Connecting the Research Culture of Teachers to the Development of Undergraduate Student Competencies*

Maday Alicia Coronel-Santos †
School of Education and Humanities
Tecnologico de Monterrey
Monterrey Mexico
madaycs@gmail.com

María Soledad Ramírez-Montoya
School of Education and Humanities
Tecnologico de Monterrey
Monterrey Mexico
solramirez@tec.mx

ABSTRACT

Higher-level educational institutions promote the development of research competencies to have a positive impact on the creation of knowledge. Studies on research competency are focused on the teacher, the student, the training process, or the results based on scientific production, opening up the possibility for investigations that integrate these elements. This document aims to present the current status of a research plan undertaken as a doctoral thesis on the study of the development of research competencies through the transfer of research culture from teacher to student within a training process. For the development of the research, a mixed study with a sequential design is proposed, allowing the analysis of quantitative and qualitative data together to provide a profound understanding of the studied phenomenon. The goal is that the results obtained will help establish the guidelines for a technology-based-assessment model that analyzes the formation of research competencies through the transfer of the research culture from the teacher to the student. These would guide the design of innovative training practices within contextual frameworks. The current state of this research accounts for the contributions to the theoretical framework and provides a first look at the methodology to construct the model.

CCS CONCEPTS

• Social and professional topics • User characteristics • Cultural characteristics

KEYWORDS

Research competencies, Research culture, Evaluation model, Teaching competencies, Educational innovation

1   Context and motivation that drives the dissertation research

The need for proactive education that addresses social issues has encouraged higher education institutions to incorporate research competencies to provide new knowledge that will impact the environment positively. Regarding that impact, the proper training of researchers results in the construction of useful knowledge in a society that demands answers to changing social, political, and economic questions, where cognitive capital is the key to adapting to a competitive environment in the XXI century [1]. Universities contribute significantly to strengthening research capacity with processes that involve young people as the seedbed of competition [2]. However, the cognitive preparation of a student to master

scientific knowledge requires much time [3]. Therefore, to contribute to the kind of training that satisfies social needs, it is crucial to integrate the teacher's influence in the teaching-learning process.

Research formation relies mainly on the research competencies that teachers possess because, from their experience, they guide the formation of their students. Teachers are the most solid and influential factor in guaranteeing the quality of education [4], and it is, therefore, necessary to ensure that they have the relevant skills provided by professional training [5]. Research competencies contribute to the gestation of the professional teacher who promotes research and becomes self-critical of his or her practice to grow, improve, and generate impact [6]. To promote quality in research formation, educators must start with an evaluation model that develops the teaching competencies in research that enable making diagnoses that guide the design of innovative training practices within each contextual framework.

In an era of information technology, the development of competencies requires technology-based models that facilitate evaluative processes for decision-making that lead to educational improvements. Teacher assessment is a key factor in the professional success of students. Conflicting dichotomies and objectives that are not clear complicate their training [7]. Therefore, in order for the assessment to be congruent with the development of competencies, it must focus on providing feedback during the training process, and not just giving a grade as a measure of knowledge acquisition [8]. To be accessible and easy to use, the evaluation model must operate in a technological ecosystem, understood as the integration of software, operational components (hardware and internet, for example), and the information set that improves the experience of users [9]. The proper design of a technology-based evaluation model facilitates the analyses of research competencies during training. The focus must be on the transfer of research culture from the teacher to the student, guided by the design of innovative training practices within each contextual framework.

In Mexico, the development of research competencies is still incipient. International organizations such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO) highlight the importance of research as a factor in accelerating economic development that leads to the construction of more sustainable societies [10]. Nevertheless, according to the National Research System in Mexico, in 2018, out of a total population of 126,190,788 [11], only 28,578 people (0.02%) were registered researchers that year [12]. In this regard, since 2013, Tecnologico de Monterrey (Mexico) has focused on being a university oriented toward satisfying the needs of society practically. Through its Tec 21 Educational Model, it promotes education for research through high-quality teachers, academic excellence, global vision, and a focus on research that leads to solving current and future world problems [13]. As part of its strategies to promote research competencies in students, the model proposes Research Concentration, which aims to provide undergraduate students and their professors with the resources and support necessary to carry out high-quality research that has a high social impact. This means that courses in the university curricula will include a focus on conducting research and the methodologies to do so.

Based on the above, we offer this present research as an opportunity to create new knowledge for educational innovation in the formation of research competencies developed in a model designed for teaching that focuses on the transfer of research culture from the teacher to the student. Therefore, this research aims to answer the question: How and to what degree is research culture transmitted from teachers to undergraduate students in research courses?

