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METHODOLOGY TO DEVELOP CRITICAL THINKING THROUGH SOCIAL NETWORKS

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Abstract: In the age of information and data analysis, students do not always have the disciplinary and / or transversal competences, nor do they always have the correct strategies to select content and arguments that reinforce the construction of their disciplinary criteria, even though the tools to achieve it are at their fingertips. In the new educational model of the Tecnológico de Monterrey, a priority is to contribute to higher education through the development of critical thinking based on the personal motivations of students. As a link between the knowledge acquired and their context, an alternative that allows the above is to promote the dissemination of collective knowledge in social networks (SN). In the present work, an educational innovation is proposed that allows to combine the knowledge acquired in the classroom with the use of SN, in order to develop critical thinking in students. The methodology includes 3 phases: i) Students develop content related to the course topics, ii) Students share this content on social networks, iii) Teachers monitor the impact of publications and do the sentiment analysis. This process was successfully implemented to a total of 150 undergraduate students of different specializations and semesters during four academic terms in different subjects of the four Professional Level schools. Pre and post tests, where critical thinking competence criterion were evaluated, were performed, resulting in 74% of the students improving in at least one criteria Additionally, it was observed, based on entry and exit surveys, that the appropriate and guided use of the different SN's, positively modifies the student's perception of the content of the subjects and the teaching of the class, since it allows them to relate academic topics with social reality, thus forming their own and responsible criterion on the published content.

Keywords: Social Networks, Critical Thinking, Educational Innovation, Higher Education, Sentiment analysis

Introduction

Technology could be conceived as a distraction during the teaching-learning process, specifically the use of smartphones and tablets. However, actually students face a constantly changing world that requires them to have the skills for the demands of the media and technology (O'Halloran, Tan, & K.L. E, 2017). As a response to student's requirements, in recent years' technology has proven to be a strategic tool within the teaching-learning process. Some applications enable opportunities for pedagogical approaches that facilitate the development of skills necessary for students in the digital age. (Reza, 2018). Social media might be an example of these applications, as it has opened up new ways to spread information. In such a way that both, the information and those who create it, increase exponentially every day (Kelly, Christen, & Snyder, 2013).

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In order for social networks to be useful in the learning process, it is necessary to develop critical thinking skills that give the student the ability to integrate and evaluate scenarios that allow them to validate the results (Boholano, 2017). The Mexican university, Instituto Tecnológico y de Estudios Superiores de Monterrey (Tec) has the 155th place in the QS World University Rankings 2021 and remains in place number 1 of private universities in Mexico (Symonds, 2021). Since 2019, Tec has introduced a new education model, named "Tec 21. The aim is to activate and enhance the innovation capacities of students, allowing them not only to keep up to date, but also to be agents of change in these moments in which the world faces a constant deep transformation. As part of this model, Tec has introduced 7 transversal competences, being reasoning for complexity one of them. The institute defines it as the recognition "that the world is complex and knows how to use methodologies and strategies such as design thinking, critical thinking and learning to learn. (Tecnológico de Monterrey, 2018)" Therefore, Tec was chosen for the study. Our primary objective is to test the proposed methodology to develop critical thinking through social media in different specialization students.

Conceptual Framework

The rapid growth of information and communication technologies has boosted the creative inclusion of social networks (SN) in the current pedagogical processes. Besides, student's social media usage has increased so fast in the last years, that demands deeper analysis for academic purposes (Ahern, Feller, & Nagle, 2016), as they have open opportunities to improve the teaching-learning process (Boholano, 2017).

Literature shows collaboration as an important part of the learning process. Campbell (2015) work, proposes learning tools that use collaboration as part of the process of understanding and applying knowledge, but also forces students to think critically and deeply about the problem posed. Research suggests that activities that promote collaborative learning and engagement encourage the student to achieve a better learning performance (Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013). The results presented by Loes & Pascarella (2017) suggest a positive impact of participating in collaborative activities on students' critical thinking.

