# Work In Progress: Social Networks Analysis in the Transition of an Educational Model Among Groups of STEM Teachers

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## Abstract

This work-in-progress research focuses on understanding and describing how nineteen groups of university engineering and science educators learn and assimilate the new educational model being adopted in a private Mexican university. Their role is to face the forces of globalization that are transforming the system of higher education in the university. This investigation adopts the notion of Social Network Analysis (SNA) to characterize and visualize the patterns of interactions among the different teams of teachers. Education research has been supported more frequently in recent decades by the analysis of social networks, which is a tool to quantify and visualize connections and structures of relationships and interactions within organizations. With this perspective, it has been possible to deepen the study of the nature and the determinants of interactions among teachers [1]. The data from a questionnaire applied to the team of participating educators was used at the beginning of the deployment of the new educational model known as the Tec21 Educational Model. The support patterns and collaborative networks of the educators are represented from the data through sociograms and descriptive social network indicators such as density, transitivity, and reciprocity in the network [2]. This approach is a methodological and pedagogical innovation because it has the potential to inform and provide feedback about the participants' work, promote reflection on their collaborative practices and contribute to cohesion, dialogue and the flow of knowledge within the team to continuously improve the internalization of the new educational model.


**Keywords:** Educational Change, Teacher Collaboration, Social Network Analysis, Educational Innovation


## Research Background and Motivation

This work-in-progress research is being carried out at a large multi-campus private university in Mexico and focuses specifically on the area of engineering and sciences. The institution is characterized by its development and strength in entrepreneurship, its sense of the humane, and the internationalization of these characteristics by its students. Current-day, real challenges are incorporated in the course offerings of the various curricula, promoting the generation of new educational models that help students to develop a profile of competences that will serve as a toolkit to face challenges of the real world post-graduation.

The Tec21 Educational Model considers undergraduate student learning to be centered on the relationship between student and professor and between student and the environment. This is where students develop disciplinary and transverse competences by solving challenges linked to real problems; they demonstrate their mastery through learning evidence. In this model, competences are defined as the conscious integration of knowledge, skills, attitudes, and values that allow the students to successfully face both structured and uncertain situations. *Disciplinary competences* refer to all those knowledge, skills, attitudes and values that are considered necessary for professional practice. The development of disciplinary competences implicates a gradual construction that starts from the fundamental competences until reaching the specific competences of the discipline. On the other hand, the *transverse competences* are developed throughout the process of formation of any discipline; they are useful during the life of the graduate and directly impact the quality of professional practice. In this model, the challenges

posed to the students are the central units of learning; they are experiences designed to expose students to a challenging situation in their surroundings that help them develop both disciplinary and transversal competences. These challenges develop said competences because the students apply their knowledge, skills, attitudes, and values in both an individual and collaborative way. This research focuses on understanding and describing how nineteen groups of University Science, Technology, Engineering and Mathematics (STEM) educators assimilate the Tec21 Educational Model. For this purpose, the following questions are addressed: What is the pattern of interaction among professors? What are the *density*, *transitivity*, and *reciprocity* of the interactive networks? At this moment, the objective of this research is to observe and characterize the patterns of collaboration among the professors, not to measure the progress in the implementation of the new educational model or the students' development of disciplinary and transversal competences. That will be carried out in studies later.

**Social Network Theory**

This research adopts and uses the notion of social network. One of the basic conceptual foundations in understanding social network theory is the concept of social capital. Some theorists have written about social capital, each foregrounding a different aspect of the concept and offering a nuanced understanding of the idea [3]. Lin [4] notes that the common denominator among all major theorists is the notion that social capital consists of the resources embedded in social relations and structure, which can be prepared when an actor wishes to increase the possibility of success through purposeful action. Social capital is, therefore, composed of a system's social relations through which the resources of other individuals can be accessed, appropriated, or leveraged. Social capital is different from human capital, which refers to the training, development, or certification of individuals; and physical capital, which is contained in infrastructure, tools, and artifacts.

