

DESIGN OF AN ONLINE DIPLOMA COURSE FOR THE TRAINING OF TECNМ TEACHERS IN SCIENTIFIC AND TECHNOLOGICAL RESEARCH.

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Abstract - This article proposes an online diploma course to train teachers of the Tecnológico Nacional de México (TecNM) in scientific and technological research. The course is designed to offer training to teachers who seek to strengthen their research skills, guiding them from a fundamental understanding of research principles to the preparation and presentation of a complete scientific article. The structure of the diploma course is organized in five sequential modules: (1) Scientific and technological research at the TecNM, (2) Initiation in scientific and technological research, (3) How to write a scientific article, (4) Support tools for research, and (5) Presentation of the article and submission. The course and its resources were implemented in the Moodle platform to facilitate access and interaction.

The pedagogical approach of the diploma is based on Constructivism, enriched with Project Based Learning (PBL) and Collaborative Learning methodologies. This approach promotes active and meaningful learning, facilitating the connection of the contents with the professional reality and fostering the autonomy and responsibility of the participants. In addition, a system of continuous evaluation and constructive feedback has been implemented to guarantee a complete and fair assessment of the participants' performance, thus ensuring the development of solid and relevant research competencies.

The implementation of this program will be fundamental for the professional development of teachers and the strengthening of the institution's research capacity. In addition, it could contribute significantly to the advancement of scientific and technological knowledge in Mexico, raising research standards and fostering a culture of innovation and academic excellence.

Keywords: Teacher training, Scientific research, Educational technology, Constructivist learning.

Abstract -- This article proposes an online diploma course to train teachers at the National Technological Institute of Mexico (TecNM) in scientific and technological research. The diploma is designed to provide training for teachers who seek to strengthen their research competencies, guiding them from a fundamental understanding of research principles to the development and presentation of a complete scientific article. The structure of the diploma is organized into five sequential modules: (1) Scientific and technological research at TecNM, (2) Introduction to scientific and technological research, (3) How to write a scientific article, (4) Research support tools, and (5) Article presentation and submission. The diploma and its resources have been implemented on the Moodle platform to facilitate access and interaction. The pedagogical approach of the diploma is based on Constructivism, enriched with Project-Based

Learning (PBL) and Collaborative Learning methodologies. This approach promotes active and meaningful learning, facilitating the connection of content with professional reality and fostering the autonomy and responsibility of the participants. Additionally, a system of continuous evaluation and constructive feedback has been implemented to ensure a complete and fair assessment of participants' performance, thereby ensuring the development of solid and relevant research competencies. The implementation of this program will be fundamental for the professional development of teachers and the strengthening of the institution's research capacity. Furthermore, it could significantly contribute to the advancement of scientific and technological knowledge in Mexico, raising research standards and fostering a culture of innovation and academic excellence.

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INTRODUCTION

Training in scientific and technological research is fundamental for the advancement of Higher Education Institutions (HEIs) in Mexico. This importance is repeatedly highlighted in the periodic reports presented by rectors and directors of these institutions at the national level. There is a general consensus on the lack of an authentic research culture in Mexico, largely attributed to insufficient technological resources and lack of familiarity with effective research methodologies. This situation underscores the need to address deficiencies in research training within academia, emphasizing the importance of effective approaches and resources to foster scientific and technological development in HEIs.

Internationally, various rankings evaluate the educational quality of HEIs, with research being a determining factor in their positioning [1-3]. However, evaluations such as the "Evaluation of the quality of higher education in Mexico" [4] reveal that Mexican universities have limited participation in these rankings, since national indicators do not meet international standards. This problem also extends to HEIs throughout Latin America [5].

The Tecnológico Nacional de México (TecNM) increasingly recognizes the positive impact of research on its institutional indicators, as evidenced in the Management Self-Assessment Report for the first semester of fiscal year 2023 [6]. However, indicators related to research in the institution are still low, especially in terms of the number of article publications, particularly in journals indexed in the JCR, patents granted in exploitation and technology transfers. This is also

is reflected in the number of teachers with a desirable profile, in the formation of Academic Bodies in membership in the National System of Researchers (SNII). Specifically, this last indicator, the report indicates that by the end of 2022, the TecNM had 1,389 active researchers in the SNII, distributed in 181 campuses. However, this figure is significantly lower in comparison with other institutions, such as the University of Guadalajara, which in the same year had 1,982 researchers distributed among its 15 campuses [7]. Consequently, it is imperative that the TecNM establishes as one of its main objectives the generation of resources for the training of teachers in research and technology. Despite these efforts, there is still a long way to go, since the current offer lacks flexible and comprehensive training programs that facilitate effective training in scientific and technological research.

