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Artículos Científicos

Estudio de la satisfacción de un objeto de aprendizaje para la enseñanza del tema equilibrio ácido-base en la licenciatura de Medicina

*Study about the satisfaction regarding a learning object for the teaching of
the theme acid-base equilibrium in the bachelor of Medical School*

*Estudo da satisfação de um objeto de aprendizagem para o ensino da
disciplina equilíbrio ácido-básico em
Bacharel em medicina*

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Resumen

El pH en el cuerpo humano es de vital importancia para su buen funcionamiento, ya que un desequilibrio en él puede causar graves problemas de salud e incluso la muerte. Este tema se aborda en el curso de Bioquímica I de la licenciatura de Medicina en todas las universidades y siempre ha mostrado un alto grado de dificultad, de ahí que el índice de reprobación sea alto. Para apoyar en la atención de esta problemática, en trabajos previos se describe el diseño y desarrollo de un objeto de aprendizaje para este tema haciendo énfasis en su importancia. En este trabajo, en cambio, se describe la metodología que se siguió para llevar a cabo un estudio de la satisfacción de ese objeto de aprendizaje, cuyos contenidos se presentaron en tres videos. En la investigación participaron estudiantes de nueve cursos de Bioquímica I del primer semestre de la Facultad de Medicina de la Benemérita Universidad

Autónoma de Puebla, durante el semestre de otoño de 2019. Los resultados documentan un grado de satisfacción alto y señalan áreas de oportunidad para producir objetos de aprendizaje similares.

Palabras clave: bioquímica, pH, satisfacción, usabilidad.

Abstract

The pH in the human body is of vital importance for its proper functioning, an imbalance in it can cause serious health problems and even death. This topic is addressed in the first Biochemistry course of the Bachelor of Medicine in all universities and has always shown a high degree of difficulty, consequently, the failure rate is high. To support the attention to this problem, previous works describe the design and development of a Learning Object for this topic, emphasizing its importance and at the same time, seeking to influence the increase in the approval rate. This work describes the methodology that was followed to carry out a study of the satisfaction of this Learning Object, whose contents are presented in three videos. Students from nine sections of the first Biochemistry course from the first semester of the Faculty of Medicine of the Benemérita Universidad Autónoma de Puebla participated in the study, which was carried out during the fall semester of 2019. The results document a high degree of satisfaction and indicate areas of opportunity to produce similar learning objects.

Keywords: Biochemistry, pH, satisfaction, usability.

Resumo

O pH do corpo humano é de vital importância para o seu bom funcionamento, pois um desequilíbrio no mesmo pode causar sérios problemas de saúde e até a morte. Esta disciplina é abordada no curso de Bioquímica I do curso de Medicina de todas as universidades e sempre apresentou um alto grau de dificuldade, logo o índice de reprovação é alto. Para apoiar a atenção a este problema, trabalhos anteriores descrevem o projeto e desenvolvimento de um objeto de aprendizagem para este tópico, enfatizando sua importância. Por outro lado, neste trabalho, é descrita a metodologia que foi seguida para realizar um estudo da satisfação deste objeto de aprendizagem, cujos conteúdos foram apresentados em três vídeos. Alunos de nove cursos de Bioquímica I

do primeiro semestre da Faculdade de Medicina da Benemérita Universidad Autónoma de Puebla participaram da pesquisa, durante o semestre de outono de 2019. Os resultados documentam um alto grau de satisfação e indicam áreas de oportunidade para produzir objetos de aprendizagem semelhantes.

Palavras-chave: bioquímica, pH, satisfação, usabilidade.

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Introduction

As indicated in Soledad, López and Muñiz (2017), information and communication technologies offer learning environments that contribute to the development of skills to think and favor deep learning, so its use in teaching is essential to enhance learning biochemistry. These same authors, however, also warn that the large amount of information that is generated every day in this study area forces students to stay updated, hence it is necessary to design and implement didactic resources to facilitate the understanding of concepts that are not intuitive.

