Application of an Instructional Design Model Using an Online Training Course Standard: A Didactic Proposal

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Abstract

The didactic proposal was implemented to incorporate prior knowledge into the vector calculus course, specifically in Unit 1 called vectors in space, reinforcing the topic of the equation of the line and the plane. For this, the instructional design model called ADDIE, adapted by TECNM (Tecnológico Nacional de México), was used in its stages of: Analysis, Design, Development, Implementation, and Evaluation, which was complemented with CONOCER standard 366 (Consejo Nacional de Normalización y Certificación de Competencias Laborales), which indicates how to develop online courses. Additionally, at the level of activity or task design, the learning outcome suggested by J.I. Pozo was used.

The main objective was achieved by designing and implementing the didactic proposal on the aforementioned topic, in the B-learning modality, with all the planned didactic and disciplinary foundation. The objectives have been included in the introduction section.

The characteristics of the students, teachers, the infrastructure of the distance learning modality, the vector calculus program, learning theories, as well as the prior knowledge that needed to be incorporated for Unit 1 were analyzed at a general level. Subsequently, the production of didactic materials and evaluation instruments was addressed. These materials and resources were implemented on two educational platforms, Moodle and Classroom, and formative and summative evaluation instruments were also developed. All of this was done according to the methodology proposed to implement, combining both the ADDIE model and CONOCER standard 366.

A design was made through a didactic guide and a general document of the subject, so that the student can see what activities they will carry out, both online and in-person, and what the subject consists of.

In the development phase, different materials were created on prior knowledge and the contents of Unit 1 of Vector Calculus, covering vectors in both two-dimensional and three-dimensional planes, as well as the equation of the line in the plane and in space, and the equation of the plane. All of this was done in accordance with the different theories and learning outcomes established by J. I. Pozo. The exercises were modeled using GeoGebra, so that the student can appreciate the different forms of the equation of the line through a single exercise, and with this prior knowledge, apply it to the vector equation of the line and the equation of the plane, thus transitioning to more complex knowledge.

The evaluation will be formative and summative, the former at the beginning and during the course; the latter at the end. The initial formative evaluation will be carried out by the academic peer and will involve the course design, didactic instrumentation, and course materials, using checklists provided by TECNM under the ADDIE model and CONOCER standard 366. The formative evaluation during the course will be applied to students through online questionnaires to assess evidence of prior content. The final summative evaluation will also use various instruments to assess different learning outcomes.

We conclude that with this proposal, we aim to establish a prototype for the development of didactic instrumentation, based on the ADDIE instructional design model, CONOCER Standard 366 for the development of online training courses, and J.I. Pozo's three-component learning system.

Keywords:ADDIE Model, CONOCER Standard 366, Vectors in Space.

I. INTRODUCTION

One of the main activities that every higher education teacher must carry out is undoubtedly the planning or didactic instrumentation, which must be prepared before the start of the semester or quarterly period, as the case may be. Depending on the teacher's experience, this planning can be done following some instructional design methodology, an educational approach or model, or perhaps just some learning theories, and in the best case, following all of the above. In this case, we are proposing not only to know how to prepare the planning or didactic guide but also to develop all the instructional elements to be used in this planning, as well as to implement all this on an educational platform to carry out a course in face-to-face or distance learning modality. It is necessary to specify that the proposal includes applying a standard for the development of online training courses, meaning that all materials to be produced will follow an instructional design model and the

mentioned standard. Additionally, we will apply a training system that includes learning theories.

The main objective we achieved was to design a complementary teaching proposal on the topics of the equation of a straight line in its vector form and the equation of a plane. This approach includes prior knowledge to improve the learning of these contents for vector calculus students through a B-learning course. This course utilizes the ADDIE instructional design model (1), complemented by the CONOCER standard 366 (2), and the learning outcomes suggested by Pozo (3) to design the course activities.

