Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

https://doi.org/10.23913/ride.v11i21.778

Artículos científicos

Evaluación de la consolidación de conocimientos de la anatomía radicular mediante el uso de realidad aumentada por alumnos del posgrado de Endodoncia de la UNITEC

Evaluation of the consolidation of knowledge of root anatomy using augmented reality by students of the Postgraduate Endodontics of UNITEC

Avaliação da consolidação do conhecimento da anatomia radicular por meio do uso da realidade aumentada por alunos do programa de pós-graduação em Endodontia da UNITEC

Carlos Fidelmar Andrade Mosqueda
Universidad Tecnológica de México – UNITEC México – Campus Marina-Cuitláhuac, México
eecarlosandrade@gmail.com
https://orcid.org/0000-0002-6764-7234

Resumen

Los esquemas educativos actuales cada vez se centran más en modelos basados en competencias y en el aprovechamiento de los recursos tecnológicos. Estos elementos propician que los roles de los alumnos, profesores y autoridades educativas vayan cambiando y adaptándose en beneficio de un mejor proceso de enseñanza y aprendizaje. Por ello, es importante investigar si los diseños instruccionales basados en los nuevos paradigmas educativos son funcionales en la enseñanza de las diversas asignaturas del área odontológica. Con la participación de 10 residentes del posgrado de Endodoncia de la Universidad Tecnológica de México, campus Cuitláhuac, se realizó un estudio cuasiexperimental, en donde se creó un rotafolio tipo libro acerca de la anatomía radicular. Por medio de investigación bibliográfica, los residentes recopilaron información e imágenes acerca del tema y posteriormente, con el uso de plastilina profesional, crearon modelos anatómicos 3D

que se transformaron en imágenes digitales por medio de un *software*; a continuación, esas imágenes se utilizaron para diseñar y crear el rotafolio de realidad aumentada. Para evaluar la consolidación de conocimientos se utilizó una evaluación diagnóstica *Knwoledge and Prior Study Inventory* (KPSI) antes de la actividad, y una evaluación sumativa al terminar su implementación. La prueba diagnóstica mostró que 60 % de los residentes iniciaron el posgrado con una categoría de conocimiento no consolidado. Después de implementar el diseño didáctico del rotafolio de realidad aumentada, creado por los alumnos con la guía y apoyo del docente, se observó que 90 % de los residentes alcanzó en su evaluación la categoría de conocimiento consolidado; finalmente, se aplicó la prueba estadística de chi cuadrado (X^2) para determinar si existía relación entre las variables analizadas. El resultado de la prueba arrojó que la implementación del rotafolio de realidad aumentada impactaba en la consolidación del conocimiento de la anatomía radicular. En conclusión, los resultados obtenidos mostraron que incorporar los nuevos modelos educativos basados en competencias y nuevas tecnologías es favorable para la consolidación de conocimientos y aprendizajes instrumentales y procedimentales.

Palabras clave: aprendizajes, diseño didáctico, rotafolio, tecnología educativa, tratamiento de conductos.

Abstract

Current educational schemes increasingly focus on operational models in competencies and in the use of technological resources. These elements are conducive for the roles of students, teachers and educational authorities to change and adapt to benefit a better teaching-learning process. It is therefore important to investigate whether the instructional designs detected in the new educational paradigms are functional in teaching the various subjects in the dental area. With the participation of 10 residents of the Endodontic Postgraduate Course at the Technological University of Mexico Campus Marina-Cuitlahuac, a quasi-experimental study was carried out, a book-type Flipchart was created about root anatomy. Through bibliographic research the residents collected images and information about the topic, later with the use of professional clay they created 3D anatomical models that are transformed into digital images through software, then these images will be used to power and create the Flipchart of augmented reality. To evaluate the consolidation of knowledge a diagnostic evaluation (KPSI model) was used before the activity and a summative evaluation at the end

of its implementation. The diagnostic test showed that 60% of the residents started postgraduate studies with an unconsolidated knowledge category. After implementing the didactic design of the augmented reality flip chart, created by the students with the guidance and support of the teacher, it was observed that 90% of the residents reached the category of consolidated knowledge in their evaluation. Finally, the Chi-square statistical test (X2) was applied to determine if there was a relationship between the variables analyzed, the result of the test showed that the implementation of the augmented reality flipchart had an impact on the consolidation of knowledge of root anatomy. In conclusion, the results obtained in this study showed that incorporates the new educational models, based in competencies and new technologies, in the teaching-learning process of dental anatomy is favorable for the consolidation of instrumental and procedural knowledge and learning.

