas.	The published information has a proper grammatical structure, spelling and punctuation, but does not facilitate understanding of the ideas.	The published information has proper grammatical structure, spelling and punctuation, but it is not clear in expressing ideas.	The published information lacks proper grammatical structure, with spelling and punctuation errors. Furthermore, it uses imprecise vocabulary.	It completely lacks organization and appropriate vocabulary.
Use of netiquette.	Uses the set of behavioral rules appropriately to express ideas.	Uses the set of behavioral rules to express ideas.	Does not use the set of behavioral rules to express ideas.	Does not utilize the set of behavioral norms appropriately to express ideas.	Does not follow guidelines or manage to express ideas.

The rubric results across the four dimensions revealed a consistent but nuanced picture. Participation was timely and evidence was submitted within established deadlines, indicating that students honored their one–hour daily commitment throughout the intervention. Information quality was appropriate: keywords, terms and images were used correctly and content was organized in a way that facilitated discussion. Netiquette guidelines were followed consistently, suggesting that the behavioral norms established at the outset were internalized rather than merely imposed. The weakest dimension was grammatical clarity: while spelling and punctuation were generally correct, written expression lacked the precision needed for ideas to be fully understood by peers without additional context a limitation that points to the need for explicit academic writing instruction alongside digital strategy implementation.

Taken together, these results indicate that students engaged with the Facebook academic space in a purposeful and responsible manner, using it to extend and refine their understanding of electronic circuit analysis. The main area requiring further development was written academic expression, which suggests that future implementations of this strategy should incorporate explicit guidance on digital academic writing to complement the subject–specific content.

In summary, the Facebook–based intervention produced measurable gains across both dimensions evaluated: scientific competence in electronic circuit analysis and quality of digital academic participation. Students took an active role throughout, engaging in collaborative activities, discussions and practical exercises both online and in the classroom. Table 5 summarizes the pre– and post–intervention stores across the four competence criteria and Table 6 presents the Wilcoxon signed–rank test results confirming the statistical significance of the observed improvements.

Table 5: Comparison of the Results of the Initial and Final Evaluation of the Strategy.

N	Criteria Of Evaluation	Before	After
1	Series, parallel and mixed circuits.	20	25
2	Laws of current, voltage and behavior of electronic devices.	15	25
3	Operations with electronic circuits.	15	20
4	Symbols used in electronic devices.	20	25

Note: Prepared By the Authors Based on the Results of the Assessments Detailed in Tables 2 And 3.

Table 6: Wilcoxon Signed–Rank Test Results, Pre– And Post–Intervention Comparison

Criterion	Pre M (SD)	Post M (SD)	W	p	Cohen's d
Circuit identification	20.00 (3.27)	24.67 (1.29)	0.000	0.0005	1.57
Electrical laws & devices	15.00 (3.27)	24.33 (1.76)	0.000	0.0002	2.92
Circuit operations	14.67 (3.52)	20.33 (2.97)	0.000	0.0001	3.22
Electronic symbols	20.00 (3.27)	25.00 (0.00)	0.000	0.0006	1.53
Overall score	**69.67 (12.74)**	**94.33 (4.58)**	**0.000**	**0.0003**	**2.75**

Note: M = Mean; SD = Standard Deviation; W = Wilcoxon Statistic;
P = Significance Level (A = 0.05); D = Cohen's D Effect Size.

Table 7 summarizes the overall scores obtained for each evaluated activity, combining the scientific competence assessment and the social network participation rubric.

Table 7: Points Obtained After Evaluating the Teaching Strategy.

N	Activity Description	Points
1	Social Networking	95

2	Competitor Assessment	95

Note: Prepared By the Authors Based on the Results of the Assessments Detailed in Tables 3 And 4.

These results confirm two overarching findings. First, students engaged with the platform actively and responsibly: participation was timely, information quality was consistent with the subject matter, netiquette guidelines were respected throughout and grammatical expression, while moderate, showed improvement over the baseline. Second, scientific competence in electronic circuit analysis advanced significantly across all evaluated dimensions: students consolidated their understanding of series, parallel and mixed circuits, mastered Ohm's Law and device behavior and overcame initial difficulties in circuit operations and symbol recognition. The statistical analysis confirmed that these gains were not incidental: all four criteria showed large effect sizes ($d > 1.5$), indicating that the intervention produced substantial and consistent learning outcomes.