Other objectives achieved are:

1. To design, a didactic strong proposal in a more supported and professional manner, the teaching tools of the Vector Calculus curriculum in the opening, development, and closing activities on the topics of the equation of a straight line in its vector form and the equation of a plane, where prior knowledge of said contents is included; achieving the cognitive scaffolding to the level necessary for achieving its understanding using B-learning.
2. Develop didactic material in accordance with CONOCER standard 366 and the ADDIE instructional design model adapted by TecNM (4) for online course teaching activities.
3. Design a didactic proposal using teaching-learning strategies at the verbal levels (verbal information, concepts, and conceptual change) and procedural levels proposed by Pozo (3), in conjunction with the ADDIE instructional design model.
4. Develop the online course, that is, upload the activities and resources to the platform, putting the didactic proposal online, necessary to carry out in the B-Learning modality. This can be implemented on various learning platforms: Teams, Moodle, or Classroom, based on the ADDIE model and CONOCER standard 366.

This document has the following structure: A research methodology is considered in section II, where the ADDIE model and CONOCER standard 366 are used to evaluate the proposal in general. In section III, we detail the development of the proposal, mentioning the products generated in each phase of the ADDIE model and standard 366, that is, our results. Finally, we provide some conclusions in section IV.

II. Research Methodology

The ADDIE model is a structured and systematic methodology used in instructional design, consisting of five phases: Analysis, Design, Development, Implementation, and Evaluation. This model is widely recognized for its ability to create effective training programs tailored

to the needs of learners. In this paper, we will apply an educational research methodology to evaluate and improve the implementation of the ADDIE model.

II-A. Analysis Phase

The analysis phase is crucial for identifying learning needs and specific objectives. In this stage, information is gathered about the learners, the training context, and the available resources. The research methodology in this phase may include:

- According to the TECNM educational model for distance education, "the programmatic content of the subjects, the competencies and their structure in the curriculum, as well as the characteristics of the students, must be analyzed to identify specific teaching needs and subsequently design a plan in the teaching guide to best meet them".

II-B. Design Phase

The design phase uses the information generated in the analysis phase as input. This means that, based on a review of the program content and its classification and dosage, as well as an analysis of the characteristics of students in the distance learning modality and the professional skills they must acquire, the subject-specialist teacher, supported by the instructional designer, defines the strategies that will lead to the achievement of the skills established in the corresponding study program. The following are then designed:

- Teaching and learning strategies, as well as assessment strategies, are designed to determine the level of achievement, even remotely.
- Instruments are also designed to assess the evidence that students must submit as a result of the learning activities. The product generated in the design phase is the teaching guide/instrumentation.

In conclusion: This stage determines the objectives and tools that will be used for content transfer, focusing on learning objectives, content, content analysis, practical exercises, lesson planning, assessment tools to be used, and the selection of technological media to support learning.

II-C. Development Phase

The development phase begins the production and testing of the methodology used in the project. In this phase, designers draw on the data collected from the previous two stages and use this information to create a program that will convey what is to be taught

to participants. This phase includes three tasks: development, production, and evaluation. Therefore, development involves the creation and testing of learning outcomes.

– In this phase, the digital resources planned in the design phase are developed. The TECNM methodology establishes that these resources can include videos, electronic presentations, activities and assessment tools, mind or concept maps, podcasts, learning objects, exercises, and animations, among others, covering the different topics that comprise the course.

The material developed must be engaging and impactful to keep students motivated and foster their interest in learning more about the subject, fostering self-directed learning and teacher-guided learning through virtual or complementary environments.

II-D. Implementation Phase

The developer and instructional designer must redesign, update, and edit the course to ensure the transfer of knowledge expected in the previous objectives.

– All materials resulting from the development phase are implemented on the educational platform, and the appropriate learning environment is established to achieve the competencies defined in each subject, that is, to implement the instructional design efficiently and effectively in the media selected for dissemination.

