Article **Journal High School**
June 2022, Vol.6 No.15 1-8

# Tutorial action integrated to the scientific method for the development of engineering projects

# Acción tutorial integrada al método científico para el desarrollo de proyectos en ingeniería

SOTOMAYOR-OLMEDO, Artemio†, MARTÍNEZ-HERNÁNDEZ, Moisés Agustín* and AVENDAÑO-JUAREZ, José Luis

*Universidad Autónoma de Querétaro, Faculty of Engineering, Mexico.*

ID 1er Author: *Artemio, Sotomayor-Olmedo* / **ORC ID:** 0000-0001-8054-4654, **CVU CONACYT ID:** 341158

ID 1er Co-author: *Moisés Agustín, Martínez-Hernández* / **ORC ID:** 0000-0001-5495-5185, **CVU CONACYT ID:** 370689

ID 2do Co-author: *José Luis, Avendaño-Juarez* / **ORC ID:** 0000-0003-3546-8570, **CVU CONACYT ID:** 169297

**DOI:** 10.35429/JHS.2022.15.6.1.8 Received January 10, 2022; Accepted June 30, 2022

**Abstract**

Currently, the tutorial action is of vital importance to integrate in the processes of teacher training, as well as for the execution in practice of the students. However, the application in courses of scientific orientation is complicated, causing the tutorial action to be oriented to cases of attention in administrative, academic courses or exclusively for degree purposes. Thanks to University Educational Models and Institutional Tutoring Programs, it is possible to apply the tutorial action in scientifically oriented subjects to have a significant contribution in the training of students, promoting actions that place it in the place that, as a teaching practice, corresponds to it. In the present, a case study is exposed with the revision of a series of subjects of the automation career of the Faculty of Engineering of the Autonomous University of Querétaro, focused on the development of projects through the scientific method, an analysis and proposal to improve the conceptions and practices of university tutoring, in the application of knowledge and development of skills in students, likewise, offer the foundations and methods to achieve the objectives that the didactics of these subjects pursues in the training of students

**Tutorial, Engineering, Projects**

**Resumen**

Actualmente la acción tutorial es de vital importancia tanto para integrar en los procesos de formación docente, como para la ejecución en práctica de los estudiantes. Sin embargo, es complicada la aplicación en materias de orientación científica, causando que la acción tutorial sea enfocada a casos de atención en cuestiones administrativas, académicas o exclusivamente con fines de titulación. Gracias a Modelos Educativos Universitarios y Programas Institucionales de Tutorías es posible aplicar la acción tutorial en materias de orientación científica para tener un aporte significativo en la formación de los estudiantes. Promoviendo acciones que la sitúen en el lugar que, como práctica docente, le corresponde. En el presente documento se expone un caso de estudio con la revisión de una serie de materias de la Licenciatura en automatización de la Facultad de Ingeniería de la Universidad Autónoma de Querétaro. Dicho conjunto de materias está enfocadas al desarrollo de proyectos implementando el método científico. Por lo cual, se realiza un análisis y propuesta para mejorar las concepciones y prácticas de la tutoría universitaria en la aplicación de conocimientos y desarrollo de competencias en los alumnos. Así mismo, se ofrece una propuesta sobre los fundamentos y métodos para alcanzar los objetivos que la didáctica de dichas materias persigue en la formación de los estudiantes.

**Tutorías, Ingeniería, Proyectos**

**Citation:** SOTOMAYOR-OLMEDO, Artemio, MARTÍNEZ-HERNÁNDEZ, Moisés Agustín and AVENDAÑO-JUAREZ, José Luis. Tutorial action integrated to the scientific method for the development of engineering projects. Journal High School. 2022. 6-15:1-8.

* Correspondence of the Author (E-mail: moises.martinez@uaq.mx)
† Researcher contributing as first author.

