

The effectiveness of a course taught in the flipped classroom modality**La efectividad de un curso impartido en la modalidad de aula invertida**

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Abstract

The purpose of this research was to determine, through the Kirkpatrick and Kirkpatrick evaluation model, the effectiveness of a course taught in the flipped classroom modality to students of Information Technology Engineering at a Technological University in Mexico. This model comprises four levels for measuring the effectiveness of a training program: satisfaction, learning, applicability and results. To carry out the present study, a methodology with a quantitative approach and a quasi-experimental design of a group with measurement before and after, without a control group, was used. To measure the level of learning, the group was evaluated by a pre test starting the course and by a post test after finishing it. To measure the levels of satisfaction, applicability and results, Likert-type questionnaires were administered. The results showed that the level of satisfaction of the course participants was 86.6%. Regarding the level of learning, it was found that students improved their learning by 25.3%. Regarding the applicability, 86.5% was obtained, while 89.2% was reached for the level of results. In conclusion, it was possible to conclude that the course taught in the flipped classroom modality was effective.

Effectiveness, Flipped classroom, Kirkpatrick's model

Resumen

El propósito de esta investigación fue determinar, mediante el modelo de evaluación de Kirkpatrick y Kirkpatrick, la efectividad de un curso impartido en la modalidad de aula invertida a alumnos de la Ingeniería en Tecnologías de la Información de una universidad tecnológica de México. Dicho modelo comprende cuatro niveles para la medición de la efectividad de un programa de formación: satisfacción, aprendizaje, aplicabilidad y resultados. Para realizar el presente estudio se empleó una metodología con enfoque cuantitativo y un diseño cuasi-experimental de un grupo con medición antes y después, sin grupo de control. Para medir el nivel de aprendizaje, el grupo fue evaluado mediante una prueba antes de iniciar el curso y después de finalizarlo. Para medir los niveles de satisfacción, aplicabilidad y resultados se administraron cuestionarios tipo Likert. Los resultados demostraron que el nivel de satisfacción de los participantes del curso fue del 86.6%. Respecto al nivel de aprendizaje, se comprobó que los estudiantes mejoraron su aprendizaje en un 25.3%. En cuanto a la aplicabilidad, se obtuvo un 86.5%, mientras que se alcanzó un 89.2% para el nivel de resultados. Como conclusión, se pudo concluir que el curso impartido en la modalidad de aula invertida fue efectivo.

Efectividad, Aula invertida, Modelo de Kirkpatrick

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Introduction

With the advent of Information Technologies in the classroom, several new teaching methodologies have emerged in higher education, which are, according to Aznar and Romero (2018), e-learning, blended learning, flipped classroom and mobile learning. All of them are characterized by the active role of the student and self-regulated learning (Chaves, Trujillo & López, 2016). If nowadays, both students and teachers are immersed in a society in which the applications of technological development impact the way in which teaching and learning take place, it is necessary to take advantage of this trend and raise the need to change traditional teaching methodologies for a new approach called flipped classroom (Reyes, Dzul & Melken, 2019).

The research problem

In this sense, in a technological university in Mexico, located in Nuevo Vallarta, Nayarit, the professional career of Information Technology Engineering is offered. Recently, in 2018, the curriculum of that academic program was updated, thus replacing Plan 2009 (A. Ochoa, personal communication, 2018). With this update, the number of hours of the Database course, which is taught in the second quarter, was reduced from 6 to 4 hours per week. This is equivalent to a reduction from 90 to 60 hours per four-month period, considering that the four-month period has a duration of 15 weeks (CGUTyP, 2009, 2018).

It is relevant to take into account that, although there is a reduction of 30 hours per quarter, the 2018 curriculum generally retains the same thematic content, although reorganized with respect to the 2009 curriculum. In fact, the learning objective of the Database course in the 2018 curriculum is literally the same as the corresponding one in the 2009 curriculum. It should be noted that, in the case of this technological university in Mexico, the study plans and programs are dictated by the General Coordination of Technological and Polytechnic Universities, through the Subdirection of Educational Programs (CGUTyP, n.d.).

For the professors who are members of the Information Technology Academy, the reduction in the number of hours in the Data Base course is considerable and casts doubt on the students' achievement of the learning objectives. According to this collegiate body, the programmatic progress, from the outset, is affected by holidays, and sometimes by extraordinary situations such as bad weather, official events, teacher's commissions, among others (Academy of Information Technologies, 2019a).