II-E. Evaluation Phase

This is the final phase of the ADDIE method and is where the project undergoes final testing. This phase can be divided into two parts: formative and summative.

– The training phase takes place while students and faculty are conducting the course. Initial formative assessment will be conducted using online course design assessment tools and can be performed by an academic peer. During the course, formative assessment will be administered to students using closed questionnaires primarily to assess the prerequisite content. It will only have a minimum score, as otherwise, the student may fail to complete the questionnaire.

– While the summative portion occurs at the end of the program, it will be conducted at the end of the unit to assess student learning from the various pieces of evidence presented.

The application of an educational research methodology to the ADDIE model allows for rigorous evaluation and continuous improvement of instructional design. By following the phases of the model and utilizing various research techniques, instructional designers can

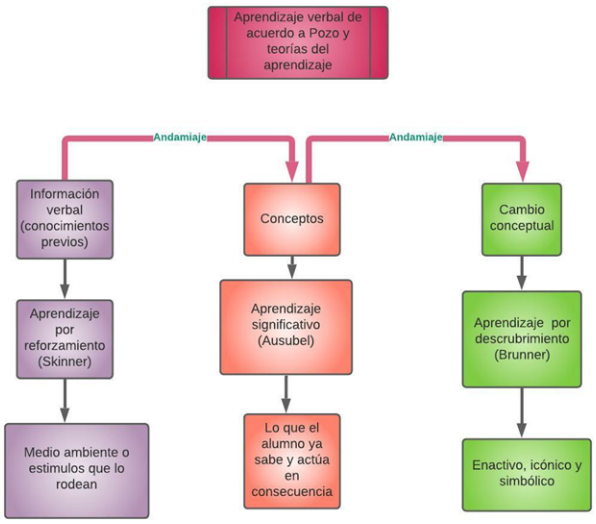


Figura 1. Verbal Learning and Learning Theories

create training programs that are effective, relevant, and tailored to the needs of learners. The ADDIE model will be complemented by CONOCER's 366 standard to evaluate the proposed course in the B-Learning modality, and will be addressed in detail in the proposal in section III.

III. Results (Development of the Proposal)

The proposal of this work encompasses the phases of the **ADDIE** model, complemented by **CONOCER's standard 366** and the learning outcomes suggested by Pozo (3). **ADDIE** was applied as follows:

III-A. Analysis

An analysis was conducted of the subject content (course syllabus), competencies and curriculum placement, student characteristics, learning theories, and online education modalities, suggesting a blended or combined approach (B-Learning).

For this work, the aim is to approach verbal learning at the levels of: verbal information, concepts, and conceptual changes (see Figure 1), and procedural learning at the levels of: techniques, strategies, and learning strategies (see Figure 2) according to the learning theory suggested by Pozo (3) to subsequently determine the instructional design.