The structure of the paper presents a state of art of formation in research competencies, research teacher's competencies and technology-based assessment models for competency development. Subsequently, hypothesis, research objectives and research approach and method are described. Finally, the results to date and their validity, and the dissertation status are presented, closing with the current and expected contributions and a conclusion of the work carried out.

2 State of art
2.1 Formation in research competencies

Research is the vehicle for creating new knowledge demanded by a constantly changing society. To be a researcher implies mastery in the area to be investigated and knowledge of reflection, methodologies, ethics, and communication, in order to generate new knowledge that addresses identified needs [1]. The development of research competencies integrates factors that are cognitive, regulatory, communicative, and personal [14]. Therefore, research competency is considered a macro-competency that encompasses a set of competencies for scientific development.

Nevertheless, research is consolidated in the methodological bases that provide the guidelines for producing reliable knowledge. Several research methods address the various problems in different paradigms. Each methodology is used according to the objectives pursued [15]. They are classified according to the methodological approaches as quantitative [16], qualitative [17], and mixed [18]. In this sense, the research methodology is an indicator of coherence between the stated objectives and the information analyzed.

The study of formation in research competencies lies in a fertile field for more investigation. The few reviews of the literature related to research competencies focus on medicine, with topics related to clinical research competencies [19], the study of mentoring to develop research competency in nursing [20], and the study of medical training to identify topics related to teaching and evaluation of research competencies [21].

Therefore, through a Systematic Mapping Study (SMS) of the empirical evidence published from 2015 to 2020 regarding research competencies, we could principally identify that there is interest in developing research in education, given the need to strengthen training in research methodology that brings scientific rigor to the development of research.

2.2 Research teacher's competencies

Teachers face the challenge of adjusting their training to the demands of society by incorporating the development of research competencies into their profiles, through the application of pedagogical and transversal competencies that equip students for a knowledge-based society. Teaching competencies involve having the disciplinary and pedagogical mastery of knowing what to teach and how to teach it [22]. In contrast, transversal competencies allow teachers to adapt and contribute to the development of key competencies [23]. Teacher preparation in research competencies is a key factor in research education because, from their experience, they can design the teaching-learning process.

Analyzing teacher training in research competencies brings with it important opportunities for formative programs. In the literature, there are systematic literature reviews concerning pedagogical competencies in the STEM disciplines [24], evaluation competencies to develop automated assessments [25], and techniques that support the teaching-learning process for educators [26] [27] [28]. Although these reviews have provided interesting data on teaching competencies, they have not specifically analyzed research competencies in these.

Therefore, through a Systematic Literature Review (SLR) of the empirical production from 2015 to 2020 related to research competencies in teachers, it was found that the study of research competencies in teachers is a nascent field that is in the continuous process of construction. Research competencies are analyzed from the perspective of transversal competencies, from the educational models that make up the learning environments [29], and from the theoretical-critical paradigmatic approach that seeks to improve the established conditions [30]. Also, we identified that teaching competencies are analyzed mainly using mixed methodologies that allow a deeper understanding of the phenomenon [31], and through the use of questionnaires that rate the perception that teachers have regarding the mastery of various competencies. Finally, teachers perceive a lack of training and motivation towards research.

2.3 Technology-based assessment models for competency development

Over the years, the educational field has employed models with guidelines that transmit the complexity of its processes. Models are an analogy used to understand something complex that cannot be directly observed and serve to offer blueprints. [32]. The evaluation model involves a fundamental element that regulates and helps monitor achievement in the teaching-learning process so that established goals can be met [33]. The models are made up of key elements that support their coherence, including their ultimate goals (philosophy), their internal order (theory), their practical orientation (policy), and their implementation (educational processes and practice) [34]. Therefore, the design of an evaluation model implies understanding how to analyze the educational reality from the standpoint of its philosophical, theoretical, practical, and operational components in order to deliver an assessment consistent with the educational phenomenon.

An ultimate goal shapes the educational process in an evaluation model based on a paradigm, a set of accepted beliefs, attitudes, values, and procedures, etc. [35]. An internal structure is based on theories of learning, which help to understand the meanings attributed to the learning as it progresses [36]. It has a practical orientation with different ends and moments that include diagnostic [37], formative [38], and summative evaluation [39] exercised by different persons in charge and having self-evaluation [40], co-evaluation, and mixed-evaluation components [41]. Moreover, the implementation must be adjusted to the demands of a digital society, which has influenced all business domains, academia and research [42], through technology-based operationalization that creates a technological ecosystem [43]. Therefore, each of the elements that make up the technology-based evaluation model must rest on theoretical foundations that support its systematization.