Keywords: Learnings, Didactic design, Flipchart, Educative technology, Root canal treatment.

Resumo

Os esquemas educacionais atuais estão cada vez mais focados em modelos baseados em competências e no uso de recursos tecnológicos. Esses elementos permitem que os papéis dos alunos, professores e autoridades educacionais mudem e se adaptem para beneficiar um melhor processo de ensino e aprendizagem. Por esse motivo, é importante investigar se os desenhos instrucionais baseados nos novos paradigmas educacionais são funcionais no ensino das diversas disciplinas da área odontológica. Com a participação de 10 residentes do curso de pós-graduação em Endodontia da Universidade Tecnológica do México, campus Cuitláhuac, foi realizado um estudo quase experimental, onde foi elaborado um flip chart do tipo livro sobre anatomia radicular. Por meio de pesquisa bibliográfica, os residentes compilaram informações e imagens sobre o assunto e posteriormente, com o uso de plasticina profissional, criaram modelos anatômicos 3D que foram transformados em imagens digitais por meio de um software; Essas imagens foram então usadas para projetar e criar o flip chart de realidade aumentada. Para avaliar a consolidação do conhecimento, foi utilizada uma avaliação diagnóstica Knwoledge and Prior Study Inventory (KPSI) antes da atividade, e uma avaliação somativa ao final de sua implantação. O teste diagnóstico mostrou que 60% dos residentes iniciaram a pós-graduação com uma categoria de conhecimento não consolidado. Após a implementação do desenho didático do flipchart de realidade aumentada, elaborado

pelos alunos com orientação e apoio do professor, observou-se que 90% dos residentes alcançaram a categoria de conhecimento consolidado em sua avaliação; por fim, aplicou-se o teste estatístico qui quadrado (X2) para verificar se havia relação entre as variáveis analisadas. O resultado do teste mostrou que a implementação do flipchart de realidade aumentada impactou na consolidação do conhecimento da anatomia radicular. Em conclusão, os resultados obtidos mostraram que a incorporação dos novos modelos educacionais baseados em competências e novas tecnologias é favorável para a consolidação de conhecimentos e aprendizagem instrumental e procedimental.

Palavras-chave: aprendizagem, design didático, flip chart, tecnologia educacional, tratamento de canal radicular.

Fecha Recepción: Junio 2020 **Fecha Aceptación:** Noviembre 2020

Introduction

Endodontics - as Cohen and Hargreaves (2016) point out - "is the branch of dentistry in charge of the prevention, diagnosis, and treatment of pulp and periapical diseases. Root canal treatment being the therapy indicated to preserve teeth that would otherwise be condemned to extraction "(p. 15). For an adequate root canal treatment, it is essential - as Ingle and Rotstein (2019) refer - to achieve a good instrumentation of the root canal system, a process that consists of the complete elimination of microorganisms and pulp tissue by expanding the diameter and creating a root canal configuration that allows optimal filling and sealing.

However, one of the main causes of root canal (endodontic) failure is inadequate knowledge of root anatomy and its variations. These anatomical landmarks, if not managed correctly, can lead to procedural errors such as perforations, apical transport, step formation, loss of working length, fracture of instruments, among others, which reduces the prognosis of treatment and in some cases it can cause the loss of the dental organ. For this reason, it is of the utmost importance - as proposed by Cohen and Hargreaves (2016) - that the process of teaching and learning of root anatomy and its variations be efficient and effective so that the resident has adequate knowledge to perform quality treatments and thus solve the clinical cases that you face.