TecNM's efforts to train teachers in research include the 30-hour research courses and workshops offered at its various campuses. These courses are part of the updating and teacher training program that is carried out during the intersemester periods of January, June and August. In general, these courses-workshops focus on the introduction to research, addressing topics such as the writing of technical-scientific articles. However, the limited duration of these sessions makes it difficult to acquire in-depth knowledge about the development of a research project and the writing of a complete scientific article. As a result, instructors are forced to focus on providing courses with more theoretical rather than practical content.

Since the COVID-19 pandemic, virtual training courses at the TecNM have become increasingly important. Since then, the Tecnológico has expanded its training offerings through the Distance Education Area, offering courses, micro-courses and nano-courses as part of the "Jornadas de Formación Docente en Competencias Digitales del TecNM" [8]. This virtual space, hosted on the Moodle platform, includes a variety of short courses. It is important to note that, among the diversity of courses available, only three are focused to some extent on research training: "Online registration of a practice manual before INDAUTOR", "Bibliographic Manager" and "Agile Questionnaire Design".

MOOCs (Massive Open Online Courses) represent another valuable virtual tool offered by the TecNM to promote self-training of both its academic community and society in general in a wide range of knowledge areas. These online courses [9] allow participants to learn at their own pace and

from , promoting wider access to education. Within this offer, TecNM has a specific course related to research training, entitled "Research. Discovering facts and principles" [10]. This MOOC is designed to introduce participants to the basic concepts and fundamental strategies of scientific research, providing a theoretical foundation for those interested in developing research skills.

In the field of diploma programs, the TecNM's Department of Teaching and Educational Innovation currently offers four virtual programs, each with a duration of 150 hours. These programs are designed to strengthen various teaching competencies, although none are specifically focused on research training. The diploma programs available are: "Diploma in Teaching Competencies", "Diploma in Tutoring", "Diploma in Educational Resources in Virtual Learning Environments (DREAVA)" and "Diploma in Inclusive Education". Each diploma course is carefully structured in 4 or 5 modules, covering a wide range of topics relevant to the improvement of educational practice. The modules are taught by experienced teachers from the different TecNM campuses, which guarantees a consistent educational quality adapted to the specific needs of the academic community.

Despite the diversity and value of current programs, there is an urgent need to develop a diploma course focused specifically on teacher training in scientific and technological research. This diploma course aims to cover a fundamental area that is currently not being comprehensively addressed, thus ensuring a more complete and effective training for TecNM teachers. The objective of this initiative is to encourage the active participation of teachers in research activities in order to improve institutional indicators, specifically by increasing the number of scientific publications accredited to TecNM. This article presents the design of this diploma course, oriented to training in scientific and technological research, aimed at TecNM teachers.

THEORETICAL FRAMEWORK

Diploma courses are short courses designed to deepen or update knowledge and skills in specific areas. Their main objective is to meet the particular and updated needs of professionals, responding to the demand for continuous training in a constantly evolving work environment. Unlike traditional academic programs, diploma programs do not grant degrees or titles that certify an achievement in a specific period. They do, however, provide certifications that recognize the acquisition of specialized competencies, offering

a formal recognition that validates the training obtained in specific areas of knowledge.

Specifically, virtual diploma courses stand out for their dynamic and flexible curricular nature, allowing students to customize their learning according to their own pace and availability. This online modality facilitates access to education from anywhere, eliminating geographical and time barriers. In addition, virtual diploma courses usually incorporate various digital tools and resources that enrich the learning process, such as discussion forums, videoconferences and interactive materials.

The flexibility of virtual degrees not only benefits students by allowing them to balance their studies with other responsibilities, but also facilitates the continuous updating of content, ensuring that the knowledge imparted is aligned with the latest trends and advances in the corresponding field. This feature is especially relevant in dynamic areas such as scientific and technological research, where changes and advances are constant.

In the field of HEIs, diploma courses, with common durations of 80, 120, 150 and 180 hours, have an essential resource for the updating and continuous training of teachers. The rapid evolution of technological trends in fields such as communication, training and education requires constant adaptation on the part of educators. This justifies that teachers remain at the forefront not only in terms of disciplinary knowledge, but also in the management of innovative tools that effectively support their academic activities.

The diploma programs facilitate the acquisition of practical skills that are directly applicable in the classroom, promoting more dynamic and effective teaching. Continuing education through diploma courses also fosters a culture of constant improvement among teachers, which has a positive impact on the quality of education received by students.

Structure of the diploma courses

According to Vela et al. [11], a diploma course should include at least the following components for its structure and academic quality:

1. Identification
 - 1.1 University Educational Institution
 - 1.2 Title of the diploma
 - 1.3 Teacher(s)
2. Justification
3. Description of the methodology
4. Curricular structure
 - 4.1 Objectives
 - 4.2 Contents
 - 4.3 Educational resources

4.4 Evaluation Criteria (Description of how the diploma is evaluated)

4.5 Schedule for the development of the course

5. Hourly intensity and equivalence in academic credits (in case of face-to-face courses, define the number of face-to-face hours).