In this sense, Biochemistry is a subject of the basic plan in the training of a medical student. The learning of this chair in various universities - including the Faculty of Medicine of the Benemérita Universidad Autónoma de Puebla (BUAP) - has shown a high degree of difficulty for students, which is evidenced in the low level of achievement of academic tests applied.

Now, given the importance of the topics that make up this subject in the training of future doctors — and taking advantage of the knowledge that we have about learning objects (LO), minimum units of content that help make learning possible (Digital Communities for Learning in Higher Education [Codaes], 2015) -, researchers from the BUAP School of Medicine (FM-BUAP) and the Computer Science School of the same university (FCC-BUAP) created a OA of the acid-base balance topic (hereinafter OA-EAB). In addition to the support for learning that the OA-EAB provides to students, it demonstrates the importance of collaborative work and the inclusion of a multidisciplinary approach among teachers, which is essential for the development of technology and academic resources that support the learning of specific topics in the classroom. Health area.

The acid-base balance issue mainly considers pH, which is a unit of measurement of the degree of acidity or basicity of a substance (its values range between 0 and 14, with 7 being its state of neutrality). The human body contains many acidic and basic substances, obtained endogenously and exogenously, which, when kept in balance, favor its correct functioning. Acids are substances that lose ions (H^+) when they dissociate, and bases are substances capable of accepting them. Maintaining pH is essential as it affects the ionization of proteins and, consequently, the activity of many enzymes. The regulation of extra and intracellular pH is closely related to gas exchange and the latter, plus the acid-base balance, when suffering alterations cause a variety of diseases of the renal and respiratory systems.

The OA-EAB has been implemented according to the Codaes methodology (Codaes is a project carried out with funding from the Secretary of Public Education-Undersecretary of Higher Education-General Directorate of Higher University Education in Mexico). The authors of this document have experience using the Codaes platform, where they have also participated in the development of other LOs.

The support they offer for the development of LO and the service they provide is considered adequate for the student population to be impacted. It should be noted that those responsible for the Codaes platform are always available to listen to proposals to improve the platform.

Currently, the OA-EAB is in the last stage before it is available on the Codaes portal, which means it is being evaluated. It is important to mention that the OA-EAB was developed according to a validated methodology, composed of different stages and that each one has been evaluated by members and experts of the community. The design and development of the OA-EAB is described in Castillo et al. (2019) and a summary of this is presented in the next section.

Usability is an aspect to be evaluated in LOs, as it allows achieving specific objectives with users defined in a specific context of use, and is related —among other aspects— to the satisfaction of the participants once they have used the LO. This document presents the methodology that was followed during the implementation of a study to evaluate satisfaction and the results achieved with students from nine Biochemistry I courses (from the first semester of the BUAP School of Medicine in autumn 2019), who used the OA-EAB contents represented in three videos.

This document is organized as follows: the second and third sections present the related works, as well as the preliminary concepts necessary to understand this article. The fourth section outlines the methodology followed to evaluate satisfaction. In the fifth part, a discussion of results is established and, finally, conclusions and future lines of action are offered.

Related jobs

Regarding the analysis of the use of videos to support learning in the medical area, Sowany Abu (2014) describes a study on the design and response of students to a clinical nursing skills course in which transmission technology was used. of videos (these corresponded to real and ideal recordings). Now, in the present work - unlike the one developed by Sowany Abu (2014) - the methodology applied to evaluate the satisfaction of the students who used the videos that were part of an LO designed to support learning in Biochemistry I courses is described. of the FM-BUAP. In addition, the videos of this investigation were designed from storyboards and were produced using animations.