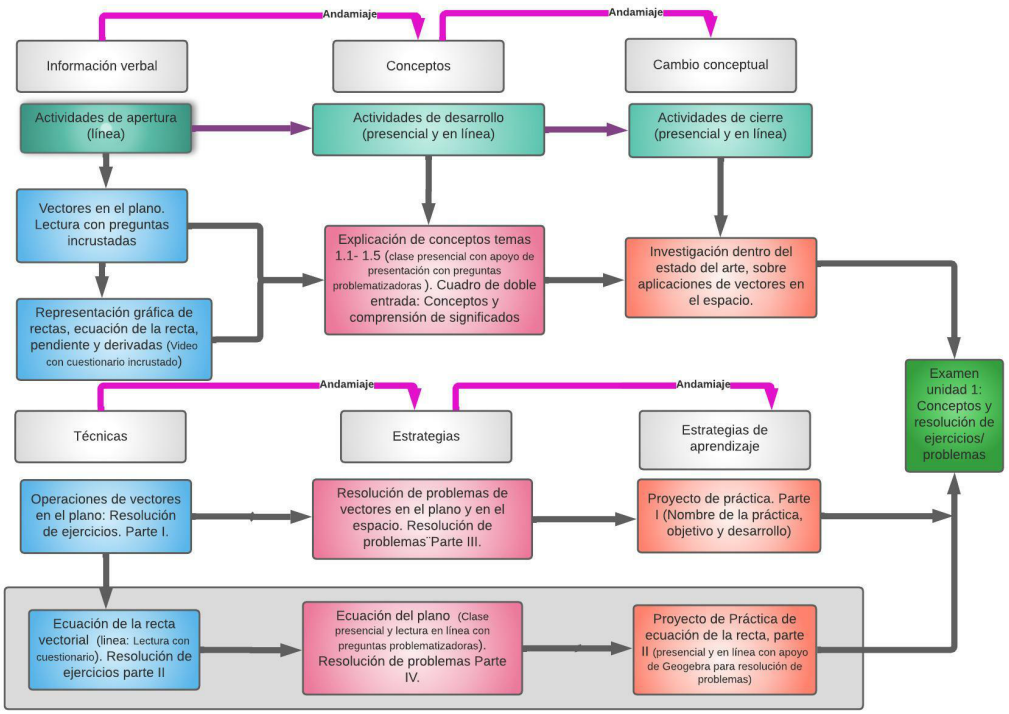


Figura 3. Verbal/Procedural Learning Unit 1 of Vector Calculus

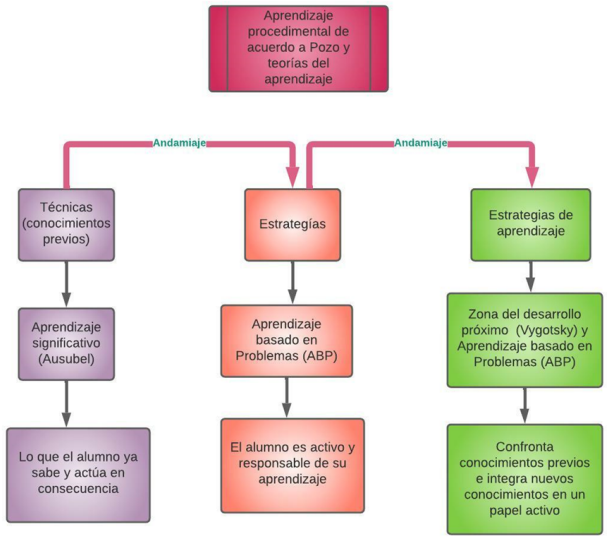


Figura 2. Procedural Learning and Learning Theories

Our interpretation of the verbal and procedural learning suggested by Pozo (3) for Unit 1 of Vector Calculus (5) (5, p. 79), and in accordance with the Analysis phase, is graphically shown in Figure 3. This analysis will serve as the basis for the next phase.

III-B. Design

Based on the information generated during the analysis, it is classified and organized according to the course syllabus to be developed. Complemented with **Standard 366**, this results in the schedule or **instructional guide** (instrumentation) and the **general course information document**. During this phase, teaching and learning strategies are defined, as well as the evaluation tools that will be used to assess learning evidence. Additionally, the technological means to support learning are specified. All these elements are included in the **instructional guide** or schedule aligned with both the **ADDIE** model for online education and **Standard 366** of **CONOCER**. The complete instructional guide can be downloaded (in Spanish) via the following hyperlink: https://drive.google.com/file/d/1BRFtnVHj33F5kFireanR2olZ3KsqQbiB/view

In conclusion, this phase of the **ADDIE** model is complemented by element 1 of 3 of the **CONOCER standard 366**, which suggests the following:

Element 1 of 3. Plan the development of the online training course. According to **CONOCER**, the products obtained are:

- ◇ The **schedule** for the development of the online course prepared. This is equivalent to the **guide/instructional materials** already completed
- ◇ The general information document for the online course. This document can be consulted online at the following link:: https://drive.google.com/file/d/1EbrZF4-474etaR2cUDN0XmEB9RwK-Ixa/view

III-C. Development

This phase includes three tasks: development, production, and evaluation. In this phase, the digital resources planned in the design phase (teaching guide) are developed: videos, electronic presentations, activities and assessment tools, mind or concept maps, learning objects, exercises and animations, etc., covering the different topics that comprise the course and in accordance with **CONOCER Standard 366**.