In addition, these authors emphasize that diploma programs must be approved by a curriculum committee. This approval must be requested in writing and be subject to a thorough review to ensure the quality and relevance of the program.

During the design of a diploma course focused on teacher training in scientific research, it is essential to consider previously implemented successful models. For example, Sandoval et al. [12] proposed a curriculum design for a diploma course in scientific academic writing under the competency-based approach, aimed at university teachers. This course, with a duration of 80 hours, was organized into four modules comprising learning units on APA standards, the scientific writing process, and micro- and macro-textual strategies for academic-scientific writing.

Another example is the diploma course proposed by Bernal et al. [13], designed to train teachers in educational research methodology. This diploma course was structured in three modules totaling 60 hours, also under the competency-based approach. The modules cover "Theoretical and methodological foundations of educational research", "Development of educational research and the construction of the article" and "Criteria for publication of the scientific article". Likewise, González et al. [14] developed a 150-hour diploma program focused on educational research and innovation. This program includes several modules dealing with research and the elaboration and defense of a final research, providing comprehensive and practical training for teachers.

In addition, several faculties and universities offer online diploma courses in teacher training in scientific research on their official websites [15-18]. For example, the Polytechnic Faculty of the National University of Asuncion in Paraguay [15] offers a 90-hour diploma course entitled "Diploma in scientific research methodology". This diploma, based on the competency-based approach, consists of five modules: "Knowledge society and research methods", "Applied informatics in research", "Management of scientific research", "Design of qualitative and quantitative research" and "Scientific research reports". The Institute of Technologies for Education in Peru [16] offers a 240-hour online diploma course entitled "Publication of scientific articles". This course is composed of five modules: "Establishing the basics", "Designing your scientific article", "Preparing your scientific article", "Writing your scientific article", "Writing your scientific article" and "Writing your scientific article".

scientific article", "Postulating your scientific article" and "Visualizing your article". The Christian University of Panama [17] offers a hybrid diploma course entitled "Diploma in Scientific Research Training". This diploma consists of six modules: "Promotion of research", "Research development", "Lines of research", "Advice and development of academic research", "Scientific research reports" and "Writing refereed articles". The Universidad Juárez Autónoma de Tabasco [18] offers two diploma courses in its education and training catalog: one entitled "Scientific Research" of 160 hours and the other "Development of Scientific Research" of 125 hours. The modules of the first diploma course are: "Quantitative methods", "Writing research protocols", "Qualitative methods" and "Writing scientific articles". The modules of the second diploma include: "Writing scientific texts", "Statistics applied to research", "Use of APA norms in research" and "Editing articles through EndNote".

Unlike the proposals mentioned above, the diploma course for research training of TecNM teachers, proposed in this article, follows a Constructivist approach, complemented with elements of Project Learning (PBL) and Collaborative Learning. The training stages range from the understanding of the importance of research to the practical application of technological tools in the writing of scientific articles, ensuring a comprehensive and effective training for TecNM teachers.

DEVELOPMENT

For the creation of the diploma, the following five stages were established, as detailed below:

Evaluation of the impact of the diploma

To evaluate the impact of the diploma course, a survey was designed using Google Forms, which was distributed via WhatsApp to various groups of TecNM teachers. The survey collected responses from 223 academics, belonging to 16 federal and federal technological

17 decentralized technological centers. The data revealed that 58% of the respondents do not conduct research activities, mainly due to lack of knowledge and training opportunities in this area. Nevertheless, an encouraging 94% of the participants expressed interest in taking a diploma course in research training offered by the TecNM. The majority expressed a strong interest in learning how to write and publish scientific articles. These results underscore the need for and potential positive impact that a diploma course focused on scientific and technological research training could have, thus validating the relevance and acceptance of the project among TecNM faculty.

State of the art search

At this stage, a review of programs and platforms dedicated to research skills training for teachers, mainly in Mexico, was carried out. This process included an analysis of the contents of courses, workshops, diploma courses and relevant articles on the subject. Various academic and educational sources were examined to identify best practices, innovative methodologies and pedagogical approaches that have proven to be effective in research training.

In addition, a comparative study of existing programs was carried out order to identify both their strengths and areas for improvement, integrating these elements in the design of the proposed diploma course. The information gathered was discussed with experts in the field, which made it possible to enrich and adapt the content of the diploma course to the specific needs of TecNM teachers. This rigorous analysis ensured that the diploma course not only covered basic research competencies, but also incorporated advanced tools and techniques for the production of quality scientific knowledge. Some of the most outstanding works found during this review were incorporated in the introduction and theoretical framework of this article.