Other works to support and evaluate the learning of the Biochemistry subject in the health area are those of Cardozo and Luciano (2009a, 2009b). In the first, the impact of the integration of research into the teaching-learning process of the aforementioned chair is analyzed, which was carried out at the Faculty of Dentistry of the Central University of Venezuela during the 2008-2009 school period. In the work, an experimental research design of the pre-test-post-test type was used (before and after the methodology used). The subject of the course was related to the following topics: 1) dentistry, 2) evidence-based dentistry, and 3) effective strategies to search for evidence in repositories of digital publications or online databases. Cardozo and Luciano (2009a) conclude that there was a substantial improvement in student performance after integrating the research into the teaching-learning process. In addition to this work, the aforementioned authors (2009b) carried out a simultaneous study of the same subject and in the same period, but this time with the objective of determining the degree of satisfaction of the participants. According to these researchers, this variable is a source vital feedback for both the teacher and the institution because it allows to identify strengths, weaknesses and opportunities of the teaching-learning process.

Preliminaries

Next, the elements used for the development of this work are briefly described.

pH in the human body

The following summary was made based on the information described by Aristizábal, Calvo, Valencia, Montoya, Barbosae Hincapié (2015), Barrett, Barman, Boitanoy Brooks (2018), Baynes and Dominiczak (2019), as well as Murray, Bender, Botham, Kennelly, Rodwell and Weil (2019).

Maintaining pH is essential because it affects ionization of proteins, enzymes, and ion channels, as well as the shape of the hemoglobin saturation curve and, therefore, tissue oxygenation. A decrease in pH increases sympathetic tone and can lead to the appearance of cardiac arrhythmias, so a serious imbalance can be lethal. The main source of acids in normal state is cellular metabolism. The CO₂ formed is hydrated to H₂CO₃, which is the most important acid in body fluids; However, due to its volatility, most of the CO₂ is excreted through the lungs and small amounts of hydrogen ions and HCO₃⁻ - product of the dissociation of H₂CO₃, are excreted by the kidneys, as are non-volatile acids (eg. , lactic, phosphoric, hydrochloric and keto acids). For correct cellular functioning, a pH at the arterial level is required that ranges between 7.35 and 7.45, which represents an indirect measure of the H⁺ concentration, which remains between 35 nmol / l and 45 nmol / l, and a proportion of HCO₃⁻ and CO₂ of approximately 20: 1. Organs and cells as well as buffer systems are required to maintain the acid-base balance. The lungs control the exchange of carbon dioxide and oxygen between the blood and the atmosphere, the erythrocytes transport Gases between the lungs, tissues, and kidneys control bicarbonate synthesis in plasma and hydrogen ion excretion. Buffer systems are molecules or substances that maintain acid-base balance by avoiding sudden changes in pH (these are found in an intracellular or extracellular environment). Among the physiological buffers are proteins, phosphates, hemoglobin and the carbonic acid-bicarbonate system, the main buffer that neutralizes hydrogen ions released from cellular metabolism, by buffering the pH by 75%.

Codaes and OA

A community is defined as a collectivity or group of people who live together and have common interests, or who work on a common task (Codaes, 2015). Based on this idea, it can be said that a learning community constitutes a group of people who share their experience to define and develop strategies to approach knowledge (Codaes, 2015). In the framework of the Codaes project, the communities are conceived as groups of experts who collaborate in the design and production of educational resources, through a process of collaborative construction through a digital environment. The Codaes communities are groups made up of students, teachers and scholars dedicated to learning. development of applications and educational resources; The latter are tools to support the teaching-learning processes in higher education that promote educational innovation, support teacher updating, link the university with society and, at the same time, allow people outside the formal educational system to acquire the necessary competencies both for their professional performance and for lifelong learning. The Codaes instructional design model is made up of six phases (Codaes, 2015): planning, analysis, design, development, implementation and evaluation.

An OA is the minimum unit of content, capable of promoting a teaching-learning process, based on the instructional design. An LO is organized based on a compositional hierarchy of granularity levels that range from multimedia objects and information objects (images, video, plain texts, among others), to more complex sets of educational content such as sections, units or modules (Codaes,2015, p. 2).