In this sense, Social Network Analysis (SNA) is based on the intuitive notion that these patterns are important features of the lives of the individuals who display them. Network analysts believe that individual life depends mostly on how that individual is tied to the larger web of social connections. The network approach to the study of behavior involves two commitments of thought: (1) It is guided by formal theory organized in quantitative terms; and, (2) it is grounded in the systematic analysis of empirical data, mainly obtained from questionnaires and surveys. Social network research understands individuals within their social context, acknowledging the influence of relationships with others on one's behavior. Hence, social networks can support innovative processes and expand opportunities for learning.

Despite the consensus regarding the value of social network approaches, there is a lack of empirical investigations in innovation and futures studies that use SNA. In most cases, scientific literature uses the concept of social networks metaphorically, ignoring the possibilities for improvement presented by SNA methods. At the same time, conventional empirical research in innovation and futures studies often disregard relational information. Therefore, analyses of statistical data in structural and individual levels are treated separately. Activities that are expected to impact future developments are usually modeled as an isolated individual or group behavior, on the one hand, or as the characteristics of structural issues, on the other. SNA provides us with empirical tools that capture the social context and help us to understand better how innovations are implemented and diffused and why social change takes place. Network approaches explicitly challenge the difference between deduction and induction; rather, they highlight the relevance of relationships.

## Method

In this study, the SNA methodology is used. It depicts networked structures through nodes (individual actors, people, or things within the network) and the ties, edges, or links (relationships or interactions) that connect them. This study analyzes how teachers interact with other colleagues during the Tec21 Educational Model efforts and how that collaboration will make them more likely to adopt this new model in improved ways. Studies suggest that teachers who collaborate are better able to access and make use of the individual and collective resources embedded in their professional networks [5]. At this point in the study, the development of disciplinary and transversal competencies and their impact on the implementation of the TEC 21 model are not analyzed. In collecting data for SNA, surveys and questionnaires are widely used to assemble data in connections among people or other social actors.

This study uses an adapted version of an 18-question survey entitled, "Collaboration for Effective Team Working," which was given to 98 professors from nineteen teams clustered into four discipline-related groups and an academic coordinator team (all professors). It asked background information about them as professors, the types of collaborative practices they had been involved in, and which collaborative practices supported the Tec21 model. Finally, the research team calculated a series of network measures using R software on each of these frequent relationships to understand and compare network structure among teams better.

## Findings and Preliminary Conclusions

In this WIP research, the data collection process concentrated social networks at various frequencies of interaction. This paper focuses on *density*, which considers the grade-level teams to determine the percentage of ties within each of the grade levels. The density of a network can be thought of as a measure of network connectedness or cohesion [6]. Density is calculated as the number of connections among actors divided by the number of total possible connections in the network. The calculation means that the higher the proportion of social relationships among professors, the denser the social network. Density was scaled from 0 (indicating no relationships among teachers) to 1 (representing a social network in which all teachers are connected).

This study also emphases *reciprocity* among teachers in grade levels to establish the percentage of reciprocal relationships within each grade level. Higher levels of reciprocity have been associated with increased organizational performance and complex knowledge exchange [7]. Reciprocity was calculated using a scale of 0 to 1, with 0 representing no mutual relationship present in the grade level team and 1 representing a grade level team in which all relationships are reciprocated and the interactions are mutual.

Also in this research, we studied *transitivity*, which refers to the relationship of two linked nodes in a network that are connected by an edge.

As seen in Figure 1, the size of the node indicates the degree to which other people turn to this actor for help [8]. For example, nodes V96 and V98 are central actors in the deployment of the Tec21 Educational Model. The thickness of the link is the degree of relevance of the information that has been obtained from that professor. IBQ and ICT groups are connected. On the other hand, ICI and IIT groups are connected but also interact with other groups. The members of the EAAA team play a significant role in the process, although there are differences among them. Isolated nodes are observed; these people did not answer the survey. It is found that the density of the network is low: 0.0515. The low density may be because the teachers almost always go for help to the same actors or that the teachers prefer to collaborate with their original disciplinary

team because they identify themselves within some small clusters.
The transitivity indicator, with a value of 0.2998, suggests the possibility of there being a third actor in achieving the link (for example, a friend's friend is also a friend). This offers possibilities that in a more extended period of collaborative time, density and cohesion among colleagues can be strengthened. The reciprocity value of 0.3436 indicates that almost 40% of teachers help each other, which is a good indicator in the School of Engineering and Sciences [9]. It shows openness and flexibility on the part of the teacher in sharing experiences and best practices.