Along with active collaboration, one of the main objectives of social networks is the construction of virtual community spaces linked to common interests and the tools that facilitate their interaction (Boholano, 2017). As Reza, (2018) suggests the use of technology might impact the cooperation of students in learning activities by allowing them to interact with other classmates and learning resources. Based on the web tools and services that promote community development, through collaboration and information exchange, SN have present student's open spaces for expression and interaction with other users (Del Barrio Fernández & Ruiz Fernández, 2016). This spaces include blogs, wikis, communication media (audio, photo, video, text), sharing tools, network platforms (i.e. Facebook and Twitter), and virtual environments, becoming useful tools to increase interactivity, one of the important skills for the learning-process. Interactivity refers to the degree of collaboration that students present with their other classmates and with the same environment (Lovelace, Eggers, & Dyck, 2016).

Active collaboration and interactivity are key to critical thinking, one of the 21 century skills for higher education (Guiller, Durndell, & Ross, 2008). The literature presents many definitions for critical thinking. While they mostly refer to creative problem solving and decision making, there are

some other more explicit definitions. In such cases, it is presented as a series of processes that include questioning, reflection, evaluation, and testing of ideas and criteria (Lovelace *et al*., 2016). In the teaching-learning process, in order to develop critical thinking skills, it is sought to attract the interest of students, as to provide them with opportunities for feedback on their performance. The nature of social networks, such as Facebook or Twitter, enables the opportunity for students to interact with other classmates and people interested in the subject, by presenting their ideas and arguments and receiving feedback in a democratic environment. At the same time, it also means an opportunity and demand for teachers to interact as mediators and take advantage of these spaces as part of the student's learning to develop critical thinking skills (Ahern *et al*., 2016).

It has been found that students who use information technologies in their studies have a better chance to contribute and participate in active collaborations with other students. This collaboration indicates that technology based learning improves the commitment with the course, implying deeper connections between students, professors, and the course content. (Mbodila, Ndebele, & Muhandji, 2014). Being part of a community, drives students to get more involved with the content, enhancing their learning, critical thinking achievements, and personnel development (Pattanapichet & Wichadee, 2015). Therefore, students' enrollment with social networks can improve the connections to create virtual communities that lead them to better content learning and the development of critical thinking.

Methodology

The current work studies the impact of Social Networks in different disciplines as part of the teaching-learning process. A social network based activity was designed for this research. The activity consisted in a) choose one course´s topic and deeply research it, b) design and post on the student selected SN, c) receive feedback through comments and interact with the followers and d) a critical essay is written by the students with the results of the learning activity. The hypothesis was that students will increase their critical thinking as they were in an active collaborative and interactive learning environment. A total of 150 undergraduate students of different specializations and semesters were part of the project. Each study group was made up by 15 to 30 students. Five specialization areas were taken in consideration: engineering, business, architecture, social sciences and government students. Students were selected from the 1st to 9th semester. The study was held on Puebla Mexico. Five social networks were taken in consideration for the analysis: Facebook, Instagram, YouTube, Twitter, and LinkedIn.

The study had two measures: a) Critical thinking abilities in students after and before the learning activity through essays graded by a rubric and a final survey, b) Interactivity shown by the students measured with a sentiment analysis.

To measure the impact of the interactivity of the posts with sentiment analysis, the software used was Social blade, Google Trends, Mentionmapp, Twitter audit, SEMrush, as well as algorithms developed on R and Python, for downloading, codification, and data analysis. Figure 1 shows an example of the relationship between the student's hashtags during the activity in social networks.