Educational program design

The design of the diploma program involved a series of critical steps to ensure its effectiveness and relevance. First, the general and specific objectives of the diploma course were defined, aligning them with the needs and expectations of TecNM teachers. The content of the program was organized into thematic modules that address the various aspects of scientific and technological research, from the basic fundamentals to the preparation and presentation of a complete scientific article.

Each module was carefully structured to include clear learning objectives, specific content, and practical activities that facilitate the application of the knowledge acquired. Evaluation criteria were designed not only to measure theoretical knowledge, but also to assess participants' ability to apply this knowledge in practical contexts. Evaluative activities included the selection of a research topic and the writing, review and presentation of a scientific article.

In addition, deliverables were defined for each module, providing participants with a structured guide on what is expected of them in terms of the activities and the project throughout the course. This methodological approach seeks to ensure that the educational program is comprehensive, rigorous and relevant for TecNM teachers.

Development of Moodle resources

After designing the educational program for the diploma course, the next stage was the creation and organization of the didactic resources on the Moodle platform. Figure 1 shows a screenshot of the diploma course implemented on this platform.



Figure 1. Screenshot of the diploma course implemented in the Moodle platform.

This stage of development involved a series of detailed and coordinated activities to ensure that the course content was accessible, interactive and pedagogically effective. The main components developed are described below:

- *Creation of didactic materials:* Various educational materials were developed, including PDF documents, explanatory videos and study guides, including the "Guide-Template for writing a research article". In addition, some modules of the diploma course were enriched with multimedia resources designed to facilitate understanding of the use of research tools.

- *Configuration of interactive activities:* To promote active participation and collaborative learning, several interactive activities were implemented in Moodle. These activities include discussion forums, quizzes and practical tasks, all designed with the purpose of evaluating the participants' progress on an ongoing basis. In addition, these tools provide constructive feedback, facilitating a dynamic and adaptive learning process that responds to the individual needs of each teacher.
- *Design of evaluations:* Assessments were configured in Moodle to measure the knowledge acquired and skills developed by the participants. Online quizzes, research paper writing progress tracking activities, and critical reflection were implemented. Moodle's automated assessment tools facilitated efficient correction and allowed detailed tracking of student performance, thus ensuring an accurate and continuous assessment of the learning process.

Diploma review request

Once the previous stages have been completed, the application for review of the diploma course the TecNM's Teaching and Educational Innovation Department is processed. This process includes the following actions:

- **Preparation of documentation:** A comprehensive dossier is prepared that includes the detailed curricular design of the diploma course, its objectives and the justification of the program. This document also contemplates the methodological strategies, the didactic resources developed in Moodle and the evaluation criteria, as well as the follow-up strategies for the participants.
- **Meetings with educational authorities:** In order to obtain the necessary support, meetings are organized with the educational authorities of our campus. During these meetings, the objectives, content and potential impact of the diploma program are presented, highlighting how this program will contribute to the strengthening of teachers' research skills and the positioning of the TecNM in the academic and scientific environment.
- **Formal request:** A formal request for review of the diploma course is drafted and addressed to the TecNM's Direction of Teaching and Educational Innovation. In this request, the importance and relevance of the diploma course is detailed, as well as the expected benefits for TecNM teachers and the improvement of institutional indicators.

DISCUSSION AND ANALYSIS OF RESULTS

This section presents the structure of the proposed diploma course, entitled "**Online diploma course for the training of TecNM teachers in scientific and technological research**".

The **objective** of the diploma course was established as: "To train TecNM teachers with the necessary knowledge and skills in basic approaches and tools for scientific and technological research. It seeks to foster a research culture among teachers, in order to improve educational quality and generate a positive impact on TecNM's indicators". The duration of the diploma course was set at 150 hours.

The **thematic content** of the diploma course was designed with the objective of providing TecNM teachers with training in scientific and technological research. The sequence of modules is structured to guide participants from a basic understanding of research to the elaboration and presentation of a complete scientific article. The thematic content of the diploma course is presented below.

Module 1. Scientific and technological research at the TecNM

The **objective** of this module is: "At the end of this module, participants will understand the strategic importance of scientific and technological research in the TecNM, as well as the opportunities and resources available in the institution. This knowledge will allow them to value the relevance of research in their professional development and in the improvement of educational quality". The duration of this module was established in 10 hours.

The **justification** for this module has been defined as: "It is essential that teachers understand the context and benefits of research in order to value it and be motivated to participate actively, since research not only enriches teachers' personal and professional knowledge, but also contributes significantly to the advancement and prestige of the institution".