To issue its deliberation, the academy took into consideration the final report of the course taught (Avila, 2019a), which was sent to the Academic Program Direction by the professor who taught the course Database in the January-April 2019 term. In said report, the academic refers to the time limitations faced by the course to achieve the objective indicated in the program. Another of the elements analyzed by the collegiate body was the teaching evaluation answered by the students who took the referred course during the January-April 2019 term. In the results of this evaluation, the students expressed several comments that revolve around the fact that they felt that the weekly time dedicated to the subject was not enough and that they would have preferred to have more hours of this class (Academy of Information Technologies, 2019b).

In this regard, the IT Academy has determined that there is a need to compensate for the number of hours that were reduced. Once the issue was discussed by the members of the collegiate body, the conclusion was reached to use the inverted classroom model in the delivery of the Database course and that it is necessary to evaluate its effectiveness in order to validate the initiative and eventually propose to the university administration its extension to other subjects of the same program or even to that of other educational programs.

Background and justification

According to Avila (2019b), in 2010, some professors of the Technological University of Mexico, obtained unsuccessful results when trying to teach online two subjects of Information Technology Engineering.

As a subsequent initiative to assess the conditions to offer online courses, in 2012, a study was conducted that showed that there was a favorable context for students to start studying some courses in the virtual modality (García, et al., 2012). Based on what was indicated by the study conducted in 2012, in the following years 2013, 2014 and 2015 some subjects of the professional career of Information Technology Engineering were taught using a mixed model, i.e., mixing face-to-face and virtual activities. During that time, no formal or systematic evaluation of the results of this initiative was carried out.

It was until 2019, when Avila (2019b) conducted a scientific research work to evaluate the effectiveness of a Database course taught in the blended learning modality in Information Technology Engineering. The study was based on Kirkpatrick and Kirkpatrick's (2009) evaluation model and the conclusion obtained indicated that the blended learning course was effective. Although Avila's (2019b) research is a serious and rigorous study that proves the effectiveness of the blended learning modality, it is necessary to corroborate whether the inverted classroom model is also effective. This is because, although both approaches have similarities, they have a marked difference in that in the inverted classroom the explanations of the contents are addressed strictly outside the classroom and the implementation is done inside the classroom, a condition that does not necessarily occur in the blended learning model.

To address the above need and also with the aim of complementing the number of teaching hours of some subjects, the Academy of Information Technologies, through its president (H. Gerardo, personal communication, July 08, 2019) has expressed the urgency of knowing the effectiveness of a blended learning course attached to the characteristics of an inverted classroom. This concern becomes more relevant when knowing that one of the work prospects that resulted from the systematic review of the literature conducted by Hinojo, Aznar, Romero and Marín (2019) is to continue investigating the effect of the inverted classroom on the learning of students at the higher education level, since, according to the same authors, this approach is being placed as an educational trend.

Making a comparison of the syllabus of the Database subject plan 2018 versus plan 2009, with respect to the number of total hours of the course, it can be noticed that there is a deficit of 30 hours, going from 90 to 60 hours per four-month period. However, the learning objective remains the same "the student will perform the design, creation and manipulation of relational databases through the requirements established for information management".

Referring to the above, in one of the meetings held by the Academy of Information Technologies, the professors of said collegiate body discussed the risk of the student not reaching the level of competence in Databases due to the drastic reduction in the number of teaching hours of the course. The Academy minutes were recorded a point of agreement urging the use of the inverted classroom model to compensate the study time of the thematic contents of the subject Database (Academy of Information Technologies, 2019a).

Definition of Terms

Inverted classroom. It is an academic strategy, based on learning with online videos and tutorials, commonly viewed outside the classroom; what was previously referred to as an assignment to work at home, is performed during class time, while the explanation is provided outside the classroom (Santiago & Bergmann, 2018).

Effectiveness. It is the impact of learning evaluated through objectives that serve as a reference to make comparisons in obtaining concrete results (Armenta, 2019).

Satisfaction. It is the attitude presented by students regarding the course (Kirkpatrick & Kirkpatrick, 2009).

Learning. It is defined as the point at which students show a transformation through the expansion of their knowledge, their skills, which is the result of the formative action that the teacher provides in each of the sessions.