The problem in the teaching and learning of root anatomy is that the student cannot visualize it clinically, so the teaching is based on descriptions and textbook diagrams, tools

that are insufficient to be able to carry out an adequate construction knowledge, which reduces their study to a merely rote issue that does not contribute to a correct correlation with their clinical practice or to develop conceptual and procedural skills. All this, on the contrary, encourages the possibility of making procedural errors that will compromise the success of the treatments. Unlike, for example, the study of skull anatomy, the resident can perform exercises and practices with the skull bones, thus having the possibility of directly seeing their characteristics, visualizing their elements and physically interacting with their structures. In this way he becomes familiar with and better understands the anatomical descriptions of the texts.

Since the learning of these concepts is key within the postgraduate curricular plan, instructional designs must be adopted that accompany the student in an environment of interest and motivation so that he or she participates in the construction of knowledge. As Papert (1999) mentions, “the best learning will not come from finding better forms of instruction, but from offering the learner better opportunities to build” (p. 6). Indeed, when dealing with issues involving practical work, constructivism plays a crucial role. Taking into account this paradigm, Bers, Strawhacker and Vizner (2018) establish that it is possible for the student to interact simultaneously with two spheres: that of abstract knowledge (theoretical information on anatomical characteristics) and that of sensory (physical and clinical experience) . Thus, the student is allowed to take a central and much more active role in learning content, compared to other methods that position the student as a mere receiver of information.

Currently, in the dental area —and more specifically in the specialty of endodontics— there is little literature on the use of augmented reality as an educational resource in the teaching and learning process and its impact on the procedural and conceptual skills of patients. students. In fact, traditional teaching methods are the ones that prevail in the training of new oral health professionals, hence the opportunity arises to evaluate, through a quasi-experimental study, whether the implementation of teaching materials with new technologies of information and knowledge - supported by a constructivist conception - serve to consolidate knowledge in various areas of dentistry (in this case, root anatomy in the specialty of endodontics). The consolidation of knowledge is what is known and does not require cognitive effort to express or remember it; are those knowledge that can be explained because they are understood.

Augmented reality is one of these new technologies that can be used in the educational field, since it allows to extend the perception of reality through digital elements. It can be conceptualized as the combination of tools from a real environment with other virtual ones that have been created in three dimensions. These two aspects are combined in real time, expanding the visual perception of individuals.

The book-type flipchart, on the other hand, is a graphic medium made with a series of sheets of paper attached at the top, which allows the content to go through; in this way texts and images (graphs, photos, drawings, diagrams) are mixed that develop a theme in a logical way. The construction project of this augmented reality material is based on what Papert (1987) considers as "objects to think" (objects-to-think-with). According to this author, our understanding of the world is enhanced by creating artifacts, physically experimenting with them, modifying them and analyzing how they work.

Having explained the above, it can be said that the objective of the study was for the resident of the Endodontics postgraduate course - through this augmented reality project - to create, manipulate and experiment with the different shapes and variations of the root anatomy so that he could build and consolidate knowledge regarding this topic. In this way, they sought to directly impact their clinical practice by improving their anatomical diagnosis skills and, therefore, performing more predictable and successful treatments.

Materials and methods

The study is considered to be quasi-experimental due to the intentional manipulation of the independent variable (augmented reality flipchart), in addition to measuring the impact that its creation, application and implementation had on the dependent variable (procedural and conceptual knowledge and learning of the radicular anatomy of the residents of the specialty); therefore, a cause and effect relationship is established. In addition to this, vale highlights that in this work all the variables involved could not be rigorously controlled (such as level of prior knowledge of the subject, age or socioeconomic status) and there was no control group either.

The study was carried out in the Endodontics postgraduate course of the Technological University of Mexico (UNITEC, Mexico), Marina-Cuitláhuac campus, with the participation of 10 first-year residents. The project had the approval of the ethics

committee and the research department of the faculty; In addition, the consent of the participating students was obtained, and their personal data was protected.

This group of subjects was chosen because they enter the specialty with learning about root anatomy acquired in a traditional way in undergraduate programs. For this reason, it was considered an ideal group to evaluate the impact of the implementation of this constructivist strategy.

The participants were men and women aged between 24-35 years, with a bachelor's degree (60% from public schools and 40% from private schools), and had work experience (minimum one year) in the dental field. They were characterized by coming from urban, middle and upper-middle class environments. Specifically, 50% came from the metropolitan area of the Valley of Mexico, and 50% from the interior of the republic.