The **expected outcomes** for this module are: "Participants will identify opportunities and available resources, and understand the importance of research for themselves and their institution. It is expected that, at the end of the module, teachers will feel motivated and empowered to initiate or continue participating in research activities, thus contributing to their professional development and to the strengthening of the research culture at TecNM".

The topics included in this module are as follows:

- 1.1. **Current trends in scientific and technological research.** "This theme focuses on understanding the relevance and impact of scientific and technological research, as well as on analyzing the trends

that are shaping the future of research".

1.2. Scientific and technological research at TecNM.

"This topic seeks that participants understand the strategic relevance of research in TecNM, and identify the opportunities and resources available in the institution to support and enhance research."

1.3. Benefits of research for TecNM teachers.

"This topic addresses the various benefits that research can bring to TecNM teachers such as professional development, academic enrichment and contribution to institutional prestige."

1.4. Research Ethics.

"This topic focuses on fundamental ethical principles in research, discussing important aspects such as academic integrity, plagiarism, handling sensitive data, and authorship of scientific publications. It ensures that faculty understand and apply ethical practices in their research."

Module 2. Initiation in scientific and technological research

The **objective** of this module was defined as: "At the end of this module, participants will have acquired knowledge on strategies to initiate and strengthen their participation in scientific and technological research. This knowledge will enable them to effectively integrate into research groups and projects and actively contribute to the creation of knowledge". The duration of this module was established at 10 hours.

The **rationale** for this module was defined as: "It is essential to provide teachers with clear and practical strategies to initiate and strengthen their participation in research. This module seeks to equip participants with the necessary tools and approaches to begin their research trajectory, fostering collaboration and the development of joint projects."

The **expected outcomes** of this module were stated as: "Participants will develop skills to collaborate in research, selecting topics appropriate to their interests and academic objectives, and integrating into working groups. It is expected that, at the end of the module, teachers will be prepared to initiate and actively participate in collaborative research initiatives".

The topics that make up this module are as follows:

2.1. Research engagement. "This theme focuses on providing effective strategies for initiating and strengthening research engagement. It emphasizes the importance of research as a key driver for the

academic and professional development of teachers".

2.2. Collaborative work among faculty.

"This topic explores the relevance of research collaboration among faculty from the same department or institute. Fundamental aspects such as the formation of research groups and the formation of Academic Bodies (CA) for the development of joint projects are addressed."

2.3. Mentoring and advice on research.

"The importance of mentoring in the research process is discussed here. Guidelines are offered on how to seek out and establish effective mentoring relationships that promote fruitful collaborations and professional growth for teachers."

2.4. How to choose a research topic.

"This topic trains faculty in identifying and selecting research topics that are appropriate to their academic interests and goals. Criteria and tools are provided for an informed choice, ensuring that research projects are relevant and viable."

Module 3. How to write a scientific article.

The **objective** of this module was defined as: "To provide TecNM teachers with the knowledge and skills necessary to understand the structure of a scientific article and effectively approach the writing process. This module will guide participants from the selection of the title of the article to the placement of the bibliographic references". The duration of this module has been set at 50 hours.

The **rationale** for this module is as follows: "Writing scientific articles is an essential skill for researchers. This module provides detailed and practical guidance on how to write each section of a scientific article, enabling teachers to communicate their findings effectively and contribute to scientific knowledge". The **expected outcomes** of this module are that "participants will be able to structure and write a scientific article following publication norms and standards. It is expected that, at the end of the module, teachers will have a draft of an article on which they will work throughout the following two modules under the supervision of the instructors. The intention is that this article will be submitted to a scientific journal selected on the basis of the topic and the quality of the results".

Topics covered in this module include:

3.1. Introduction to writing scientific articles.

"This topic highlights the importance and fundamental benefits of scientific communication articles. It explains how scientific articles are an essential medium for the

dissemination of knowledge, allowing researchers to share their findings with the scientific community and the general public. In addition, the different types of scientific articles, their characteristics and typical structures are discussed".