## Introduction

Currently, society is in search of information that generates knowledge that is not only part of an academic formation, but also has an impact on the different areas that compose it. Thus, it is essential that educational systems meet the needs of society, which is characterized to a large extent by assertive changes in their training throughout their academic career. That is, offering a comprehensive training that promotes the existence of proactive, reflective and critical citizens in the face of social, economic and environmental events in their environment. Thus, the Universidad Autónoma de Querétaro (UAQ) in its University Educational Model (Universidad Autónoma de Querétaro, 2020) approved in November 2017 established an integral formation centered on the student. Said model is based on three pillars: principles and values, Educational Innovation and a pedagogical approach.

Educational systems have sought methodologies that integrate an approach with students (in search of an efficient understanding and comprehension of knowledge) to improve the efficient absorption of knowledge, develop greater inclusion within the Programs of Study (PE), better relationship between the student and his school environment, a capacity for analysis, reflection and criticism of the environment in which he develops. As a result, we hope that the above will be reflected in project proposals where the main objective is a more just society, an improvement in the economy or a sustainable development that generates a different way of relating to the environment. It is in this sense that institutional tutoring programs are created with the aim of monitoring and supporting students during their school career. In 2012, the UAQ established its Institutional Tutoring Program (PIT) (Rodríguez Gálvez, Saavedra Uribe, Sánchez Rosas, Rodríguez Muñoz, & Ordaz Guzmán, 2012).

This program defines tutoring as a process of accompanying students in their academic life, which involves the administration of the institution, the academy (tutors) and the students (tutored); with the implementation of this program a positive impact is expected on several indicators, some of them are: student retention, graduation and graduation rates. In many cases, these indicators are a requirement to obtain federal support or accreditation (national or international).

The PIT also aims to integrate students to the different PE, the establishment of a tutor to guide and advise them on different issues (academic, administrative or personal). In addition, students who present a specific need can be detected through this program and can be channeled to the specialized areas of each faculty or the university itself. As can be seen, this effort of accompaniment in the student's school career is aligned with the MEU in its humanistic vision, centered on the student and his or her formation. This generates a very important commitment to interaction and integration of the different areas that make up the UAQ. Since, to a greater or lesser extent, all university processes impact the formation of students.

In the search for alignment with the requirements established in the MEU and in compliance with the PIT, the Faculty of Engineering (FI) of the UAQ has been constantly updating the different PE that comprise it. Not only to have a quality educational program, accreditable, viable and with a long-term vision, but also to integrate a humanistic vision in the formation of its students. Consequently, the Automation Engineering program has established a commitment with the continuous improvement of its curriculum and in 2013 (INA-14 plan) the Development Workshop in Automation Technologies (TDTA) was established. The objective of this workshop is the development of a unique project where the student is trained in a multi-inter-transdisciplinary environment, focused on learning and from meaningful learning. This proposal consists of five courses that begin in the third semester of the course (TDTA I) and end in the seventh semester (TDTA V).

ISSN-2523-0336

In this sense and as part of the continuous improvement of the PE, we have had the following feedback from teachers and students: students in the third semester lack sufficient knowledge to formalize a technical proposal that proposes a solution to a problem in their environment, because in this semester students do not yet have sufficient emotional development to understand and accept a long-term commitment, to follow up on a proposed solution and in many cases they do not have enough soft skills to work in a team. Another difficulty to highlight is that during the development of the different courses, students drop out of the teams, some for academic reasons and others for lack of interest in the proposed project. In the end, this has the consequence that the proposed projects do not culminate or have a lesser impact than originally planned. An additional difficulty is the connection that exists between the TDTA courses and the Degree Seminar, since this type of projects are rarely used as a method of graduation (collective or individual thesis) and in most cases the projects are forgotten and do not reach commercialization or implementation.

Finally, as established in the feedback from teachers and students in the restructuring of the Automation Engineering career (INA-21 plan), a new approach is proposed that establishes the tutorial action as a transcendental actor in the improvement of the results obtained in the subjects that make up the TDTA together with the application of the scientific method for the consequent development to continue with the objectives set out in the PIT and in the MEU of the UAQ.

In the present document, the subjects that make up the TDTA line with the tutorial action and its management of competencies are shown in detail.