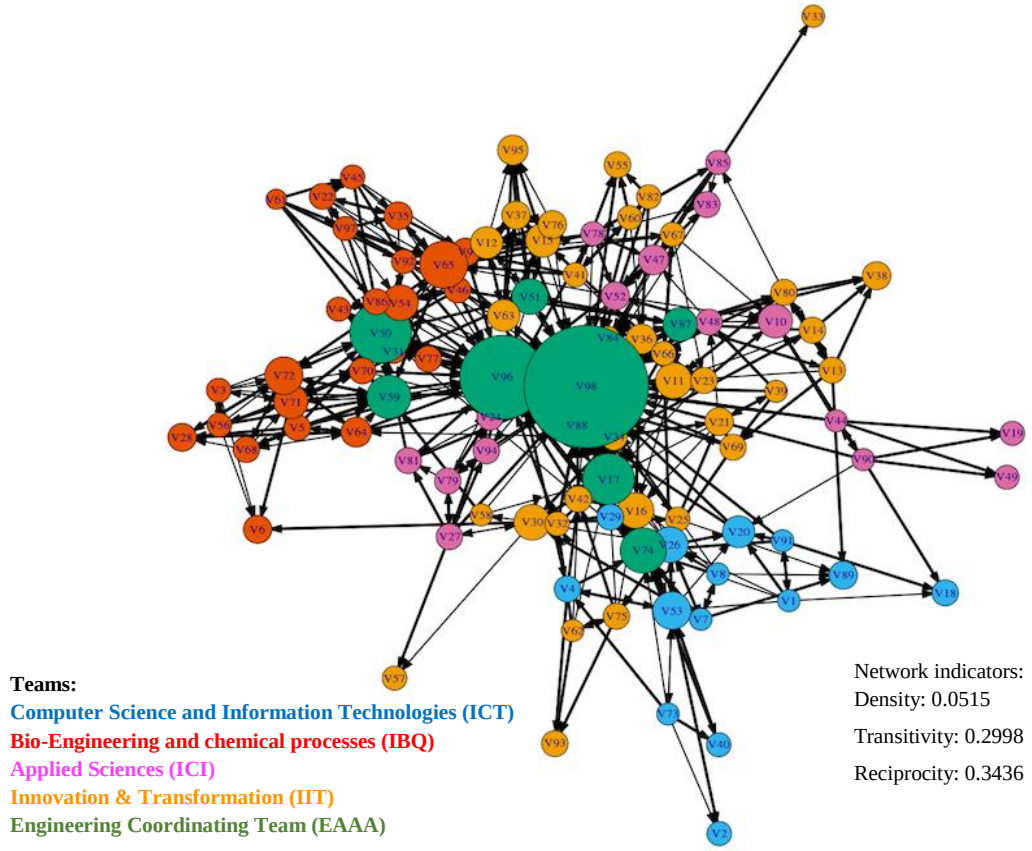


Figure 1. Social Network Analysis (SNA) of collaboration for effective teamwork. The groups of teams are differentiated by colors.

In conclusion, this information shows the importance of re-thinking collaborative activities among professors, promoting accessible spaces where questions and suggestions can be communicated among colleagues, advancing the implementation of the Tec21 Educational Model, and considering how technology can offer more flexible spaces for faster teacher interactions [10]. The limitations of this study are that, at this moment, it is only possible to take actions that help teams operate more collaboratively and timely in exchanging information; it does not offer us detailed information to link it with the type of work within the groups. Also, the study only offers an overview of the interactions and relationships among actors and teams to identify density, reciprocity, and transitivity in the network. For the next stage, it will be possible to have more contextual information about the implementation of the Tec21 Educational Model and how the teachers incorporate these learning experiences into their groups.

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