Taken together, the evidence supports the conclusion that a structured Facebook–based teaching strategy can effectively strengthen scientific competence in technical engineering subjects, provided it is accompanied by clear behavioral norms, active instructor moderation and complementary hands–on practice.

5. DISCUSSION

In the educational context, digital platforms are increasingly recognized as essential tools for developing competencies in technical and scientific fields. This study identified a significant relationship between structured social media use and the development of scientific competence in electronic circuit analysis among Electromechanical Engineering students at UTS, extending prior research conducted in similar higher education contexts.

Research consistently shows that greater digital proficiency among students enables autonomous access to information; creating conditions for the development of both knowledge and investigative competencies (Aguilera-Mata & García Martínez, 2021; Hernández et al., 2025; Hoter et al., 2009; Jiménez, 2021; Lugo-López & Pérez-Almagro, 2022; Miguélez Martínez, 2021). In this study, that dynamic was particularly evident in the way students who struggled to participate in face–to–face sessions engaged actively in the Facebook space; suggesting that digital environments lower the affective barriers to knowledge construction.

From a constructivist perspective, competencies are built through experiential learning over time (Harasim, 2017); explaining the pattern observed in this study: conceptual criteria those that can be scaffolded through discussion, feedback and multimedia content showed larger gains than procedural ones, which require sustained physical practice. Student interaction in digital environments has a positive impact on the formation of competencies during the educational process; with research showing that platforms such as Facebook and YouTube, when deliberately integrated into academic contexts, redirect students away from recreational use and toward academic and cooperative interactions that stimulate competency development (Hernández et al., 2025).

These findings are consistent with results reported by (Sobaih et al., 2016), who found that structured Facebook integration in higher education settings in developing contexts produced significant gains in student engagement when clear academic norms governed platform use. Similarly, (Manca, 2020) documented that platforms beyond Facebook, including Instagram and Pinterest, sustained peer interaction and content engagement outside formal sessions, a pattern mirrored in the 9:1 interaction-to-follower ratio observed here. More recently, (Fernández & Calderón, 2021) identified instructor moderation and explicit behavioral guidelines as the two most consistent predictors of positive learning outcomes across social media interventions in higher education; both conditions were deliberately built into the present study. Taken together, this convergence across independent studies conducted in diverse institutional settings strengthens confidence in the robustness of the approach, while also confirming that results are sensitive to implementation quality rather than the platform itself.

Stimulating scientific competence in students at higher education institutions requires continuous updating of teachers so they can design teaching strategies aligned with the digital environments students already inhabit. Beyond content knowledge, this implies developing digital pedagogical competence the ability to structure goal–oriented experiences in social media platforms rather than simply opening a channel and hoping for engagement (Zawacki-Richter et al., 2019). Likewise, motivational strategies must be developed to sustain students' interest in applying scientific knowledge to real problems in their professional environment.

However, not all evidence on social media in education points in the same direction. Manca and Ranieri (Manca & Ranieri, 2016) found that the effectiveness of these strategies depends heavily on

the instructor's active moderation role and the clarity of behavioral norms; both conditions deliberately built into this intervention through netiquette guidelines and continuous feedback. Balakrishnan and Gan (Balakrishnan & Gan, 2016) similarly noted that unstructured social media use can increase distraction rather than academic engagement; suggesting that the results reported here are not automatically replicable. The institutional context, the instructor's digital proficiency and the pedagogical design of the intervention are moderating factors that future studies should examine systematically; ideally through quasi–experimental designs with control groups and larger samples.

Collaborative approaches in teaching and learning reflect and reinforce the skills required to use ICT tools effectively (Harasim, 2017). In this study, the Facebook academic space functioned as an online learning community in the sense described by Harasim: students were not passive recipients of content but active participants who generated, discussed and refined knowledge collectively. Peer interaction and academic communication became an integral part of the course experience, with each student contributing to and benefiting from the group's collective progress (Greenhow et al., 2009; Rodríguez, 2018). This dynamic was particularly valuable for students who, due to shyness or uncertainty, had not been contributing equally in face–to–face sessions the digital environment redistributed participation in ways that traditional instruction had not achieved. Consequently, educators must encourage students to build a collaborative culture supported by digital technologies (Shonfeld & Gibson, 2019), while ensuring that the design of that culture is intentional, structured and pedagogically grounded.