## Development

With the presentation of the proposal for the automation career, addressing the TDTA subjects, there is a clear opportunity to take the students' education to a scientific process, with the preparation of a project that allows them to obtain a possible degree method.

However, addressing subjects that students learn in an undergraduate period oriented to the scientific method and that develop competencies to be professionals with ethics and skills, is complicated because it requires the support of a teacher who acts as a tutor, which allows them to have a follow-up and constant help in personalized and group counseling. To improve and support in that sense, the activities are complemented from the tutorial point of view, since having a small group and with the support of an advisor complements the structural design of the subject to obtain a better learning, taking into account the different types of tutorials of the PIT, it is possible to approach a tutorial model that complemented is a tutor-scientist, who takes the student through six steps of this method.

| Type | Basic description |
|---|---|
| Teacher | Is to a mentoring, research or project based, maintains a support in professional and academic growth. |
| Group | It is to a group, it is carried out simultaneously, with a frequency of meetings. |
| Regularizer | Individual or small groups, it deals with particular subjects, and is based on personalized counseling for students at risk due to the number of failed subjects |
| Pairs | It is an accompaniment, interaction and support; it is carried out among students, generally in higher semesters, to provide advice on administrative methods and recommendations for courses and subjects. |

**Table 1** Types of institutional tutoring

Based on Table 1, we can observe that two types of tutoring are useful for the TDTA subject scheme, teaching tutor and group tutor, because the teacher of the development workshop, semester by semester, must act as a tutor to lead the student to obtain knowledge. This must be carried out by illustrating their knowledge and experiences around scientific knowledge under a constant focus and attention in a group manner, since each participant of the subject must attend to the observations and recommendations of the tutor-scientist, proposing and discussing their discoveries throughout the educational programs.

ISSN-2523-0336

If we consider the general approach of the TDTA subjects adjusted to the characteristics of the tutorial action, we could summarize what is illustrated in Table 2.

| | |
|---|---|
| **Name of subject** | Automation Technology Development Workshop |
| **Number of courses** | 5 |
| **Complementary courses** | Degree Seminar |
| **Semestres en que se imparten** | 3er-7mo |
| **Objective General** | Know and apply the concepts of automation for the successful development of a project proposed and developed by the scientific method through the integration of working groups that promote the resolution of social, economic and environmental problems, from local and external actions. |
| **Tutorial action** | - To advise the student from the scientific point of view to solve problems.<br>- Enlighten the student to exploit the knowledge of the subjects of each semester.<br>- To maintain the learning curve by taking advantage of the semester courses.<br>- Expose group experiences through frequent group sessions.<br>- Continuous analysis of improvements for projects by working with external and internal advisors to strengthen the projects.<br>- Continuous monitoring of group and personal situations for students oriented to their personal and academic development. |

**Table 2** Generic program of the TDTA courses.

The proposed restructuring of the TDTA course with the contribution of the tutorial action is to improve the acquisition of knowledge in stages, and it is also carried out with the objective of guiding the student to know how to develop projects, plan, program and execute them. Through the monitoring and improvement process, points have been found that can be strengthened with the objective of improving the student's performance and making it a complementary subject.

Not only to obtain technical knowledge, but also to develop attitudes and skills that allow them to develop in society with ethics and responsibility, thinking about continuous improvement and the contributions we need as part of this world.

*"I educate in truth and honor".*

*"Ingenuity to create not to destroy".*

When considering the mottos of the University and the FI, it is clear that the commitment as teachers not only lies in teaching technical content, it is also an obligation to generate a commitment to society. Therefore, each TDTA course must take into account the preservation of technical concepts, student monitoring and support, constant counseling and continuous improvement process.

The following is a description of the objectives and orientations of the subjects where the activities and competencies to be obtained at the end of each course are described, explaining how tutoring would be the support for the development of the competencies for each semester.

**Tutorial Actions for TDTA Courses**

**TDTA I**

Stage of the scientific method: Observation.

General learning: Obtaining knowledge.