The literature review identified that the technology-based models that evaluate the development of competencies are based on inaccurate knowledge. Such knowledge seeks to be mitigated through the mixed method, from a post-positivist position [44], with the inclusion of diagnostic self-evaluation practices to give learners a voice in their learning [40], and to determine the learning situation before the start of the teaching process. The technology-based models for the assessment of competencies operate in ecosystems formed mainly by students, and assessment results when technology is used as a tool for the analysis of quantitative information [45]. Therefore, there is the need to improve the assessment models in the technological ecosystem by integrating the teacher and student in the teaching-learning process and the technological tools that facilitate the evaluation process and its user interface.

3 Hypothesis

The hypothesis for this study is that there is a positive correlation between the research culture of teachers and the research culture of undergraduate students in the framework of a formative process.

4   Research objectives/goals

The general objective of this study is to analyze the formation of research competencies through the transfer of research culture. The aim is to identify the set of variables that make up the research culture and to assess to what degree and how it is transmitted from teachers to undergraduate students in a Mexican institution. The ultimate goal is to propose a technology-based evaluation model for research competency formation that guides the innovative practices in each contextual framework.

Therefore, this research focuses on the following specific objectives:

1. To analyze the practices that develop research competencies in teachers and students and contrast various assessments of competencies in technology-based models through a systematic literature review.
2. To contextualize the studies in higher education scenarios and identify the approaches to the problem that brings new knowledge to educational research and innovation.
3. To investigate the correlation between the research cultures of the teacher and students in the framework of a training process and design and implement a methodological process that is transferable to other contexts.
4. To design a technology-based evaluation model for education in research competencies that is oriented toward training practices customized for each contextual framework.

5   Research approach and methods

According to the findings in the theoretical framework and the congruence with the research question, the present research will be carried out using the mixed method [46]. The use of a mixed methodology allows the collection of quantitative and qualitative data that provide comprehensive support to the research question, thus increasing the reliability of the results [47]. The development of the proposal will take place in two phases, exploration first, then implementation. The delimitation of each phase follows the institutional Research Concentration proposal being implemented in the university. Both phases will be approached through a mixed sequential explanatory method (QUAN-qual), so characterized because the quantitative data informs the collection of the qualitative data [31].

Phase 1 corresponds to the exploration where a Likert Scale questionnaire will be applied in the form of Pre-Test and Post-test (QUAN) to a group of teachers and students in a class not having a concentration on research. Later, according to these results, semi-structured interviews with teachers and students will be analyzed (qual) to obtain information that will allow the creation of the prototype of the technology-based evaluation model for the formation of research competencies.

Phase 2 occurs after the implementation of the Research Concentration. In this phase, the piloting of the evaluation model through the application of Likert scale questionnaires (QUAN Pre-Test and Post-test) to teachers and students of the classes having Research Concentration will occur. Then, according to the results obtained, semi-structured interviews with teachers and students (qual) will be analyzed to identify areas of opportunity for the implementation of the model, with the respective improvements. Figure 1 shows the synthesis of the proposed design.
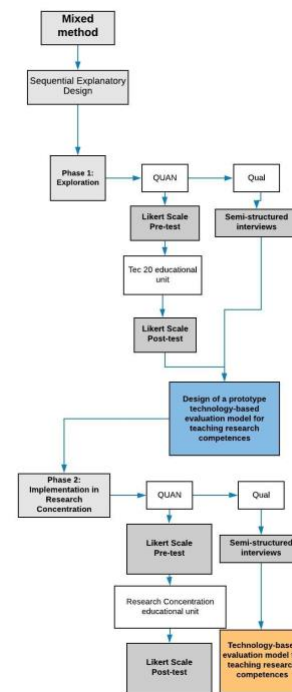

Figure 1: Research design

5.1   Population and sample

The population under study are the teachers and undergraduate students of Tecnologico de Monterrey, who have and have not taken a research concentration course. Probability sampling (QUAN) and purposive sampling (qual) will be used for sample selection [48].

5.2   Variables in the study and instruments

Three variables have been established to measure the research culture in teachers and students:

A. Values and attitudes toward research: This is the importance attributed to research according to the usefulness or satisfaction of some need [49], the disposition toward its development [50], and the evaluation of the effectiveness of developing research [51].
B. Research knowledge: This refers to what the subject knows or believes to know about the research [52] with a focus on research methodology according to its three approaches: mixed, qualitative, and quantitative.
C. Research practices at the university: This measures the pedagogical strategies used that offer students the opportunity to develop their research competencies [53] according to the following categories: research-tutored teaching, research-led teaching, research-based teaching, and research-oriented teaching [54] [55].