Application. It refers to the usefulness that a course has on the participant, seen as a transfer of knowledge (Kirkpatrick & Kirkpatrick, 2009).

Outcomes. It is the impact due to the behavior demonstrated by the student participant. It can also be defined in relation to the final results shown by the learners when the course culminates (Kirkpatrick & Kirkpatrick, 2009).

Purpose of the Study

The purpose of this research work is to determine, through Kirkpatrick and Kirkpatrick's evaluation model, the effectiveness of a course taught in the inverted classroom modality to students of the Information Technology Engineering educational program, specifically in the subject of databases, at a technological university in Mexico.

Literature review

In modern times, there is a range of possibilities for teaching a class (Velazco, Bojórquez and Armenta, 2009). The use of innovative strategies as a learning strategy can generate positive results in the short and medium term in a classroom.

The need that exists in higher education institutions (HEIs) to improve educational practices is closely related to innovation (Ríos, 2009), and in the Mexican educational context, the teaching-learning scheme has been based solely on the transmission of knowledge (Romo, 2011).

The fact of teaching a different and innovative class in the classroom allows student learning and the integral development of the teacher. According to data from ANUIES (2002), renewing and changing the pace of teaching helps to enhance the skills, competencies, abilities and above all the student's interest in the classroom.

In order to provide better educational practices in Mexican universities, a work methodology is introduced. In 2006, the concept of inverted learning appeared (Bergmann and Sams, 2017). Since then it has gone through several stages of development, however, the original concept was always the inverted classroom. In this approach, the teacher was at the center of instruction.

Later the concept changed to inverted domain model, but still focused on the teacher, and the transfer of knowledge. The advantage it had after several applications, is that it managed to consider the learning pace of the students, and the didactic contents were adapted to the needs of the students (Bergmann and Sams, 2017).

Some time later, when the concept was modified to inverted learning, the student was already the center of the classroom and, therefore, the instructional and learning strategies were already implemented with a specific objective: to generate deep and lasting knowledge in the learner (Sams and Bergmann, 2013). These authors suggest that the teacher should not be the center of instruction, and that idea changed the learning processes that are learner-centered. Under these premises, teachers are the providers of meaningful and quality learning.

Learning problems have been studied for decades, and according to Martínez and Nortes (2014), Sánchez, Segovia and Miñán (2011), the triggering factors of these problems are derived from anxiety and mostly towards the attitude of the classes. This causes low performance in students and, therefore, failure. Faced with this situation, the need to implement changes in the traditional ways of giving a lecture is born. Under the traditional schemes in which we have worked, it is required to innovate with methodologies that drive the student to meaningful learning, and as a consequence, a higher rate of academic performance (Moya and Williams, 2016). In the same way, Parr and Fung (2000), agree that academic performance can be increased as technology is used and, above all, in the pedagogical techniques appropriate for the group.

Moya and Williams (2016), make a proposal for innovation, which was considered an educational model, assisted by technology, which is currently called flipped classroom, or as in English it is called flipped classroom. The idea of this flipped classroom model has its origin in the delivery of digital content at a distance, either by a platform, page, email or similar, highlighting the collaborative work in the classroom.

Flipped classroom

The origin of an inverted classroom began with the initiative of Bergman and Sams (2012), chemistry teachers, who consolidated the term flipped classroom, and it is known as inverted classroom. They proceeded with this method, trying to achieve a general objective, which was to keep students, who for various reasons were absent from class, to take the same orientation as those who could attend, and none were affected by lack of knowledge and/or absence. To achieve this result, they decided to document the contents of the subjects with software that allowed them to record the presentations and narrations in power point to share with the students.

Over time, they realized that the material was not only used by students who could not attend the sessions, but the students who did attend, used them as a tool to review the lessons (Berenguer, 2016). Thus, they began to reverse their teaching methodology, sharing videos of the sessions for students to review them at home before class, and using class hours to generate and solve projects where the knowledge acquired with the videos was evidenced, in addition to resolving doubts in case they existed.

According to Bergmann, Sams, Daniels, Bennett, Marshall and Arfstrom (2014), who are the main leaders of flipped learning in the classroom, consider it as a pedagogical approach, where learning begins collectively and concludes in individual learning, where the path is characterized by being dynamic and interactive when applying the contents learned and when working in class hours. For their part, Santiago, and Bergmann (2018) point out that it is an academic strategy, based on learning with online videos and tutorials, commonly watched at home; what was previously referred to as a homework or assignment to work at home, is done in class time, while the explanation is provided outside the classroom.