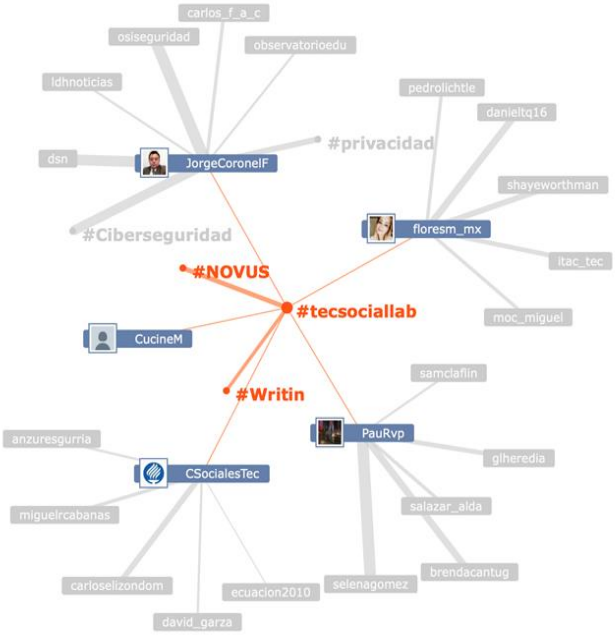

Figure 1: Example of data obtained and processed using digital tools, Feel tiptop and Mentionmapp.

A strength of relations between the used hashtags can be seen in figure 1. Social networks such as twitter provide their interactivity through hashtags, retweets and the "@" symbol to point to a specific user, which have not been used in the learning context (Veletsianos, Kimmons, Shaw, Pasquini, & Woodward, 2017). Therefore, the methodology is relatively new and allowed to measure the interactivity of our students by following their hashtags of the learning activity.

On the other hand, to measure the development of critical thinking competencies, we defined a rubric based on two criteria: a) Diagnosis based on strategic thinking, b) Congruency between the arguments and the problem context. The evaluation was held at the beginning (pre-test) and at the end (post-test) of the learning activity. In both stages, the students were asked to deliver a written work related to the topic of the course. The final deliverable was generated based on the students´ posts and the pre-test is based on a random topic given by the course professor. The data was analyzed to determine the percentage of students that improved and the average increase depending on the initial score. Finally, an anonymous survey was distributed among the students to determine their motivation and possible continuity to the activity.

Results and Discussion

Critical thinking is one of the skills considered essential in the 21st century (Hidayah, Alimah, & Yustinus, 2019). Therefore, methodologies that look for ways to increase the skill are necessary in higher education. Social network based activities prove to be successful to enhance critical thinking in undergraduate students. As figure 2 and 3 shows, the learning activity results for critical thinking with the rubric have an increase in the skill after the activity in the students.