For educators considering similar implementations, three practical guidelines emerge from this experience. First, establish behavioral norms before opening the platform: netiquette guidelines should be co-constructed with students during an onboarding session to promote internalization rather than mere compliance. Second, maintain active instructor presence throughout the intervention; passive content sharing without timely feedback significantly reduces the academic value of the digital space (Balakrishnan & Gan, 2016). Third, integrate digital activities with hands-on laboratory practice rather than treating them as substitutes: as this study demonstrated, conceptual gains from online interaction do not automatically transfer to procedural skills, which require physical repetition in controlled settings (Manca & Ranieri, 2016).

6. CONCLUSIONS

The findings of this study support three overarching conclusions. The first aspect that stands out is that the design of the assessment rubrics was an indispensable tool for accurately determining the level of competence, which served as the basis for determining the real impact of using social media as a strategy for developing scientific competence in technical subjects such as General Electronics. It also made it possible to clearly identify students' strengths and weaknesses in developing scientific competence. It facilitated the creation of personalized content that helps to overcome conceptual gaps in knowledge developed through courses or modules from previous semesters.

Second, the Facebook–based teaching strategy produced statistically significant improvements across all four evaluated competence criteria (Wilcoxon, $p < 0.05$, $d > 1.5$ in all cases); with the overall score rising from 69.67 to 94.33 out of 100. Sharing multimedia content videos on semiconductor theory, Ohm's Law, diode polarization and rectifier circuits combined with continuous instructor feedback proved particularly effective; addressing the conceptual gaps identified in the diagnostic assessment and resolving doubts that students had been reluctant to raise in face–to–face sessions due to embarrassment or uncertainty (Mazman & Usluel, 2010). The platform lowered this affective barrier; enabling more direct and personalized teacher–student communication throughout the intervention (Hernández et al., 2025).

A particularly relevant finding for institutional practice is that netiquette guidelines rather than prohibition proved sufficient to channel Facebook use toward academic purposes. Students internalized these norms throughout the intervention, maintaining respectful and purposeful interaction without external enforcement. This suggests that the question for educational institutions is not whether to allow social media in the classroom, but how to design the conditions under which these platforms become genuine learning tools: clear behavioral norms, active instructor moderation and content designed for discussion rather than passive consumption.

Third, the intervention demonstrated that social media can effectively support both sides of the teaching relationship. For students, it lowered the affective barrier to participation; extending learning beyond classroom hours through continuous access to resources and feedback. For instructors, the

platform's built–in documentation features timestamped posts, traceable interactions and visible participation records simplified the monitoring of student progress without additional administrative burden; with the ratio of 181 interactions to 20 followers (9:1) confirming that engagement was active and sustained, not merely passive viewing (Fardoun et al., 2020; Manca, 2020).

This study has three limitations that should inform the interpretation of its findings. First, the sample size (n = 15) is adequate for a descriptive pilot study but imposes clear constraints on the generalizability of the findings. Results should not be extrapolated to other institutions, engineering programs or cultural contexts without replication studies involving larger and more diverse samples. The single-group, pre–post design, while appropriate for an exploratory intervention, does not allow causal claims to be made; the observed improvements could partly reflect group maturation, repeated exposure to the instrument or the Hawthorne effect rather than the strategy itself. These constraints define the boundary conditions of the study and underscore the need for confirmatory designs before widespread adoption of the strategy is recommended. Second, the absence of a control group makes it impossible to rule out alternative explanations for the observed improvement, such as group maturation or the Hawthorne effect. Third, the two–week intervention period is short for evaluating impact on procedural skills that require sustained practice. Recognizing these limitations does not invalidate the findings; rather, it defines the conditions under which the strategy demonstrated effectiveness and establishes the starting point for future research.

Future studies should consider quasi–experimental designs with control groups, larger and more diverse samples and extended intervention periods that allow procedural competencies particularly instrument use to be fully developed. Combining Facebook–based content delivery with structured laboratory sessions would address the gap between conceptual and procedural gains observed here. Additionally, explicit academic writing instruction should be integrated into future implementations, given the moderate grammatical performance observed in students' digital publications.

Longitudinal follow-up designs would also be valuable for assessing whether the competency gains observed here are retained over time or diminish once the structured digital intervention ends. Research on technology-enhanced learning suggests that the durability of gains depends on continued reinforcement through subsequent courses (Harasim, 2017); making it worthwhile to track whether students who participated in this Facebook-based intervention demonstrate stronger baseline performance in advanced electronics subjects in subsequent semesters.

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