These variables will be analyzed using the data provided by the following instruments:

- Likert scale questionnaire (pre-test and post-test in Phase 1 and Phase 2): to be applied to teachers and undergraduate students to compare the perception of the importance attributed to research and research development in their educational practice before and after taking the classes. (Variables: a) Values and attitudes towards research, b) Research knowledge, and c) Research practices at the university).
- Semi-structured interview (Phase 1 and Phase 2): will be applied to teachers and undergraduate students to deepen understanding of the results obtained from the quantitative phase. (Variables: a) Values and attitudes towards research, b) Research knowledge, and c) Research practices at the university).

5.3 Information sources

The sources of information that will be used for the development of the research are:

- Teachers: They are responsible for promoting the development of research in undergraduate students through their formative processes. It is considered the priority to determine the research culture of the teacher.
- Students: These are the participants studying at the undergraduate level. Through them, the research culture of the students is identified and compared with the research culture of the teachers to identify the impact of the teacher on the teaching-learning process.
- Experts: These are the teachers and researchers who are experts in the field of research competency development,

with whom the instruments required for this study will be validated.
- Databases of scientific references (Scopus and Web of Science): These are digital sites that systematically store bibliographic data of abstracts and citations of articles published in scientific journals, in which are found the theoretical and empirical support for the findings in the research.

5.4 Data collection and analysis

Phase 1:

1. Design of the QUAN instrument.
   1.1. Design of the instrument to measure the research culture (Likert Scale).
   1.2. Validation of the instrument (expert validation, internal consistency, factorial analysis).
   1.3. Pilot testing of the instrument.
   1.4. Improvement of the quantitative instrument.
2. Data collection QUAN: Application of the instrument to measure the research culture in teachers and students before and after the Tec 20 training units (classes).
3. QUAN data analysis: Data analysis through descriptive and inferential statistics (using SPSS software).
4. Sequential sampling and instrument design QUAL.
   4.1. Sampling of the participants according to the results QUAN.
   4.2. Design of semi-structured interviews.
5. Data collection QUAL. Application of semi-structured interviews.
6. Data analysis QUAL: Coding and thematic evaluation of semi-structured interviews.
7. Integration of QUAL and QUAL data: Interpretation and explanation of quantitative and qualitative results.

Phase 2:

8. Design of the QUAN instrument.
   8.1. Design of the quantitative instrument with a Likert scale according to the prototype of a technology-based evaluation model for training in research competencies.
   8.2. Validation of the instrument (expert validation, internal consistency, factorial analysis).
   8.3. Improvement of the quantitative instrument.
9. Data collection QUAN. Application of the instrument to teachers and students before and after the classes having a concentration in research.
10. QUAN data analysis: Data analysis through descriptive and inferential statistics (using SPSS software).
11. Sequential sampling and instrument design QUAL.
    11.1. Sampling of the participants according to the results QUAN.
    11.2. Design of semi-structured interviews.
12. Data collection QUAL. Application of semi-structured interviews.

13. Data analysis QUAL: Coding and thematic evaluation of semi-structured interviews.
14. Integration of QUAL and QUAL data: Interpretation and explanation of quantitative and qualitative results.

6 Results to date and their validity

The study on the development of research competencies in the educational field is incipient, according to the literature reviews of empirical studies published from 2015 to 2020. The validity of the results obtained will be based on the use of the mixed method, which allows the analysis of the phenomenon under study from different approaches [16], and the triangulation of data obtained from different sources of information and with various research instruments. The triangulation allows validation of the results by reducing the risk of bias. Additional observations are needed to support our conclusions [17].

7 Dissertation status

The current status of this research includes the development of the theoretical framework, the delimitation of the nature and dimension of the subject of study, the planning of the study, and the methodological proposal.

8 Current and expected contributions

Through this study, we expect to promote the creation of new knowledge through the development of research competencies in undergraduate students, in the sense of providing valuable knowledge about the factors involved in the training process towards research in order to identify areas of opportunity that lead to the design of innovative training practices.

The research also seeks to contribute to the educational field through educational innovation developed through a technology-based evaluation model for training in research competencies that can be applied in other contexts.

9 Conclusion

This paper has described the research plan on the study of the development of research competencies through the transfer of the research culture from the teacher to the student within a formative process, which was designed from the needs identified in the state of the art of formation in research competencies, research teacher's competencies and technology-based assessment models for competency development. It was identified that research competence is an emerging field that needs to be studied considering the importance of the teacher's profile and motivation as an influence in the transmission of a research culture, together with the need to design technology-based assessment models that facilitate the process and the interface between users to support formative processes towards competence development.

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