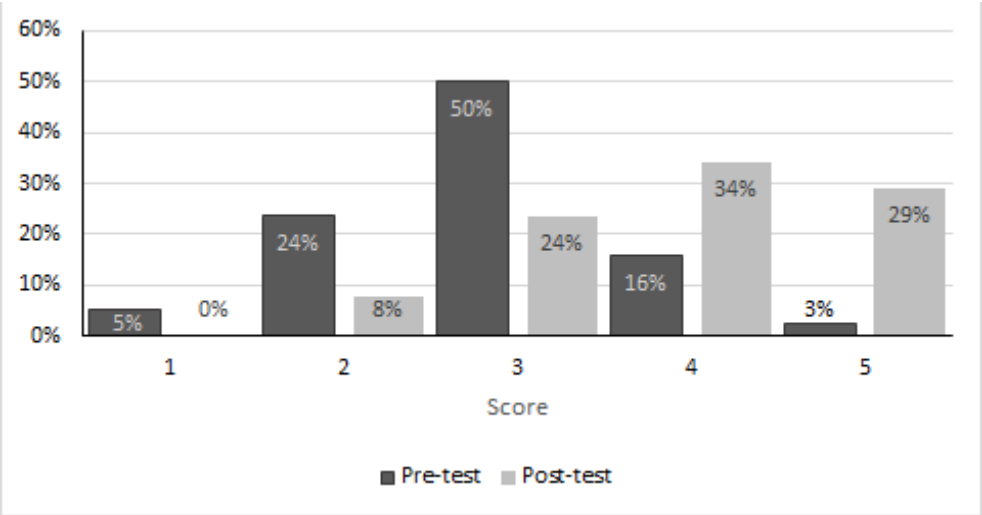

Figure 2. Criteria A pre and post evaluation

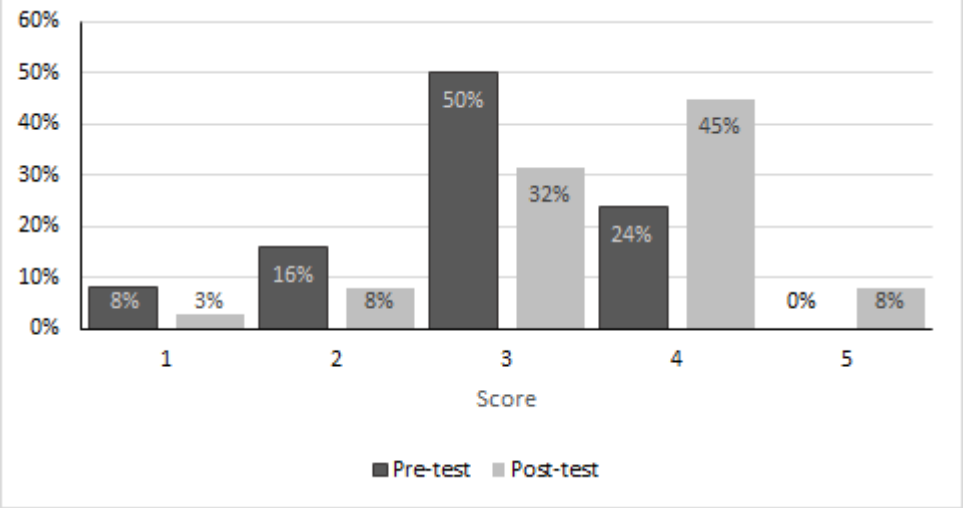

Figure 3. Criteria B pre and post evaluation

Based on the pre and post evaluation, where competence criteria were evaluated, it was observed that 74% of the students improved in at least one criteria, and 45% improved in both of them. Analyzing specifically each criterion, adding the obtained percentages of score 4 and 5 in the post-test it is observed that 63% of the students improved criteria A (see figure 2): Diagnosis based on strategic thinking, and with the same criteria 53% of the students improved criteria B (figure 3) Argument elaboration congruent to the problem context.

It can be also seen on Table 1 that the initial scores were very close in both criterion, and absolute increase was higher for criteria A than for criteria B (0.89 vs 0.47), however in the group of students with lower initial score (1 or 2) the increase was considerable higher for criteria B (1.11 vs 0.73) than for criteria A and in the group of students with higher scores, the criteria B increase was very low (0.14), this is shown in table 2. The increase of criteria A for both groups of students was consistent in both groups.

Table 1: Average score critical thinking evaluation

	Initial score	Final score	Increase
Criteria A	2.79	3.68	0.89
Criteria B	2.84	3.32	0.47

Table 2: Average score critical thinking evaluation by group of students according to initial score.

	Level 1 & 2			Level 3 & 4		
	Initial score	Final score	Increase	Initial score	Final score	Increase
Criteria A	1.82	2.55	0.73	3.24	4.12	0.88*
Criteria B	1.67	2.78	1.11*	3.32	3.46	0.14

*Development increases from the initial to the final score.

To understand the results a sample survey was applied to 33% of the students at the end of the activity. The initial hypothesis was that interactivity and active collaborative learning can positively impact critical thinking through social network based activities. The results of the survey in table 3, show a high motivation in students.

Table 3: How motivated did you feel during the project?