In this phase of **ADDIE**, it is complemented by **Standard 366**, specifically in element 2 out of 3, where the instructional design is incorporated into the activity guide. The activities are developed in alignment with the previously described learning theories and the learning outcomes established by Pozo (3).

Element 2 of 3. Developing the content for the online training course.

According to **CONOCER**, the resulting products are:

◇ The **activity guide** for each unit of the online training course designed. It can be accessed at the following hyperlink: https://drive.google.com/file/d/1uI-LLWpU8oNby3qC8JAW7IuB22mHq2KJ/view

◇ The established **general activity schedule**. It can be accessed at the following hyperlink: https://drive.google.com/file/d/1qJ1rwOOcCKGgHbb9DTSFDwL0iodzJgKX/view

◇ The text document prepared. It can be accessed at the following hyperlink: https://drive.google.com/file/d/1akiSROgOSx8-LuJ8_N9ll4R8YELC0ODM/view

◇ The electronic presentation created.

◇ The multimedia material developed.

◇ The evaluation instrument for learning created.

III-D. Implementation

This phase involves transferring all the materials produced during the development phase onto the educational platform and establishing the appropriate learning environment to achieve the competencies defined for each course. In other words, it is about efficiently and effectively executing the instructional design through the selected media for dissemination, as illustrated in the example of Figure 4. This phase is complemented by **Standard 366** of **CONOCER**, specifically in element 3 out of 3.