It is of vital importance to highlight the importance of this teaching model, since the student learns to work in an autonomous way, however, he/she does not do it alone, since he/she is accompanied by the teacher.

What is different from traditional learning methodologies are the roles played by each of the authors, since the student actively participates in his own learning (Berenguer, 2016).

Four pillars of the flipped classroom

Bergmann et al. (2014), state that, frequently, teachers refer to the inverted classroom as working at school at home, and the work at home at school, which is also correct, but inverted learning is a perspective where the teacher can apply different methodologies in the classroom, according to the context and characteristics of the students. To achieve favorable results, the aforementioned authors propose four pillars of the inverted classroom for its appropriate practice:

Flexible environment. When implementing flipped learning, it implies the inclusion of a range of learning procedures and strategies. Likewise, the teacher adapts the learning space according to the competencies, learning and skills he/she wants the student to acquire, in order to promote collaborative and individual work.

Learning culture. In the original teaching and learning models, the focus was on the teacher (Ferreiro, 2010). Now, with this type of instruction, the focus is on the student and his or her needs, and the time spent in the classroom is used to generate experiences to achieve meaningful learning.

Content directed. The teacher constantly seeks strategies to strengthen the students' knowledge and support the development of conceptual understanding and ease in the learning process. The teacher makes a selection of what the student needs to learn and explore on their own, and it is the teacher who directs the content, time and materials in order to optimize the academic resources at their disposal and achieve their goal.

Professional facilitator. The professional role of the teacher working with the inverted class methodology demands more time for the elaboration of the material to be distributed, as well as the planning and execution of activities that the student will carry out in the class sessions, in addition to the continuous and close follow-up provided to the student.

Although it may be perceived that a professional facilitator plays a less prominent role in a flipped classroom, they are the fundamental component to give rise to flipped learning.

For his part, Calvillo (2018), proposes a table containing the description of each of the pillars, in addition to a series of indicators associated with each pillar, where specific activities that the teacher, who implements the inverted classroom methodology, commits to execute are detailed. From the four pillars, 11 indicators emerge, which can also be used as compliance indicators.

Flipped Class Methodology

The way in which the flipped classroom is carried out, unlike the traditional methodology, is that the time dedicated by the teacher to develop the topics and contents of the class program, is left to the judgment of the student, who applies a constructivist vision on the flipped classroom (Serrano and Pons, 2011), which will be converted into knowledge, built by the student, owners of their learning process.

This methodology was proposed as a strategy to improve the stimuli to the student, with the main objective of strengthening the competence of student autonomy. According to Moya and Williams (2016), it also contributes to the development of: (a) organizational skills; (b) planning skills; (c) communication skills; (d) decision-making skills.

With the inverted classroom methodology, the student becomes the protagonist of his or her own learning, which is reflected in his or her academic performance. This is presented as a contribution focused on educational quality in higher education (Madrid, Angulo, Prieto, Fernández, & Olivares, 2018). To this end, Moraros, Islam, Yu, Banow, Schindelka, (2015), Angelini, García (2015) and González, Jeong, Airado, and Cañada (2016) agree on a series of steps, which they call a 10-step methodology for a flipped classroom:

1. Programming. At the beginning, the learning objectives should be defined and outlined, as well as the competencies that students should develop with the didactic content. Moraros et al. (2015) recommend a broad search for resources that can be attractive to students from the moment they discover them, as this will motivate them to learn. An organized planning of each of the sessions is recommended, allocating the corresponding assignments before, during and after the sessions.
2. Preparation of material. It is vitally important to prepare the materials that will be used for the explanation and, above all, the understanding of the topics. Gonzáles et al. (2016) recommend that the material can be own and unpublished content, although it could also be a video collection, presentations, informative clips, learning objects, and other digital tools for the student to make the knowledge his own. It is also important to include an evaluation that validates the knowledge acquired by the student.
3. Review of the material at home. The didactic material elaborated or selected should be sent to the students, so that they can learn and review the subject at home. They should be asked to complete the questionnaires or reading control mechanisms and/or activity to share and express when they have doubts.
4. Plan class sessions. The sessions should be planned with materials and/or exercises elaborated according to the doubts expressed by the students. Angelini and García (2015) indicate that activities should be developed and selected individually or in groups, in order to meet the heterogeneity of the class. In addition to including collaborative activities to strengthen active and collaborative learning in the student (Ferreiro, 2010).