Motivation	Frequency
1: Few	2.3
2: Vere few	0
3: Regular	14
4: High	41.9
5: Very highly	41.9

A tie can be seen between high and very high, being higher than half of the group. Mahle (2011) research shows that higher levels of interactivity are directly related with high levels of motivation. The same motivation and commitment with the discipline can be seen in the final essays of the students. In the search to improve education, it is necessary to extract the information implicit in the opinions of the students (Kaur, Balakrishnan, & Singh, 2017).

> "This Project strengthened my commitment to select diverse journalistic platforms, several opinion leaders, verify the figures shared by the government with other independent sources, follow fast-checking accounts because the internet is an information and misinformation powerful weapon. The misinformation culture is a huge challenge for democracy nowadays, which requires an informed political community, able to make responsible decisions, and activates its citizens' participation at every moment."
>
> Student of the social sciences and government school.

Social networks have proven a positive impact on learning by making it fun, meaningful, and interactive, increasing motivation and collaborative learning (Manca & Ranieri, 2016). Besides, collaborative active learning that emerges on social media has shown a positive impact on long-life learning by allowing a network of collaboration and feedback for learners (Ranieri, 2019). Therefore,

the continuity that our students might give to the learning activity was important, the results are shown in Table 4.

Table 4: How possible is it that you give continuity to your publications?

Motivation	Frequency
1: Few	16.3
2: Vere few	11.6
3: Regular	44.2
4: Highly	18.6
5: Very highly	9.3

> "Designing and publishing posts about a topic from the course that interested us was very productive, since we research about the things that motivate us and help others to know more about what we are studying about. It is a very good idea to do these types of posts since you inform yourself as a person and you know a little more about everything. Personally, I would like to continue making this type of posts on my personal page, since more and more people are becoming interested in this topic."
>
> Student of the architecture, art and design school

The media answers were around regular possibility to continue with the activity. Further studies should be held in order to improve these criteria. Nevertheless, as the extract of a student essay can show, students are open to the possibility of giving continuity.

Additionally, the second part of the methodology was focused on measuring student's interactivity in social networks through sentiment analysis, for the same learning activity. The hashtags followed were #TECsociallab and a specific hashtag for every specialization and student. A descriptive analysis of the contents was made, with two indicators: frequency of publication and relationship of the published content with positive, negative or neutral feelings. Figure 4 shows the relationship of the students' posts contents with a feeling (trust, fear, sadness, disgust, anger, anticipation, surprise and joy). It can be seen that most of the posts are related to trust feelings. The results show a higher impact in positive feelings such as confidence and a lower impact in negative feelings such as fear or sadness. This may be due to specific students' perceptions linked to each course.

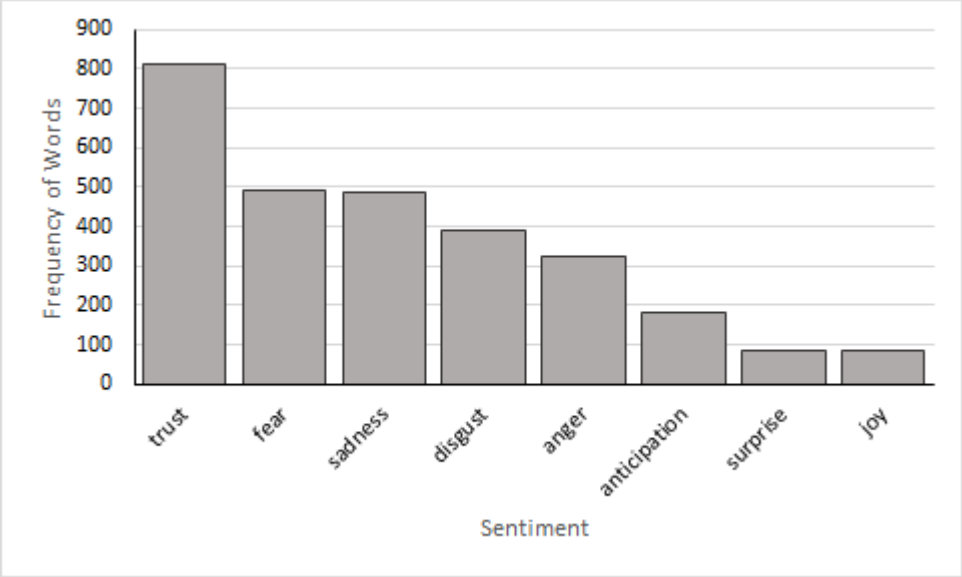

Figure 4. Relation and frequency of Words from the content of the students and sentiment analysis.