The temporary location was the year 2019, in the first year of the residency, since that moment is the ideal moment to be able to evaluate the conceptual and procedural learning with which the residents enter the specialty. In this way, failures, shortcomings and limitations are recognized around the root anatomy issue. Thus, it was possible to contrast the diagnosis made with the results obtained with the implementation of the didactic strategy applied.

This research project had three stages in its development: the first consisted of explaining the research project to the students. This made it possible to achieve freedom of participation, acceptance and the consensual signature of the entire group. Subsequently, in the classroom, a KPSI-type diagnostic test was applied to assess the prior knowledge associated with the traditional model of teaching the variants of root anatomy. Next, two innovative didactic strategies based on information and communication technologies (ICT) were implemented: flipped class together with makerspace; with both, the teacher —by means of digital resources— guides the activities of the residents asynchronously and remotely. In addition, both allow students to use technological resources to develop their creative side through design and generation of ideas. This with the aim of promoting collective work supported by educational technologies, including the flip chart with augmented reality, which was created by the students with the guidance and guidance of the teacher.

The third stage was face-to-face in the classroom. This allowed to specify the conceptual and procedural knowledge and learning of root anatomy (radiographic diagnosis,

diagnosis and clinical characteristics, classification systems, treatment options), built throughout the activity through the presentation of each student on their part flipchart and finally applying a case review assessment.

KPSI diagnostic evaluation

This evaluation was designed as a self-assessment questionnaire that served to obtain information about the perception of the level of knowledge and conceptual and procedural learning that the student had regarding root anatomy, as well as the areas where they could improve. It also gave key information to verify at the end of the research if the implementation of this learning model consolidated the learning of this subject. This differs from the summative evaluation, since it was thought more as an analysis of clinical cases that would provide information about how the student consolidated knowledge and could apply it in their clinical practice, a situation that could not be established at the beginning of the course due to that the topics of anatomical variants had not yet been presented and discussed. For this diagnostic test, five reagents were prepared for each of the anomalies to be studied in the root anatomy; The response options to these questions were determined at five levels; 0) I don't know, 1) I know a little, 2) I know, but not completely, 3) I know it well and 4) I could explain it to another colleague / teacher.

The questions were constructed with the support of three professors from the Endodontics postgraduate course at the Technological University of Mexico to detect the level of knowledge of four major areas of root anatomy: clinical diagnosis, anatomical characteristics and classification, radiographic findings and, finally, treatment plan. In this way, data were obtained that allowed us to identify the scope of the traditional educational model for teaching root anatomy to later contrast them once our proposal for a constructivist didactic technique was applied.

Flipped classroom (aula inversa)

Once the diagnostic test was carried out, the teacher gave instructions to the students for the following phases: in the first phase, the student entered the Edmodo platform to review the content prepared and provided by the teacher, which consisted of a presentation in Power Point where it was possible to know and analyze the topic Generalities of root anatomy, fundamental so that in later phases of the work the student could specify the information that

he would place on the flipchart sheets. In this presentation, the student also had access to the instructions to do the flipchart activity with augmented reality, while he was able to consult the schedule of activities.

Makerspace (espacio de creación)

In the second section of the presentation, the instructions provided by the teacher for the design of the flipchart were found: the first one consisted of the individual assignment of the different topics of the anatomical root variants. Subsequently, the residents had a period of two weeks to gather information about the assigned topic, focusing on the clinical appearance, radiographic findings, clinical characteristics, classification and treatment options of the assigned anomaly. In addition, through the following web pages (Facebook, Instagram and YouTube) the residents conducted a specialized search to identify, learn about and extract images, both from digital and real models, of the morphological characteristics of their subject.

The residents then made 3D models with professional modeling clay, at the times and places of their choosing. Said models were based on the anatomical characteristics of each anomaly, following the dimensional guidelines previously established in the presentation, so that a replica of a dental organ with the morphological characteristics of its assigned anatomical variant was obtained at the end (Figure 1). During this process, the team took photographs and videos as evidence of work and they were sent through the WhatsApp application to the teacher, who saved them and stored them in digital folders to provide feedback or consult doubts.