- 3.2. **The title, abstract and keywords.** "This topic emphasizes the importance of a well-crafted title to capture the attention of readers and teaches techniques for structuring and writing an effective abstract. It explains how the abstract acts as a synthesis of the article, highlighting the objectives, methodology, results and main conclusions. also stresses the importance of choosing accurate keywords to improve the visibility of the article in search engines and academic databases".
- 3.3. **Authors.** "This topic addresses issues related to the rules of authorship and contribution, etiquette and collaboration in co-authorship, and signing scientific papers. It also discusses the importance of creating and managing researcher profiles (ORCID, ResearcherID, ScopusID, Dialnet, Google Scholar)."
- 3.4. **Literature Review.** "Effective literature review taught, including searching and selecting relevant sources in scientific databases, organizing and synthesizing these sources in a logical manner, and analyzing the information using bibliographic reference managers."
- 3.5. **Introduction.** "This topic focuses on writing an effective introduction that captures the reader's interest and clearly relates the research topic. It is taught to establish the context and rationale for the study within the existing literature, using citations and references according to citation standards such as APA, MLA or IEEE."
- 3.6. **Theoretical Framework.** "Participants are guided in the construction of a solid theoretical framework that will serve as the foundation for their research. This topic covers the definition and clarification of concepts, the formulation of hypotheses, and the delimitation of the scope of the study, ensuring a robust conceptual basis for the research."
- 3.7. **Materials and Methods.** "This topic instructs participants in the structuring and clear and replicable writing of this section. They will be taught to describe the study design, the study population with its inclusion and exclusion criteria, the instruments used for data collection, ensuring their validity and reliability, as well as the procedures followed for data collection and analysis."
- 3.8. **Results.** "Participants will learn how to present results in a clear and concise manner, using tables, graphs and statistics to illustrate

research findings. This theme emphasizes selecting the most appropriate forms of data visualization, accurate interpretation of results, and effective communication of findings so that they are understandable and useful to the audience."

- 3.9. **Discussion.** "This topic teaches participants to contextualize their findings within the field of study, discuss the implications of their results, identify limitations of the study, and suggest areas for future research. It will focus on how to relate the results to existing literature and how to present new hypotheses based on the findings."
- 3.10. **Conclusions.** "Participants are instructed in the coherent synthesis of results, emphasizing the importance of their findings in relation to the existing literature and theoretical framework. This topic also teaches how to suggest directions for future research that may broaden or deepen the results obtained."
- 3.11. **Acknowledgements/Acknowledgements.** "This topic addresses the proper wording of the acknowledgements section, recognizing the contribution of individuals, institutions and organizations that contributed to the development of the research. It teaches the importance of expressing gratitude in a professional and respectful manner."
- 3.12. **Bibliographic references.** "This topic discusses the importance of following citation and reference standards, as well as the use of reference managers to facilitate the writing and organization of bibliographic references. Emphasis is placed on the need to maintain accuracy and consistency in citations to ensure the credibility and traceability of scientific work."

Module 4. Research Support Tools

The **objective** of this module is "to train teachers in the use of technological tools applied to research. Participants will learn to use various tools that will help them in writing, analyzing data and presenting their results". The duration of this module was set at 50 hours.

The **rationale** for this module is follows: "The use of technological tools is essential for efficiency and effectiveness in scientific and technological research. This module provides teachers with the necessary knowledge about various available technologies that can optimize their research work and improve the quality of their results".

The **expected outcomes** for this module were stated as: "Participants will know and learn how to use some key technological tools for research and writing articles.

including data analysis software, scientific text editing tools, and platforms for creating graphics and images. At the end of the module, teachers are expected to be able to integrate these tools into their daily research practice".

Topics covered in this module include:

- 4.1. Introduction to the use of support tools for research.** "This topic reviews the key features of various technological tools that facilitate scientific and technological research, allowing for greater efficiency and effectiveness in the research process."
- 4.2. Artificial intelligence as a research assistant.** "Explore how to use artificial intelligence technologies, such as chatbots and virtual assistants, to improve efficiency in idea generation, text review, and automation of routine tasks in research."
- 4.3. Prompts for text revision and article writing.** "This topic teaches how to use prompts effectively during the revision and writing process, improving the clarity, cohesion and overall quality of scientific texts."
- 4.4. Editing of technical-scientific texts in LaTeX.** "Learn how to edit scientific articles using LaTeX, a widely used tool for the creation of technical and scientific documents due to its ability to handle complex formulas and bibliographic references."
- 4.5. Tools to create vector graphics.** "Use visual tools for the creation of vector graphics, designing clear and accurate graphical representations that enhance the visualization and communication of data in scientific articles."
- 4.6. Tools for creating images and tables.** "Explore specialized software that facilitates the creation of high-impact visual content, including images and tables, that complement and enrich scientific texts."
- 4.7. Tools to analyze data.** "Instruct on the use of specialized software for data analysis, enabling teachers to handle significant volumes of information and obtain meaningful results from their research."
- 4.8. Agile questionnaire design.** "Explore available platforms for conducting online surveys, designing effective and efficient questionnaires that facilitate data collection in an agile and accurate manner."
- 4.9. Tools to verify plagiarism.** "Instruct on the use of technological tools to guarantee academic integrity, verifying the

originality of texts and preventing plagiarism in research papers".

Module 5. Presentation of the article and shipment.

The main **objective** of this module is to train participants in the submission and submission of scientific articles. Teachers will learn how to select appropriate journals, prepare the format of the article according to editorial standards and handle the peer review process. The duration of this module was set at 30 hours.