The relationship of posts with positive, negative or neutral feelings was measured three times along the learning activity. As figure 5 shows, posts that contain words that generate a neutral feeling remain near 60%, while positive feelings increase and negative feelings decrease.

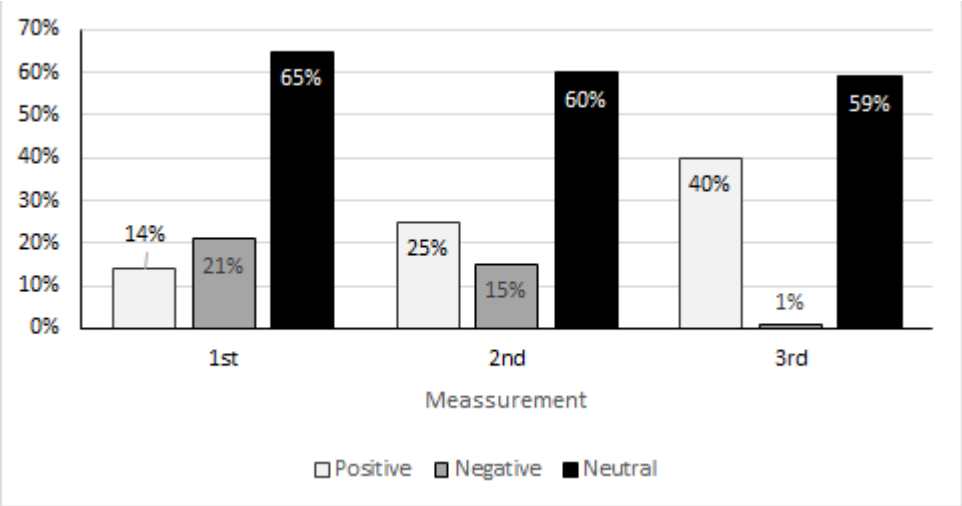

Figure 5. Relation sentiment analysis

In the sentiment analysis a high tendency to a positive sentiment towards student posts was shown. Results might be linked to the fact that students feel freer to express themselves on social networks, which makes them perceive the academic content distributed by these media in a positive way (Kaur *et al*., 2017).

Conclusions

The research shows a methodology that combines disciplinary competencies with the usage of Social Networks (SN) to increase the critical thinking skills in high education students. A positive impact has been shown between interactivity and critical thinking through social media learning activities. Previous studies show that the tools provided by social networks can have a positive impact on critical

thinking due to the possibility of interaction and collaborative learning that these digital spaces present (Ahern *et al*., 2016). The results show an increase in the critical thinking skill after the activity, such as high motivation due to the social network possibilities.

Interactivity has been proved to be key for critical thinking (Mahle, 2011) and social media to give opportunities to increase interactivity (Veletsianos *et al*., 2017). Nevertheless, few research has been made on hashtags as a strategy to follow interactivity in the learning process through social media. Further studies should be carry out to determine the impact of hashtags and critical thinking for each discipline. Besides, it has been proved to have positive feelings linked to the learning content published in social networks. But, a deeper understanding for each discipline will allowed to develop better learning activities that increase critical thinking.

An important approach to long life learning has been discovered, that should be research in future studies. Although, literature mentions about the positive implications of social networks in lifelong learning, it also mentions the possibility of being exposed to inaccurate content (Manca & Ranieri, 2016). However, this is where critical thinking can play an important role.

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