Once the models were obtained, the students went to a 3D scanning center to obtain three-dimensional digital images; Those files were collected on USB sticks and taken to their computers. The next step was to use the Augment application to upload your images of the various models and have them ready for the next phase in the form of “trackers” (QR images containing the previously uploaded augmented reality 3d models).

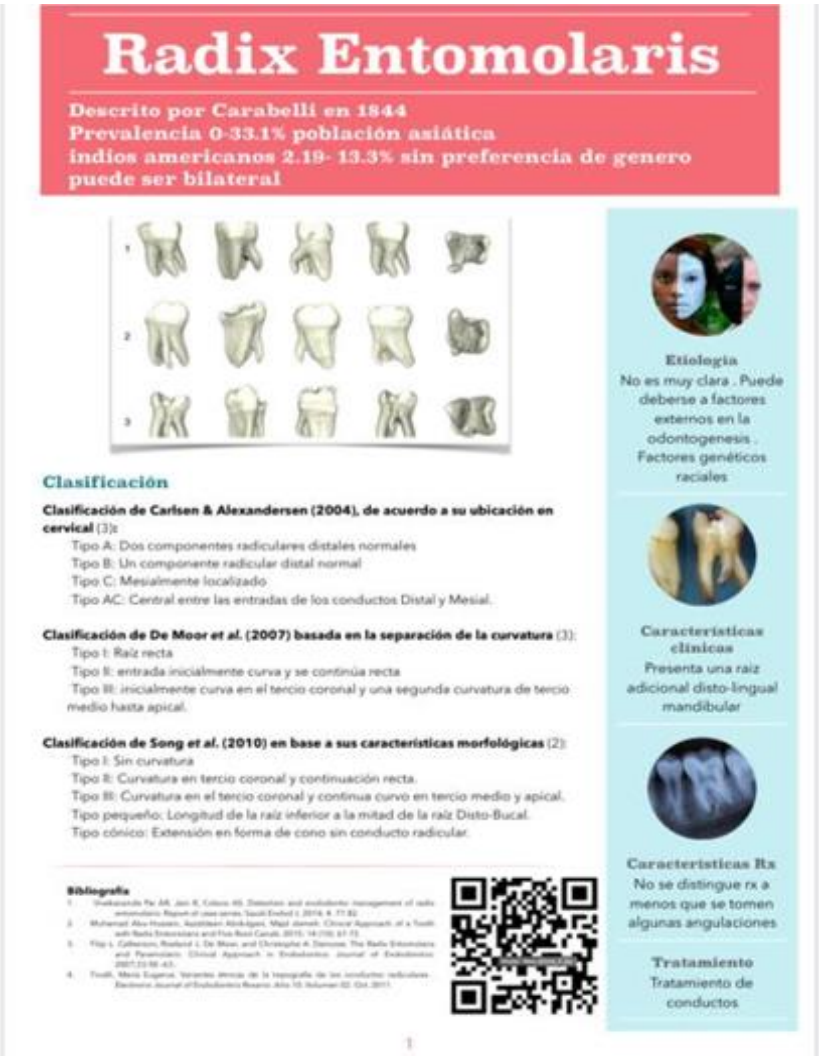
Figura 1. Diseño anatómico terminado (se utilizó pintura acrílica para su acabado)

Fuente directa

Making augmented reality flip chart

The residents - based on the readings, literature research (guided by the teacher) and presentation of the topic provided by the teacher - prepared the different sheets of the book-type flip chart of the variants of root anatomy. Each sheet of the flip chart corresponded to one student; The design was at free discretion, but with the guideline of covering the following items in its content: clinical appearance, radiographic findings, clinical characteristics, classification and treatment options. Photos were taken on the various pages and sent to the teacher through the Whastapp application; the teacher reviewed the content and offered feedback, in such a way that the information on the flipchart was approved. Then the resident, through the Augment platform, added the trackers to the design of his theme, so that at the end each sheet of the flip chart had a QR image that functioned as a storage code for the 3D models (figure 2).