The **rationale** for this module is as follows: "The presentation and submission of scientific articles are fundamental steps in the dissemination of knowledge generated by research. This module is designed to ensure that faculty members understand and master publication guidelines, as well as effective strategies for responding to reviewers' comments, increasing the chances of acceptance their work".

The **expected outcomes** in this module were worded as follows: "Upon completion of this module, participants are expected to be able to select appropriate scientific journals for their research, prepare their articles according to editorial requirements, and handle the peer review process. Faculty should be able to submit their manuscripts to scientific journals with confidence".

The topics that make up this module are as follows:

- 5.1. How to select scientific journals.** "This topic deals with the exploration of divulgation, refereed and indexed journals. It teaches how to evaluate the quality of periodicals using indicators such as JCR, SJR, Google Scholar Metrics, among others (Latindex, CIRC, Carhus Plus, MIAR), to ensure the choice of appropriate journals for the dissemination of their research."
- 5.2. Review of article format and style.** "Participants are instructed on how to prepare their articles according to the style and presentation guidelines required by the selected journals, ensuring that each manuscript meets specific editorial standards."
- 5.3. Types of scientific evaluation and the peer review process.** "This topic explores the various types of scientific evaluation, providing an understanding of the peer review process from initial submission to acceptance or rejection of the article. It details the stages and highlights best practices for navigating this process."
- 5.4. How to respond to reviewers' comments.** "Effective strategies are presented for responding to reviewers' comments, focusing on how to improve the article based on

these observations and increase the likelihood of acceptance. The importance of respectful and constructive communication with reviewers is emphasized."

5.5. Strategies to improve the visibility of publications.

"This topic provides practical recommendations for increasing the visibility of scientific articles. Techniques for using academic platforms and social networks are discussed, ensuring that research reaches a wider audience and has a greater impact."

5.6. Research Impact Assessment.

"Participants are taught how to measure and evaluate the impact of their research in terms of citations and scholarly recognition. Specific metrics and tools are used to analyze the reach and influence of published work, helping researchers understand and improve their contribution to the scientific field."

Pedagogical approach of the diploma

The pedagogical approach of the diploma is based on Constructivism, complemented with elements of PBL and Collaborative Learning.

The Constructivism approach focuses on learning as a process of construction, where the instructors of the diploma course are the facilitators who guide and support the participants in the construction of their own knowledge. In this approach, the following three elements were established:

1. *Active learning*: Participants will be actively involved in the learning process, reading, searching for information, analyzing and constantly reflecting on the contents of the course.
2. *Connection with reality*: The topics and activities of the diploma course will be connected with real situations and practices of scientific and technological research, allowing teachers to apply what they have learned to their specific contexts.
3. *Autonomy and responsibility*: Participants will have the autonomy to choose research topics and direct their own projects, developing self-management skills and responsibility in their learning.

PBL, in the context of the diploma course, each participant will develop an individual or team research, which will culminate in the writing and presentation of a scientific article. In this approach, the following three elements were established:

1. *Real projects*: Participants will work on real research projects relevant to their area of teaching or interest, promoting meaningful and applicable learning.
2. *Research process*: Throughout the course, participants will follow a research process.

The course is structured, from the formulation of questions to the presentation of results, supported by the instructor's guidance and the information contained in the five modules of the course, where the "Guide-Template for writing a research article" stands out.

3. *Continuous evaluation*: Continuous evaluation of research progress will be implemented, providing constant feedback and opportunities for improvement.

Collaborative Learning involves students working together to solve problems, complete tasks and learn new concepts. This approach encourages cooperation, communication and knowledge sharing among participants. The following three elements were established in this approach:

1. *Group work*: Participants will work in groups to discuss topics, share resources and collaborate in the research and writing of the scientific article.
2. *Mentoring and support*: Mentoring will be promoted among peers and diploma instructors, providing support and guidance throughout the process.
3. *Discussion forums*: Use of forums and discussion in the Moodle platform for the exchange of ideas, resolution of doubts and feedback among participants.

Diploma evaluation techniques

Three evaluation techniques are proposed to ensure a complete and fair assessment of the participants' performance, promoting active and reflective learning.

1. Formative evaluations

These evaluations allow to monitor the progress of the participants and provide continuous feedback, helping to improve the learning process.

- **Multiple-choice quizzes and questionnaires**: Periodic multiple-choice assessments are given at the end of each topic to measure understanding of key concepts. Moodle tools are used to automate grading and provide immediate feedback.
- **Discussion forums and written reflections**: Online discussion forums are implemented where participants can reflect on the topics studied and share their opinions. Participation and quality of contributions will be evaluated using specific rubrics.
- **Continuous feedback on activities**. Continuous and constant feedback is provided allowing participants to identify areas for improvement and adjust their strategies.