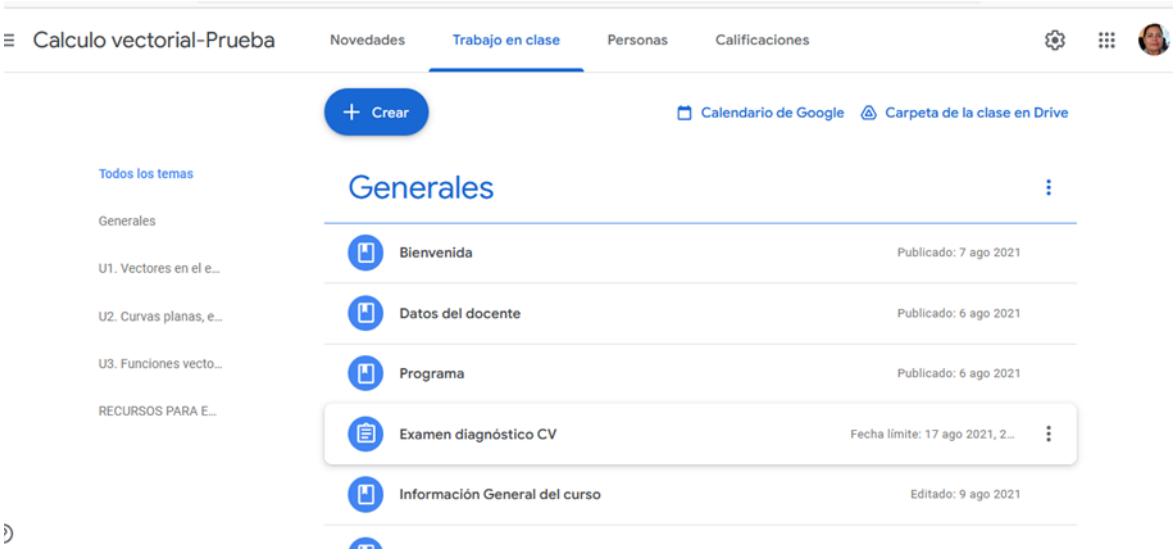


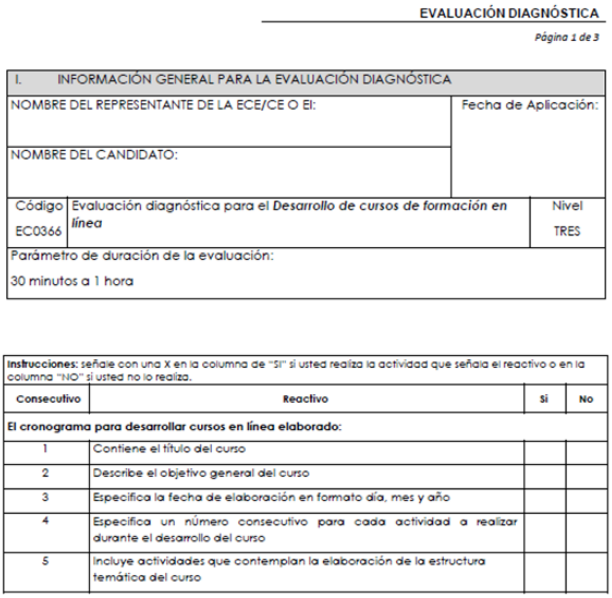
Figura 4. Example of a Vector Calculus Course implemented in Classroom.

Element 3 of 3. Verifying the functionality of the course on the educational platform. The product is:

◇ The report prepared for the review of the functionality of the online training course.

III-E. Evaluation

This stage is carried out at the beginning to assess the structure and resources of the course implemented on the platform (formative evaluation). Checklists are used for the resources established in Standard 366 of CONOCER, which online courses must have, according to the documents: E1Diagnóstico EC0366.pdf, E2Diagnóstico EC0366.pdf, and E3Diagnóstico EC0366.pdf, corresponding to Figures 5, 6 and 7, respectively. The complete documents can be accessed at the following link:
https://drive.google.com/drive/folders/1xwGLSFUFcmWxKos_74MVbhuFGcpN0Otg



EVALUACIÓN DIAGNÓSTICA

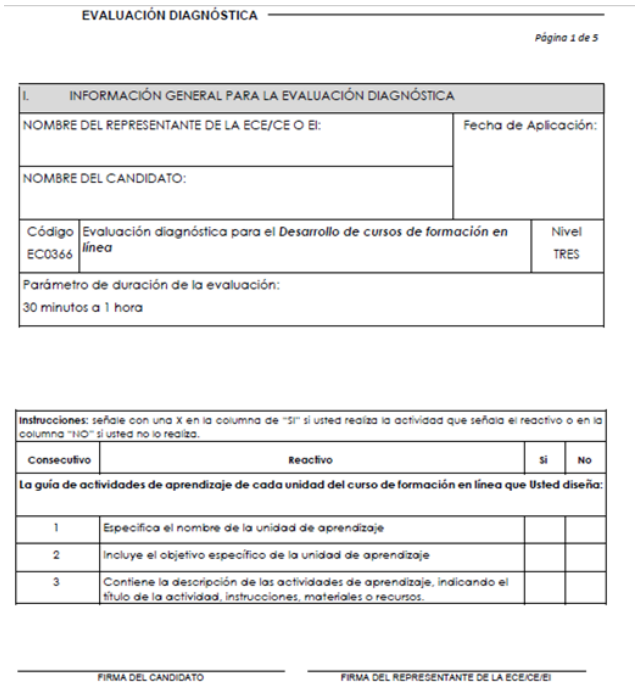
Página 1 de 3

I. INFORMACIÓN GENERAL PARA LA EVALUACIÓN DIAGNÓSTICA		
NOMBRE DEL REPRESENTANTE DE LA ECE/CE O EI:		Fecha de Aplicación:
NOMBRE DEL CANDIDATO:		
Código EC0366	Evaluación diagnóstica para el ***Desarrollo de cursos de formación en línea***	Nivel TRES
Parámetro de duración de la evaluación: 30 minutos a 1 hora		

Instrucciones: señale con una X en la columna de "SI" si usted realiza la actividad que señala el reactivo o en la columna "NO" si usted no lo realiza.