Main objective: To generate awareness in students, in order to make them critical and sensitive to the various problems facing society, through the diversified presentation of issues at local, regional, national and international levels.

Tutorial Level Competency: The student remembers and recognizes information and ideas in addition to principles in approximately the same form in which he/she learned them.

Tutorial activities:

- Relate the types of projects that can be developed, as well as the differences between them (administrative, social, academic, research, resolute, etc.) advising against student findings.

ISSN-2523-0336

- Record informative meetings such as talks and conferences related to the living context to expose social and professional needs.

- Relate experiences with speakers and peers to create awareness of problems in their context, social, economic, environmental, etc.

- Teach research databases and explain methods and search mechanisms for debugging information.

**TDTA II**

Stage of the scientific method: Asking questions.

General learning: Understanding and integration of knowledge.

Main objective: Identify particular needs to propose solutions based on ethical proposals, forms and models that improve the quality of life that generate a social, economic, environmental impact among others.

Tutorial level competence: The student clarifies, understands or interprets information based on previous knowledge through personalized counseling with experts in different areas.

Tutorial activities:

- Recognize impacts based on general issues the student has had in the previous course.

- Distinguish possible research problems associated with an educational and social impact that the student is able to identify.

- Interpret results through interviews to denote the importance and impact of their project, identifying the fields of application.

- Analyze the student's capacity to reaffirm the viability of his/her research project from theoretical and contextual elements.

**TDTA III**

Stage of the scientific method: Hypothesis generation.

General learning: Analyze, extend and reaffirm knowledge.

Main objective: Apply knowledge and research to integrate into projects in real practical scenarios based on the student's experience throughout his or her training, as well as his or her social context.

Tutorial level competence: The student clarifies, understands or interprets information based on prior knowledge through personalized counseling with experts in different areas.

Tutorial activities:

- Analyze group and particularly the knowledge obtained from students against their proposal to extend the proposed solution.

- Illustrate the classification of information (bibliography) obtained and acquired to address a problem with social, economic and educational impact.

- Continuous advice for the formal presentation of the Senior Project content.

- Selection and use of necessary tools to support with the validation of a sample in data management, as well as activity management.

- Explain with rationale the deliverable points for your master document, such as: Hypothesis, justification, objectives, background and problem definition.

**TDTA IV**

Stage of the scientific method: Conduct the experiment.

General learning: Use of significant knowledge.

ISSN-2523-0336

Main objective: To develop the methodology of a project through the application of tools and methodologies that allow the reduction of possible execution and validation errors.

Tutorial level competency: The student selects, transfers and uses data and principles to complete a task or solve a problem.

Tutorial activities:

- Advise on technical and management tools, for project management.
- Relate personal experiences within projects, mistakes, consequences, learnings.
- Explain TRL levels of projects, learn about administrative platforms such as ASANA, Mendely bibliographic citation software.
- To denote a program adequately its development activities in execution times by semesters, for each team of the course.
- Explain and direct the development of the different Methodologies, activity schedules, Human Resources and Materials for the senior project.

**TDTA V**

Stage of the scientific method: Analysis of results and search for a conclusion.

General learning: Generates productive mental habits.

Primary Objective: Validate project components and steps with testing in a controlled environment to demonstrate the technical feasibility of the proposed solution.

Tutorial Level Competency: The student generates, integrates, and combines ideas into a product, plan, or proposal new to him or her.

Tutorial activities:

- Inclusion of Standards that the student must know for the realization of the projects, such as: NOM, ISO, IEC, ISA, etc.
- Perform light experiments for validation of functionality.
- Explain sizing conditions for operations and limits within the project.
- Metrological orientation, data processing and acquisition through previous knowledge.
- Analysis of skills and attitudes of team members in order to generate proposals for task assignment.
- Illustration of recommended platforms, easy access and efficient use for data acquisition.
- Review and support in preparation for the Senior Project draft, analyzing the points and giving recommendations of what will be requested.

**Degree Seminar**

Stage of the scientific method: Reporting and analysis of results.