5. Solution of doubts. To work with this methodology, it is important to dedicate the first minutes of class to review the work control instruments such as questionnaires and/or essays and/or exercises, in order to clarify doubts about the topics. The promotion and encouragement of student participation in the classroom should be considered.
6. Strengthening of the activities. The knowledge acquired in the previously designated activities should be strengthened. The areas of opportunity of each student can also be detected and work with them according to their specific needs.
7. Collaborative work. According to Ferreiro (2010), to promote collaborative work, not only one session is not enough, but two to four sessions should be dedicated, since the student will be challenged to solve problems, develop projects, generate their learning through experiments, participate in debates, and it is the teacher who must guide them to the realization and mastery of each of these skills.
8. Study away from home. The teacher should encourage students to work in teams, beyond the classroom, generating collaborative work spaces with their classmates. It is also the teacher's role to provide guidance and supervision to avoid doubts that may cause the work to be truncated.
9. Verification and study. The work done by the student should be reviewed and shared with the entire class. They should be encouraged to express their perception of the work methodology, as well as their learning experience, to culminate resolving any doubts that may remain.
10. Evaluation and self-evaluation. The evaluation of the student should be through a rubric that contains the objectives and competencies to be acquired and that were proposed at the beginning of the class and/or topic. The evaluation can also be a self-evaluation, where they themselves issue a value judgment to the work they did, and in turn, exercise the co-evaluation with their peers. This will encourage them to develop critical and reflective thinking about their successes and areas of opportunity.

Designing a course

Each Higher Education Institution generates its learning programs and courses (ANUIES, 2012). For this, according to Romo (2011), interaction and flexibility are required, since the design of a course program and its respective class plan are two essential components to achieve success in the learning environment under any modality, whether face-to-face, blended or online.

When these components of interaction and flexibility are present, it can support the decrease, or even the elimination of procrastination in students, as well as other aspects related to this variable (Dominguez, Villegas and Centeno, 2014). Likewise, Ríos (2009), mentions that there should be a strong focus on the design of online courses, including daily and weekly structured assignments.

On the other hand, according to the indications of ANUIES (2012), interaction should encourage students and faculty to maintain a close relationship with respect to course materials and content. Likewise, flexibility should be encouraged within the activities and in the formation of work teams. In these cases, the use of the flipped classroom as a parallel strategy to face-to-face sessions generates positive effects on meaningful learning and understanding of academic content (Moya and Williams, 2016).

When designing an online course, or implementing activities such as the flipped classroom strategy, one is fostering student success, as one of the pillars in the improvement of existing education is being addressed (Cherif et al., 2019). Boiling, Hough, Krinsky, Saleem and Stevens (2012), question about the existing forms of online courses, as in some cases the expected result is not being obtained, and argue that new alternatives must be found.

Returning to the ideas of Ros and Rosa (2014), there are principles for an effective practice and design of blended courses, which will definitely contribute to the success of students in higher education. These are: (a) the promotion of contact between students and teachers; (b) the development of reciprocity and cooperation among students; (c) the stimulation of active learning; (d) the emphasis on the time of completion of activities; (e) clearly explaining the expectations of the course; and (f) respect for the diversity of student learning.

Evaluation Models Referent to the Transfer of University Education

Once the variables that are considered effective for virtual didactic content (Ocampo et al., 2014), it is important to review the approaches derived from formative plans, commonly called evaluation and development models. From the first point of view is that of Aramburuzabala (2013), who indicates that each educational institution indicates the formative approach and practice, since they generate their student training model according to their objectives, vision and mission.

On the other hand, Villar (1992), emphasizes the professional development models, which consider the knowledge, skills, abilities and above all the attitude of the teacher, which will be decisive in the development of the student during their professional training. It also proposes four types of treatment that the university professor can apply in the classroom:

1. Individual improvement, to locate and attend to the needs of all those involved in the educational act.

2. Evaluation for the improvement of teaching, for the feedback to the teacher himself, and to the student in his training process.
3. Inquiry, for reflection on educational practice.
4. Organization, in order to establish a specific training determined by the university.