Consecutivo	Reactivo	Si	No
El cronograma para desarrollar cursos en línea elaborado:			
1	Contiene el título del curso		
2	Describe el objetivo general del curso		
3	Especifica la fecha de elaboración en formato día, mes y año		
4	Especifica un número consecutivo para cada actividad a realizar durante el desarrollo del curso		
5	Incluye actividades que contemplan la elaboración de la estructura temática del curso		

Figura 5. Development of the online course. Step 1. (Source: **CONOCER**)



EVALUACIÓN DIAGNÓSTICA

Página 1 de 5

I. INFORMACIÓN GENERAL PARA LA EVALUACIÓN DIAGNÓSTICA		
NOMBRE DEL REPRESENTANTE DE LA ECE/CE O EI:		Fecha de Aplicación:
NOMBRE DEL CANDIDATO:		
Código EC0366	Evaluación diagnóstica para el ***Desarrollo de cursos de formación en línea***	Nivel TRES
Parámetro de duración de la evaluación: 30 minutos a 1 hora		

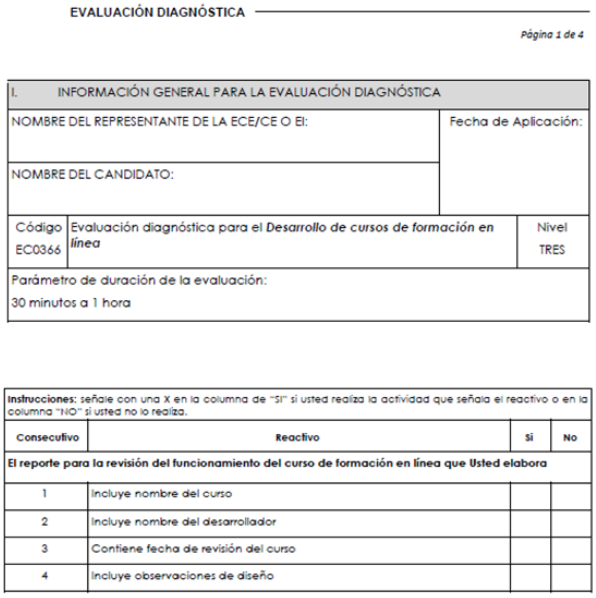
Instrucciones: señale con una X en la columna de "SI" si usted realiza la actividad que señala el reactivo o en la columna "NO" si usted no lo realiza.

Consecutivo	Reactivo	Si	No
La guía de actividades de aprendizaje de cada unidad del curso de formación en línea que Usted diseña:			
1	Especifica el nombre de la unidad de aprendizaje		
2	Incluye el objetivo específico de la unidad de aprendizaje		
3	Contiene la descripción de las actividades de aprendizaje, indicando el título de la actividad, instrucciones, materiales o recursos.		

FIRMA DEL CANDIDATO

FIRMA DEL REPRESENTANTE DE LA ECE/CE/EI

Figura 6. Development of the online course. Step 2. (Source: **CONOCER**)



EVALUACIÓN DIAGNÓSTICA

Página 1 de 4

I. INFORMACIÓN GENERAL PARA LA EVALUACIÓN DIAGNÓSTICA		
NOMBRE DEL REPRESENTANTE DE LA ECE/CE O EI:		Fecha de Aplicación:
NOMBRE DEL CANDIDATO:		
Código EC0366	Evaluación diagnóstica para el ***Desarrollo de cursos de formación en línea***	Nivel TRES
Parámetro de duración de la evaluación: 30 minutos a 1 hora		

Instrucciones: señale con una X en la columna de "SI" si usted realiza la actividad que señala el reactivo o en la columna "NO" si usted no lo realiza.