General learning: Self-regulation.

Primary Objective: To compare and discriminate among ideas; to give value to the presentation of theories; to make choices based on reasoned arguments; to verify the value of evidence; to recognize subjectivity.

Tutorial-level competency: The student assesses, evaluates, or criticizes based on specific standards and criteria.

Tutorial activities:

- Importance or relevance assessment by determining how important the knowledge is and the reason for the student's perception.
- Efficiency assessment by identifying their beliefs about skills that will improve their performance or understanding of specific knowledge.
- Identify emotions about specific knowledge and the reason why a specific emotion arises due to academic or personal conditions.

ISSN-2523-0336

- Identify their level of motivation to improve their performance or understanding of knowledge and the reason for their level.

- Counseling on degree methods and follow-up of requirements fulfilled or to be fulfilled for academic support.

With the implementation of this proposal for the INA-21 plan, it is expected that students who take this series of subjects will have a competency-based training, that the development of a project that aims to have an impact on the student's environment, whether social, economic or environmental, will be achieved. Thus seeking to contribute to the fulfillment of the objectives set out in the MEU and to definitively demonstrate the benefits provided by the follow-up established by the PIT through the tutors.

## Conclusions

As an institution of higher education, the university must support the generation of knowledge with the intention of contributing to its generation through processes that allow establishing growth in constant improvement, thus becoming a reference of change towards the continuous improvement of society. For this, it is necessary that their teachers, professors and tutors are able to encourage the singular thinking of students from a reflective and critical attitude in them, as well as the constant participation of these three entities with the obligation to guide towards the general welfare of academic, personal and professional training.

By proposing that the student develops a clear concept and applies the scientific method for the approach and development of a project during a rough stage of his career. Having as a condition to contribute to the personality of the students, in order to complete it as an individual component and professional project, it is required that the university provides the means, mechanisms and conditions for the achievement of this dual purpose. It is necessary to emphasize considerations on which the actions of university teaching are based, since the starting conceptions have a determining influence on the whole process and goals of the students' action.

Thus, the facilitation of choices, the group and personalized advice, the contribution to form criteria and give options as processes through the TDTA courses, it becomes necessary the participation of a scientific tutor, understanding that the university tutoring has a teaching character; and, within the current teaching practice, it is carried out by professors with their teaching and research activity, being able to do it in parallel to work with the objective of the development of the generic competences proposed.

## References

Alcón, E. (2003). Tutoría personalizada y pedagogía reflexiva en el contexto universitario. In F. Michavila, & J. García Delgado (Eds.), La tutoría y los nuevos modos de aprendizaje en la universidad (pp. 85-94). Madrid: Comunidad de Madrid. Dirección General de Universidades.

Almajano Pablos, M. P. (2003). La tutoría universitaria en la sociedad del conocimiento. In P. R. Álvarez Pérez, & H. Jiménez Betancort (Orgs.), Tutoría universitaria (pp. 79-93). Santa Cruz de Tenerife: Servicio de Publicaciones Universidad de La Laguna.

Álvarez, M., & Álvarez, J. (2015). La tutoría universitaria: del modelo actual a un modelo integral. Revista Electrónica Interuniversitaria de Formación del Profesorado, 18(2), 125-142.

Álvarez Pérez, P. (2002). La función tutorial en la Universidad: Una apuesta por la mejora de la calidad de la enseñanza. Madrid: EOS.

Álvarez Pérez, P. R., & González Afonso, M. C. (2015). Estrategias de intervención tutorial en la universidad: una experiencia para la formación integral del alumnado de nuevo ingreso. Tendencias pedagógicas, 16, 237-256.

Anuies. (2000). Programas institucionales de tutoría. Ciudad de México: Asociación Nacional de Universidades e Institutos de Educación Superior. (Colección de la Biblioteca de la Educación Superior. Serie Investigaciones)

ISSN-2523-0336

Bejar, L. H. (2018). La tutoría como instrumento esencial para desarrollo personal, comunitario, social y el aprendizaje intelectual de los/as estudiantes de nivel superior, de manera integrada e integradora a la vida. Universidad y Sociedad, 10(1), 52-58.