In another sense, effectiveness is a topic that generates controversy in learning (Armenta, Zea, Abundis, & Quiroz, 2019), since the effectiveness and impact of learning can be closely related, because when effectiveness is evaluated, the objectives, established in the educational context, will serve as a starting point in making comparisons in obtaining concrete results (Armenta, 2019). When conducting evaluations of effectiveness and the desired impact on students, there is no perfect or optimal model in a consensual manner.

To date, one of the best known and most widely used models is Kirkpatrick (2007), in which he considers a series of study levels, which are: reaction, learning, behavior and, finally, results. The research application of these levels is as follows:

1. Reaction. This factor assesses the confrontation of students in their academic training, which is very similar to the evaluation of the satisfaction of a customer in a company, however, it is expected that students present a favorable attitude, since effective learning will depend on it, otherwise, there is no reason to justify learning.
2. Learning, which is defined as the point at which students show a transformation through the expansion of their knowledge, their skills, which is the result of the formative action that the teacher provides in each of the sessions.

With this type of evaluations, the acquisition of knowledge can be assessed in the classroom or virtually, with the use of virtual platforms, or computer content used for academic purposes. Also, what is expected to be evaluated are mainly three aspects, which are knowledge, skills and attitudes.

These three components will be decisive in their professional performance when facing situations that must be solved.

3. Behavior. This is seen as a transfer of knowledge, and can be determined through the change that the student demonstrates inside and outside the classroom, being a consequence of class attendance and their academic and professional training. Through behavior, an analysis is made of the information and usefulness of the course, subject and/or session for the participant.
4. Results. The result can sometimes be seen as an impact, due to the behavior demonstrated by the student participant. It can also be defined in relation to the final results shown by the students when the course ends. Within this, what is considered is the production generated, the contribution to knowledge, the quality of the knowledge itself, and the frequency with which the student participates in the activities proposed by the teacher.

In order to carry out an evaluation that contains these elements, it is necessary to consider one more level, because according to Armenta, et. al (2019), the course design must be functional, that is, effective, efficient and, above all, relevant. The elements that will make up the course must also be considered, as well as the impact it will generate on the user, which in this case is the student participant.

Chalmers (2012), on the other hand, takes Kirkpatrick's model as a reference, the same that must be answered in the design and training phase. The sole purpose is to choose the most appropriate learning strategies to generate impact on knowledge acquisition.

Research Questions

1. What is the level of satisfaction of the students with respect to the database course studied in the inverted classroom modality within the educational program of Engineering in Information Technologies of a technological university in Mexico?
2. What is the level of learning obtained by the students who studied the database course taught in the inverted classroom modality within the educational program of Engineering in Information Technologies of a technological university in Mexico?
3. What is the applicability of the knowledge and skills acquired by the students who studied the database course taught in the inverted classroom modality within the educational program of Information Technology Engineering of a technological university in Mexico?
4. What are the results obtained in the end-of-semester project by the students who studied the database course in the inverted classroom modality within the Information Technology Engineering educational program of a technological university in Mexico?

Methodology

The selected sample that was the object of this study consisted of eighteen students, who are regular students enrolled in group 2 "A" of the Information Technology Engineering program. The sample was determined through a non-probabilistic method, which consists of not selecting the participants at random. This is due to the fact that the composition of the groups was dictated by the School Services Office and the assignment of group 2 "A" to the professor who taught the course in inverted classroom mode was a decision made independently by the director of the educational program. In this sense, the researcher did not intervene in the selection of the sample, since it was the result of decisions beyond the researcher's control.

Instruments

To measure the level of satisfaction of the students with respect to the database course studied in the inverted classroom modality within the Information Technology Engineering educational program of a technological university in Mexico, the Questionnaire to Measure Satisfaction was used, which was obtained with the consent of its author, Dr. Correa (2013).

To determine the level of learning, a pre-test and post-test was administered that measured the knowledge and skills around the subject of Database before and after the experiment. This test consists of fifty items intended to measure the level of knowledge and skills acquired by the students in the Database course. This instrument was designed by Avila (2019), who granted permission for its use and application.