Figura 2. Hoja del rotafolio (contiene el desarrollo del tema y el código QR que alberga la imagen anatómica 3D)



Fuente directa

Flip chart presentation

When the ten sheets of the flip chart were ready, they were shared, in such a way that each student built their own flip chart with all the assigned topics; Later, a face-to-face session was organized where the teams presented the work obtained, having as a dynamic that the students followed the speaker's presentation, reviewing the augmented reality models of each topic with their smart devices, this being a space in which they debated and the content was fed back (figure 3).

Figura 3. Presentación del rotafolio (se utilizó el diseño anatómico 3D de cada tema como apoyo y guía de la exposición)

Fuente directa

Summative evaluation

This second instrument was applied at the end of the creation and implementation of the augmented reality flip chart; With this summative type test, the aim was to obtain information about the impact that the design, creation and implementation of this didactic strategy had on the procedural and conceptual knowledge and learning of root anatomy that residents of the specialty had, and thus contrast them with the data obtained with the KPSI diagnostic test.

For the creation of the test, two clinical cases were developed with the support of three endodontics postgraduate professors. Real cases presented in the postgraduate clinic were taken as a basis, and the diagnosis, anatomical characteristics, radiographic findings and treatment plan were taken as parameters.

Statistical test

The statistical test that was decided to use was the chi-square (X2) test because it determines whether two variables are related or not, which is why it is suitable for this work, since the study aimed to evaluate whether the application of a didactic strategy of Virtual reality is related to a consolidation of knowledge about the variants of the root anatomy.

Results

After carrying out the field work, the data obtained was captured by means of tables in the Excel program of the Office 365 package, which are shown in table 1 (KPSI test) and table 2 (evaluation of cases). The fact that they were different tests at the beginning and end of the project did not affect the data analysis, since the results could be unified by categorizing them into levels of knowledge, in this way it was possible to establish a point of comparison to apply statistical instruments. The diagnostic test had to be different because at the beginning of the subject the residents had not yet reviewed the topics of the subject, therefore it would not be valid to establish a test of clinical cases.

Tabla 1. Resultados de la prueba KPSI

Alumno	Diagnóstico radiográfico	Diagnóstico clínico	Características anatómicas	Plan de tratamiento	Puntaje final	Nivel de conocimiento
1	34	34	30	32	130	Bueno
2	24	28	26	27	104	Suficiente
3	25	36	25	29	106	Suficiente
4	34	36	34	32	136	Bueno
5	25	25	27	24	101	Suficiente
6	22	22	26	23	93	Suficiente
7	26	24	24	21	95	Suficiente
8	28	26	24	25	103	Suficiente
9	36	36	36	36	144	Excelente
10	31	30	34	29	124	Bueno
Total	285	297	286	278	1136	

Nota: (E) Excelente=144 (B) Bueno= 108-143 (S) Suficiente= 72-107 (I) Insuficiente= 0-71.

Fuente: Elaboración propia

Tabla 2. Resultados de la prueba sumativa

Alumno	Diagnóstico radiográfico	Diagnóstico clínico	Características anatómicas	Plan de tratamiento	Puntaje final	Nivel de conocimiento
1	3	2	2	3	10	Bueno
2	3	3	2	3	11	Bueno
3	3	3	3	3	12	Excelente
4	3	3	2	3	11	Bueno
5	3	3	3	3	12	Excelente
6	2	2	2	1	7	Suficiente
7	2	2	3	3	10	Bueno
8	3	2	2	2	9	Bueno
9	3	3	3	3	12	Excelente
10	3	3	3	3	12	Excelente
Total	28	26	25	27	106	

Nota: Excelente= 12 Bueno= 8-11 Suficiente= 4-7 Insuficiente 0-3.
Fuente: Elaboración propia

For the purposes of this study, it was determined that the student had a consolidation of knowledge if he reached the level of good or excellent in the diagnostic evaluation; Likewise, it was considered that he achieved or maintained a consolidation after the application of the didactic design when he obtained the good or excellent category, leaving for both evaluations a category of unconsolidated with a level of sufficient or insufficient.

The KPSI test shows that 60% of the residents had a "sufficient" category knowledge regarding the root anatomical variants, observing that the majority of the students entered the specialty with a traditional teaching model that was framed at the level of “unconsolidated” knowledge. Also noteworthy is that none of the participants scored “insufficient” for this test.