2. Summative evaluations

These evaluations will be conducted at the end of each module to measure the overall learning of the participants.

- **Theoretical exams:** Theoretical multiple-choice exams are used to evaluate the knowledge acquired in each module. It is ensured that the exams cover the main topics and that the questions are aligned with the objectives of the module.
- **Evaluation rubrics:** Rubrics are used to evaluate activities. These rubrics include clear and specific criteria, such as accuracy, organization, depth of analysis and quality of information.

3. Evaluation of the scientific article written

The writing and presentation of the scientific article developed by the participants is the most relevant component of the diploma course.

- **Development of the article draft:** The progress of the article is evaluated through partial deliveries. The information contained in the "Guide-Template for writing a research paper" will be used for the evaluation rubric. Continuous feedback is provided to improve and refine the article.
- **Final scientific article:** The final scientific article is evaluated using again rubrics based on the Guide-Template, which covers aspects such as clarity and precision of the title, structure and coherence of the abstract, depth of analysis in the literature review, methodology, presentation of results, discussion and conclusions.

The implementation of this diploma course is aligned with several diploma courses proposed in previous research that emphasize the importance of training in research competencies for teachers [12-18]. These studies agree that research training is essential to improve educational quality and foster innovation in the academic environment. However, there are notable differences in the content, duration and the requirement that participants write and submit an article to a scientific journal.

In terms of content, the diploma course proposed by Sandoval et al. [12] focuses mainly on the scientific writing process, addressing APA standards and micro- and macro-textual strategies for academic-scientific writing. On the other hand, González et al. [14] structure their diploma program around the elaboration and defense of a final research paper, i.e., not necessarily a scientific article. The diploma program proposed in [16] focuses on the design, preparation and presentation of a scientific article. Similarly, the diploma courses proposed by the Universidad Juárez Autónoma de Tabasco [18] also focus on the design, elaboration and postulation of a scientific article.

emphasize the writing of scientific articles. These variations reflect a shared trend: the need to train teachers in academic writing as a fundamental tool for the communication and dissemination of knowledge.

A distinctive feature of the diploma program proposed in this article is the requirement that participants write and submit an article to a scientific journal. This practical approach differs from other programs that, due to their shorter duration, tend to be more theoretical. For example, the diploma programs of Sandoval et al. [12] and Bernal et al. [13] have a duration of 80 and 60 hours, respectively, while the program proposed in [15] is 90 hours. The programs offered in [17] vary between 60 and 80 hours. We believe that these durations are insufficient to provide a comprehensive experience in scientific research work, which limits the ability of participants to apply what they have learned in practice.

In contrast, the diploma course proposed in this article, with a duration of 150 hours, is designed to provide complete and practical training, guiding participants from the theoretical foundations to the preparation and submission of a scientific article. In the case of the diploma course mentioned by Bernal et al [13], participants are required to publish an accepted article in databases and indexing systems such as Web of Science, Scopus, SciELO, Redalyc or DOAJ to accredit the program. Although we agree on the importance of publication, we do not restrict indexing systems, allowing participants to submit their articles to other indexes, thus facilitating the publication of their first article.

These studies also recognize that research training programs have a significant impact on the motivation and performance of teachers. This statement is consistent with the objectives and expected results of the proposed diploma program, since its structure, practical approach and duration, position it as an effective tool to strengthen the competencies needed to conduct high quality and relevant research.

CONCLUSIONS

The proposed diploma course has been presented as an initiative to strengthen the research competencies of TecNM teachers. Through a constructivist pedagogical approach, complemented with PBL and Collaborative Learning methodologies, this diploma course has been designed to provide the necessary theoretical knowledge and develop practical skills essential for scientific and technological research.

The structure of the diploma, distributed in five sequential modules, seeks to guarantee a progressive learning process that guides participants from an initial

basic understanding of research through to writing a full-length scientific article. Each module is designed to address key aspects of research, from theoretical background to writing scientific articles and managing the publication process.

The focus on continuous evaluation and constructive feedback, together with the implementation of formative and summative evaluations, aims to ensure a complete and fair assessment of the participants' performance, promoting active and reflective learning. In addition, it fosters autonomy, responsibility and collaboration among participants, contributing significantly to their professional and academic development.

The implementation of this diploma could contribute significantly to the professional development of teachers and strengthen the research capacity in the TecNM, thus promoting the advancement of scientific and technological knowledge in Mexico.

For future lines of research, two main approaches can be proposed: (1) to perform a statistical analysis to evaluate the impact of the diploma course, specifically quantifying how many teachers manage to complete and publish the requested research article, as well as identifying the factors that facilitate or hinder the successful completion of the research process; and (2) to design a MOOC or similar diploma course aimed at TecNM students interested in strengthening their research competencies from early stages in their academic training.

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