To measure the applicability of the knowledge and skills acquired, the Questionnaire to Measure the Applicability of Learning was applied, which is composed of seven pre-coded and closed questions, offering answers with an ordinal Likert scale. To determine the level of results obtained in the end-of-term project by the students who studied the database course in the inverted classroom modality, the Questionnaire to Measure Learning Results was used, which is made up of closed and pre-coded items, with Likert-type response options.

Procedure

The methodological approach of the present research was quantitative, which included a quasi-experimental study with a before and after measurement group, but without a control group. This design did not constitute in itself a pure experiment because the sample to be studied was an intact group of students previously constituted and does not come from chance. To develop this research it was necessary to carry out the following series of activities:

1. The researcher asked the director of the academic program for authorization to carry out the research in coordination with the head professor of the database course in inverted classroom modality.
2. Once the permission of the academic director was obtained, the purpose of the research and the techniques to be used to collect the data, as well as his role in this process, were explained to the professor of the course. It is important to mention that the professor was in charge of designing and teaching the course in the inverted classroom modality, leaving the researcher completely outside this activity.
3. Subsequently, the purpose of the research was explained to the students in the group and they will also be informed that they have been chosen as participants in the sample. The doubts raised by the students were resolved and finally they were asked to sign a written document expressing their consent to participate in the research.
4. At the beginning of the course, the pre-test was applied to the students, which consisted of answering the Test to Evaluate Learning on the digital platform of the course. The purpose of this test was to measure the notions about databases that the students had before attending the course.
5. The participating students attended the database course under the inverted classroom modality taught by the professor in charge of the course.
6. Before finishing the course, the students answered the post-test, which consisted of the same questions as the pre-test and which was also available electronically on the course's digital platform.
7. Then, the participating students answered the Questionnaire to Measure Satisfaction, which was available electronically through the OnlineEncuesta.com platform.
8. Once the students presented their end-of-course project, which consisted of the design and creation of a database for a point-of-sale system, they answered the Questionnaire to Measure the Applicability of Learning, which was available on the OnlineEncuesta.com platform.
9. Finally, the course instructor was asked to answer the Questionnaire to Measure Learning Outcomes once for each of the participating students. The instrument was accessible only electronically by accessing the OnlineEncuesta.com platform.

Results

Regarding research question number one, what is the level of satisfaction of the students with respect to the database course studied in the inverted classroom modality within the Information Technology Engineering educational program of a technological university in Mexico, it was observed that the students possess a degree of satisfaction of 86.6% on average, which is considered an acceptable percentage to represent the conformity of the group of students with respect to the database course taught in the inverted classroom modality. At the same time, it can be observed that the mode was 90.8%, a superior measure that supports the idea that the students were satisfied with the course.

The aspect of the course with which the students were most satisfied was that the Canvas learning system was adequate to deliver the course online. However, the aspects with which the students were least satisfied were the time distribution and relevance of the proposed exercises, as well as the course in general. According to Kirkpatrick and Kirkpatrick's (2010) model, a degree of satisfaction of 86.6% represents that the students reacted with a favorable attitude towards the database course taught in the inverted classroom modality and with the support of the Canvas technological platform. The above agrees with Bergmann and Sams (2012b) who state that one of the benefits of using the inverted classroom paradigm is that by distributing the class material through the various technological media, empathy and interest is generated in the contemporary student. In the same sense, there is a coincidence of the results with those reported by Ros and Rosa (2014), since their research reinforces the idea that the inverted classroom increases student motivation.

Regarding research question two, which asks what is the level of learning obtained by the students who studied the database course taught in the inverted classroom modality within the Information Technology Engineering educational program of a technological university in Mexico, the processing of the data obtained for the learning variable indicates that the group of students increased their level of knowledge and skills in databases from 38% to 63.3% of qualification in general.

This means an average improvement of 25.3%, which was statistically validated by means of the t student test to compare paired means starting from a significance level of 0.05. With this test it was ruled out that the difference between the grades obtained in the pre-test and post-test is a product of chance and it was confirmed that the learning obtained by the students in the database course is real and statistically proven.

The above finding is congruent with the results reported by Ros and Rosa (2014), who in their studies found that the inverted classroom method helps to improve student learning. It also coincides with what was reported by Moya and Williams (2016), who stated that the use of the flipped classroom as a parallel strategy to face-to-face sessions generates positive effects on meaningful learning and understanding of academic content.