Brunet Gutiérrez, J. J., & Negro Failde, J. L. (1993). Tutoría con adolescentes: técnicas para mejorar las relaciones interpersonales a lo largo del curso. Madrid: San Pío X.

Campillo, M. L., Martínez, J. G., & León, R. M. (2016, noviembre). Prácticas de integración para disminuir el abandono estudiantil en la educación superior. Anales de la Conferencia Latinoamericana sobre el Abandono en la Educación Superior, 3, 786-797. Ciudad de México: Universidad Nacional Autónoma de México.

Corominas Rovira, E. (2001). La orientación y la tutoría en la Educación Secundaria Obligatoria. In Álvarez, M., & Bisquerra, R. (Orgs.), Manual de orientación y tutoría. Barcelona: Cispraxis.

Damasio, A. (2018). El error de Descartes: La emoción, la razón y el cerebro humano. Barcelona: Ediciones Destino.

Del Rincón, B. (2003). Las tutorías personalizadas como factor de calidad en la universidad. In F. Michavila, & J. García Delgado (Eds.), La tutoría y los nuevos modos de aprendizaje en la universidad (pp. 129-152). Madrid: Comunidad de Madrid. Dirección General de Universidades.

Díaz Galindo, Y. T., Rodríguez Sierra, A. V., & Conejo Carrasco, F. (2017). Perfil idóneo del tutor para un correcto acompañamiento a los estudiantes en el curso Práctica en Responsabilidad Social. Dilemas Contemporáneos: Educación, Política y Valores, 5(1).

Díez Hochleitner, R. (2004). El profesor universitario cara al futuro. In F. Michavila, & J. Martínez (Orgs.), La profesión del profesor de universidad (pp. 23-51). Madrid: CAM. Consejería de Educación.

Dopico Rodríguez, E. (2013). Tutoría universitaria: propuestas didácticas de competencia tutorial. Revista de Docencia Universitaria, 11(2), 195-220.
Durkheim, E. (2013). Educación y Sociología. Barcelona: Península

Fernández Pérez, M. (2005). El proceso de evaluación. In P. Sánchez Delgado (Coord.), Enseñar y aprender (pp. 147-168). Salamanca: Témpora.

Ferrer, J. (2003). La acción tutorial en la universidad. In F. Michavila, & J. García Delgado (Eds.), La tutoría y los nuevos modos de aprendizaje en la universidad (pp. 67-84). Madrid: Comunidad de Madrid. Dirección General de Universidades.

Gairín, J. G., Muñoz-Moreno, J. L. M., Galán-Mañas, A., Fernández-Rodríguez, M., & Sanahuja- Gavaldà, J. M. (2017). El plan de acción tutorial para estudiantes universitarios con discapacidad. Revista de Educación Inclusiva, 6(3), 89-107.

González Jiménez, F. E. (2005). Investigar sobre la actividad educativa. Revista Complutense de Educación, 16(2), 715-748.

González Jiménez, F. E. (2006). Conocimiento, comunicación educativa y formas de vida. In J. M. González Gómez (Dir.), Epistemología del Aprendizaje Humano (pp. 47-122). Madrid: Fundación Fernando Rielo.

González Jiménez, F. E., & Macías Gómez, E. (2004). En torno al tema de la calidad en educación: Realidad y leyes. Revista Complutense de Educación, 15 (1), 301-336.

Rodríguez Gálvez, A. M., Saavedra Uribe, L. P., Sánchez Rosas, L., Rodríguez Muñoz, E., & Ordaz Guzmán, G. (2012). Programa Institucional de Tutorías Universidad Autónoma de Querétaro. Querétaro.

Universidad Autónoma de Querétaro. (29 de agosto de 2020). Universidad Autónoma de Querétaro. Obtenido de Planeación UAQ: https://planeacion.uaq.mx/index.php/modelo-educativo-universitario.

ISSN-2523-0336