The basic elements of an OA are the learning objective, the content, the learning activities, the assessment, the activity guide and the metadata (Codaes, 2015). From a technological point of view, an OA must be reusable, accessible, interoperable, durable, scalable, relevant and self-contained (Codaes, 2015). In addition, you must use appropriate multimedia elements so that learning is meaningful; In addition to this, it must be coherent and properly manage redundancy (Codaes, 2015). To develop an OA, an instructional design model is used that indicates the process to systematize, plan and structure the OA. Instructional design models express main ideas or guiding guidelines for analyzing, producing, and reviewing learning environments (Jardines,2017).

Collection of information for the analysis and design of the OA-EAB

This section summarizes the way in which the information collection for the analysis and design of the OA-EAB was carried out, where the interaction that took place between the collaborators of the FCC-BUAP and the FM-BUAP played a fundamental role in achieve that goal. It is important to highlight that the collaborators of the FM-BUAP are professionals in the area of medicine, and have at least three years of experience in the teaching of the Biochemistry subject. The complete description of this stage can be found in Castillo et al. (2019).

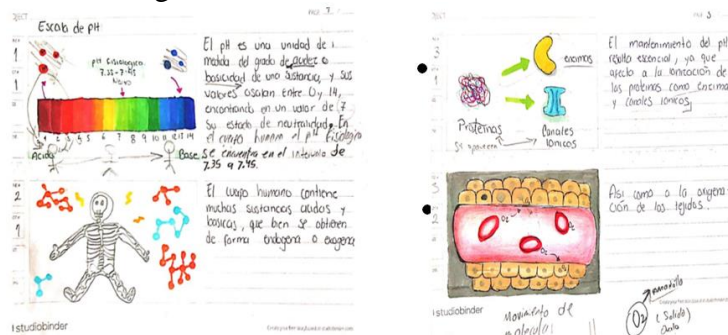
Integrating a multidisciplinary group of professionals is not an easy task, so to reach agreements, several work meetings were held between professors from both faculties and some of their students. In these sessions, the analysis and design phases of the OA-EAB were carried out, which indicate what is needed and how to do it.

Involving students had important positive repercussions in the development of the analysis and design phases, since the FM-BUAP students provided suggestions about how they would better understand a certain concept; at the same time, the FCC-BUAP students put into practice their knowledge in the use of software and management of technological platforms.

Regarding the analysis, it should be noted that the acid-base balance topic was divided into three sub-topics: introduction, buffers, and acid-base balance disorders. Therefore, the OA-EAB is organized into the same three subtopics, and each subtopic has a video and a self-assessment activity designed for the purpose of verifying the acquisition of knowledge.

It is worth noting that one of the most important tasks accomplished, through the collaboration of all the participants, was the construction of the storyboards (often known as storyboards). These are the basis for the construction of the videos associated with each of the subtopics, since they are the ones that indicate what should be presented and heard, as well as when and how. As examples, Figure 1 shows two storyboards created for one of the subtopics.

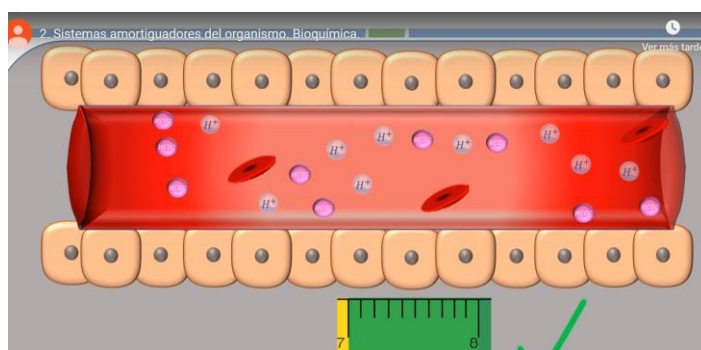
Figura 1. Guiones gráficos del subtema de introducción del OA-EAB



Fuente: Elaboración propia

In terms of design, agreements were reached to obtain a homogeneous appearance in the videos in terms of colors, shapes and images. In addition, a template was built for the font type, color and size, margins, background colors, indents and audio usage. Most of the images are their own, that is, the FCC-BUAP students built them based on the indications of teachers and students of the FM-BUAP; the rest are distributed under terms of open access policies. Figure 2 shows a screenshot that shows the lower part of the second storyboard of Figure 1 (this was obtained by viewing the video of one of the subtopics of the acid-base balance topic).