From the analysis of these elements, it can be seen that the “Clinical Diagnosis” section is the best consolidated area of knowledge (highest score achieved), while the “Treatment Plan” achieved a lower score with respect to the others.

On the other hand, in the summative test carried out after having implemented the didactic design of the augmented reality flipchart, it shows that 90% of the participants reached the category of "good" to "excellent" in their results. Only one resident got “enough” on his case analysis test.

The area that had the greatest advance in consolidation was the “Radiographic diagnosis”, which went from being the penultimate place in the diagnostic test to being the first in the summative, followed by the “Treatment plan” section, which went from the last place in the diagnostic test to second place in the summative test.

Chi square analysis

Subsequently, using the Excel 360 program, the contingency table was filled in for the chi square statistical analysis. With these data, the test was carried out; In the first instance, the observed frequencies and expected frequencies were obtained, which are observed in table 3, and then the calculations of the formula were performed:

$$x2 = \frac{\sum(\text{oi} - \text{ei})2}{\text{ei}}$$

As o_i represents each observed frequency and ei represents each expected frequency. It should be noted that the margin of error for this case was determined at 0.05 and for the degree of freedom a value of 1 was obtained.

Tabla 3. Chi2 correspondiente a cada una de las frecuencias observadas y frecuencias esperadas

Frecuencia observada	Frecuencia esperada	Chi 2
9	6.5	0.96153846
4	6.5	0.96153846
1	3.5	1.78571429
6	3.5	1.78571429
		5.49450549

Fuente: Elaboración propia

Once the value of chi 2 was obtained (which was 5.4945), it was contrasted with the value of the Distribution of chi 2 by table, which corresponds to 3.8415 for a margin of error of 0.05 and degree of freedom of 1, obtaining a value of $P < 0.05$.

Discussion

As the main finding, it can be said that the application of a constructivist didactic design favors the consolidation of conceptual and procedural learning of the root anatomy of residents of the specialty of Endodontics. The resulting chi square value was 3,815, which is why the resulting chi square is greater than the value of the critical point of chi square per table. With these results we can reject the null hypothesis and establish that there is a relationship between the construction and implementation of a didactic strategy by the

students with the teacher's guidance and the level of consolidation of knowledge of root anatomy.

The age of knowledge has brought with it a technological and computing revolution on a capital and global scale, allowing for ever better digital devices and faster and more extensive connectivity. According to what Peñalosa (2013) proposes, a significant example of this digital age is the vertiginous development that the internet has had in the last 20 years, managing to connect the various societies of the planet in a way never seen before, detonating the flow of information in a fast and without geographical limits. The educational area does not escape these changes, and has largely been the engine of this new era of knowledge.

Being aware of this niche of opportunity, we decided to design, create and implement an augmented reality flipchart as a didactic tool that allows and facilitates the teaching of root anatomy in the specialty of Endodontics of the UNITEC School of Dentistry, for which The theoretical aspects are related to its clinical importance. For this type of educational and theoretical-practical scheme, Cubero (2005) establishes that there are several educational models that are of utmost importance, as well as valuable components for the development of the teaching and learning process; Some are the following: 1) cognitive: it helps students to relate the previous knowledge acquired in the classroom with clinical work, 2) constructivist: in addition to absorbing information, students actively involve it to solve diagnostic problems and that may arise during treatment, and 3) humanist: they are involved in professional development in a socially responsible way, treating the patient from the biopsychosocial sphere and not just as a sick mouth or tooth.

To carry out the study, the use of the KPSI form was proposed, which is designed as a self-diagnostic test of knowledge. This questionnaire was ideal, since it was intended to know the level of knowledge of the dental anatomy subject with which the students entered the specialty program; Later, it was contrasted with a summative test based on the resolution of clinical cases, once the students had reviewed the different topics of the subject's root anatomy (Tamir and Lunetta, 1978).