Research question number three deals with what is the applicability of the knowledge and skills acquired by students who studied the database course taught in the inverted classroom modality within the educational program of Information Technology Engineering at a technological university in Mexico? In this regard, the participating students stated that they had achieved a level of application of what they had learned equal to 86.5%. In addition, it should be noted that half of the students rated the applicability of the course above the average of the group in general, with 82.9% being the most repeated rating (mode).

It can be noted that the aspect most highly valued by the students was that the knowledge and skills acquired had application in their school, academic and/or professional environment, with 64.3% of the students "Totally agreeing" and 35.7% "Agreeing" with this statement. On the other hand, the element that received the least recognition from the students was the contribution of the course to improve the performance of their activities as members of the final project team.

Taking as a reference the effectiveness evaluation framework proposed by Kirkpatrick and Kirkpatrick (2010), the result obtained of 86.5% regarding the level of applicability can be understood as a positive change in the student's behavior, demonstrated inside and outside the classroom as a consequence of the implementation of the competencies acquired during the database course taught under the inverted classroom modality. The above, keeps some coincidence with what was found by Moya and Williams (2016) in the sense that the inverted classroom model contributes to strengthen the competence of student autonomy in the development of organizational, communication, planning and decision making skills.

Regarding research question number four, which asks, what are the results obtained in the end-of-semester project by students who studied the database course in the inverted classroom modality within the Information Technology Engineering educational program of a technological university in Mexico, positive results were obtained, since the level of results obtained by the students was 89.2% in general. In Kirkpatrick and Kirkpatrick's (2010) model, a score like the one achieved makes it clear that the database course taught in the inverted classroom modality generated a high impact on students. The above is in line with the contributions of Cherif et al. (2019), in relation to the fact that when activities such as the inverted classroom strategy are implemented, student success is being fostered, since one of the pillars in the improvement of existing education is being attended to.

In the results, it can be seen that, although the most frequent valuation (mode) was 100%, a little more than half (57.14%) of the students obtained a result lower than the sample mean. This means that four students were recognized with the maximum score by the teacher, while eight students obtained lower scores, located below the group average. Only two participants scored above the mean, but below 100%.

Regarding the aspects considered in the evaluation of the level of results, it should be emphasized that the most highly valued aspect was that the competencies developed by the student had an application in their school, academic and/or professional environment.

This is due to the fact that 85.7% of the students answered "Totally agree" and the remaining 14.3% answered "Agree". However, the aspect in which the students obtained a lower consideration in terms of the achievement of results was the one related to the usefulness of the course given in the student's personal development.

It is interesting to note that the outcome level was the one that received the highest rating in comparison with the other levels that make up Kirkpatrick and Kirkpatrick's (2010) referential framework, a fact that contradicts the assumption held by the same authors who state that as the level increases, it is more difficult to achieve the goals of the training program. It is likely that this inconsistency is due to the difference in the criteria used at the time of evaluating each level, since it is worth remembering that the applicability level was assessed by each of the participating students, while that of the results level was estimated by the course instructor.

Conclusions

The present research work revealed interesting results that provide information of great value for the community that makes up the technological university of Mexico. In the first place, its most important contribution is the generation of scientific knowledge on the effectiveness of the inverted classroom as a methodology for teaching courses. The knowledge obtained will be used as a supply to the university's rector to face the challenges of implementing changes in the traditional ways of teaching, since, according to Moya and Williams (2016), the inverted classroom constitutes an innovation proposal that drives the student to meaningful learning and, therefore, a higher rate of academic performance.

In addition, thanks to the present study it was possible that, within the professional career of Information Technology Engineering, a course was taught for the first time in the inverted classroom modality, during which, as Sams and Bergmann (2013) referred, the student was the center of the classroom and the instructional strategies aimed to generate in the learner a deep and lasting knowledge.

From the teaching perspective, this research implied a series of challenges for the course's head teacher since, as Bergmann and Sams (2017) warned, the students' learning pace had to be considered and the didactic contents were adapted to the students' needs.

According to the results, the database course taught under the flipped classroom modality satisfactorily achieved each of the four stages of Kirkpatrick and Kirkpatrick's (2010) model, which are satisfaction, learning, applicability, and outcomes. In this sense, it was concluded that the database course taught under the flipped classroom modality was effective.

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