Consecutivo	Reactivo	Si	No
El reporte para la revisión del funcionamiento del curso de formación en línea que Usted elabora			
1	Incluye nombre del curso		
2	Incluye nombre del desarrollador		
3	Contiene fecha de revisión del curso		
4	Incluye observaciones de diseño		

Figura 7. Development of the online course. Step 3. (Source: **CONOCER**)

In summary, according to our proposal; the integration of the ADDIE model, standard 366, and the learning outcomes can be seen in Figure 8:

Figura 8. Integration of the ADDIE Model, standard 366, and learning outcomes from Pozo (3). (Source: Own authorship)

An example of application, integrating both the **ADDIE** model, the **CONOCER standard 366**, and the learning outcomes suggested by Pozo (3), is shown in Figure 9:

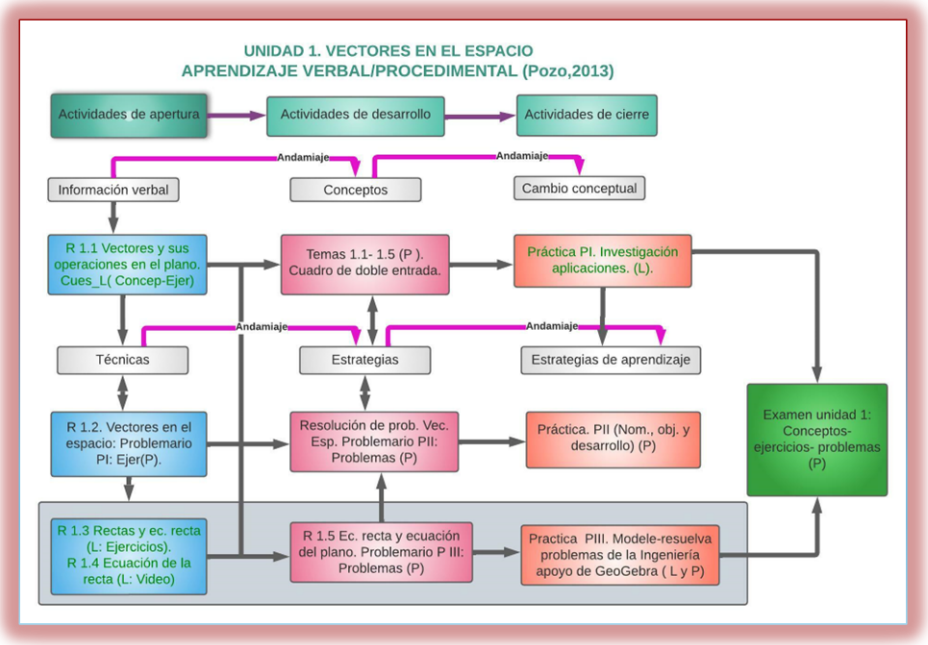


Figura 9. Verbal/Procedural Learning Topic of Vector Calculus. (Source: Own authorship)

IV. Conclusions

With this proposal, we aim to establish a prototype for the development of instructional instrumentation, supported by the **ADDIE** instructional design model, **Standard 366 of CONOCER** for the development of online training courses, and Pozo's **three-component learning system**: analysis of learning outcomes or objectives, establishment of cognitive mechanisms in learning processes, and planning of learning conditions. These components are, in turn, grounded in various **learning theories**. Certainly, those who choose to implement this proposal will achieve improved educational quality.

All materials—including the instructional guide, general documents on the selected topic, detailed activity guide, activity schedule, anthology of the topic, and various evaluation documents—are freely available for download from the web. This clearly promotes the formal implementation of courses in B-Learning mode.

Referencias

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