The idea of incorporating augmented reality as a technological learning resource agrees with what was proposed by Díaz-Barriga and Hernández (2010), who mention that learning to be adequately processed by students must be significant, mark a turning point in the receiver of the information, in such a way that it does not become a forgettable or dispensable data. On the other hand, it is considered that this design is of a constructivist

nature because it follows what was proposed by Piaget (1974), who mentions that from the epistemological perspective, constructivism focuses on making an analysis of knowledge, studying its limitations and scope. In other words, knowledge is built from the interaction that individuals have with their environment, that is, with the manipulation of their environment. According to Barlett (referenced by Good and Brophy, 1990), constructivism is based on the following:

> The learner constructs his own reality or at least interprets it according to the perception derived from his own experience, in such a way that the knowledge of the person is a function of his previous experiences, mental structures and the beliefs he uses to interpret objects and events (p. 55).

For this research, the dimensions of learning that were involved were those of significant reception and discovery, as documented by Ausubel (1983). The first of these is the significant discovery: the student through the manipulation of materials creates and discovers the various anatomical forms and their intricate structural elements, which otherwise could not be due to the clinical limitations involved. In this way, the new information is significant to the extent that it is related to the already existing in the cognitive structure in a substantive way (book outlines, for example). In a second aspect, significant reception is considered, which is presented when the flip chart is ready and the work presentation phase occurs, a scenario in which all residents present the final product to their colleagues and in this way the other students internalize the content in their cognitive structure, differentiating it from the simple memory aspect.

For his part, Fabregat (2012) establishes that the creation of didactic designs based on augmented reality benefits the educational process in several ways; For example, it helps to acquire procedural knowledge, which is fundamental, as well as to relate and understand the concepts learned through interaction with the resources that surround the individual.

In addition to the above, we also agree with Papert (1987), who mentions that for learning to be generated in a consolidated way, it must be done through cognitive reconstruction and through practice. In the present study this materialized through the manipulation of the environment and its objects, that is, through the creation of 3D anatomical models using plasticine, which is in tune with the objects-to-think concept. to think).

On the other hand, the educational technologies used in this work were chosen based on what Johnson, Becker, Estrada and Freeman (2015) explain, who explain that the flipped classroom and makerspace techniques are some of the emerging ICTs with more relevance due to their qualities and benefits for the teaching and learning process, hence they are pedagogical models that are rapidly gaining prominence.

According to Bers et al. (2018), this type of methodologies have the advantage of fostering in students a sense of belonging to the content they are creating and increasing perseverance by stimulating an ideal creation for them.

In this sense, the present work coincides with Tekedere and Göker (2016) when they mention that augmented reality has a positive effect on student learning; However, it is also convenient to rescue the words of Schmidt and Ralph (2016), who warn that if these tools are used improperly, they can lead to student conformism and generate disinterest in the subject, so it is suggested to be cautious in this regard, as the weight of the use of augmented reality may be overestimated. For this reason, the specific measurement of the impact of this type of didactic designs should be included in future works.

Conclusions

The application of augmented reality in our daily lives is increasingly common, hence the need for schools to incorporate this technology to strengthen teaching and learning processes. Areas such as medicine, nursing, industrial engineering, among others, use augmented reality devices to carry out their laboratory practices, with which they have had excellent results.

The dental area, therefore, has to incorporate these new educational elements to strengthen its curricular plan and in this way be able to offer better teaching and learning processes to its students. However, the area of opportunity for this tool should also be investigated, as in this way better prepared oral health professionals can be trained in clinical, ethical and humanistic fields.

Educational models based on constructivism, on the other hand, have proven to be fundamental for understanding and applying the new paradigms in the teaching sector. The fact of giving the student a more active role in the process of building knowledge encourages him to become more critical, analytical, organized and with a greater capacity to solve

problems he faces, both academically and personally. Given this, teachers must adapt to this new role that corresponds to them, in which they must be a facilitator and guide of the process, leaving aside that dominant quasi-parental or maternal figure that they occupied within the educational process.

This study, in summary, opens the doors to rethink the current dental educational paradigm in Mexico, since work must be done on the incorporation of new ways of understanding the teaching and learning processes, where a technology such as augmented reality must be used to favor the consolidation of knowledge and conceptual and procedural skills of students.

Acknowledgment

A special recognition to the residents and residents and professors of the Endodontics postgraduate course at the Technological University of Mexico (UNITEC, Mexico), Marina-Cuitláhuac campus who participated in this project.

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