Figura 2. Captura de pantalla del video de introducción al tema *equilibrio ácido-base* del OA



Fuente: Elaboración propia

For the implementation of the OA-EAB videos, the use of multimedia tools that could be directly related to the visual, auditory and kinesthetic learning styles, which correspond to the majority of the students, was considered. Table 1 describes the resulting OA-EAB videos, where the title of each video corresponds to the subtopic it presents.

Tabla 1. Descripción de videos

Vide o	Título del video	Duraci ón (minut os)	Dirección en internet
1	Introducción	4:10	https://www.youtube.com/watch?v=oH0p8RXno8s
2	Amortiguadores	4:39	https://www.youtube.com/watch?time_continue=6&v=x3rsUUD2Xak&feature=emb_logo
3	Alteraciones del equilibrio ácido-base	Parte 1 3:42 Parte 2 2:33	Parte 1 : https://www.youtube.com/watch?time_continue=21&v=H6E8pKs8QAo&feature=emb_logo Parte 2: https://www.youtube.com/watch?time_continue=49&v=MI88sHHTCGQ&feature=emb_logo

Fuente: Elaboración propia

OA-EAB self-assessment activities

The OA-EAB self-assessment activities were implemented using Educaplay, a platform designed to create and find educational activities, manage groups, export resources (it is adaptable to the screen size of any device, available at <https://es.educaplay.com/>). The activities for Videos 1 and 3 consist of a crossword of eight and one of five words that refer to the basics of the topic acid-base balance in the first, and alterations in the second. The crosswords have clues that help to find the solution and the students can do each crossword as many times as they want; In addition, they can know their progress through a score, as well as observe the correct solution (it should be noted that a repetition limit was not assigned).

On the other hand, the self-evaluation activity of video 2 consists of relating columns about ten relevant concepts of the shock absorber topic, for which a time limit of two minutes was assigned. At the end of the attempt or when the time limit is exceeded, the result is shown with the obtained score and the correct solution; The option to retry without exceeding the maximum number of attempts (15 attempts) is also offered.

Usability and satisfaction

Formally, the definitions of usability, according to the International Organization for Standardization (ISO), are the following (ISO 9241-11): a) “Usability refers to the ability of a software to be understood, learned, used and be attractive to the user, under specific conditions of use ”and b)“ usability is the effectiveness, efficiency and satisfaction with which a product allows specific objectives to be achieved by specific users in a specific context of use ”. Usability is an aspect to be evaluated in LOs, and is related to elements such as ease of navigation, the quality of help resources in an interface, and the ability to predict actions and events.

When usability is perceived as a process, efficiency, effectiveness and satisfaction are associated with data collection, interpreted as information from a quantitative approach that uses a set of metrics, or with a qualitative approach that highlights the experience of experts and the opinions of the users, as well as using a mixed approach according to the interests and elements to be evaluated (González, Montero and Gutiérrez, 2012); for example, consider the satisfaction scale rate, the rate of use over time, or the frequency of complaints as metrics that are associated with satisfaction.

Methodology and results

As mentioned in the introduction to this document, the OA-EAB was developed to support the training needs of future students of the Biochemistry I course at FM-BUAP. One of the aspects to be evaluated in any LO is its usability. As mentioned in the previous section, usability allows achieving specific objectives according to specific users in a given context, which is related —among other aspects— to user satisfaction. after using the OA.

Given this, this section describes the methodology that was followed during the implementation of a study to evaluate the satisfaction of students from nine Biochemistry I courses in the first semester of FM-BUAP in autumn 2019, who used the videos of each subtopic included in the OA-EAB and the results obtained. The purpose was to have an assessment of the satisfaction of each video, prior to the release of the OA-EAB on the Codaes platform.

Description of students

Table 2 shows the number and gender of the students who participated in the satisfaction evaluation of each video (see table 1). In this regard, it should be noted that some students did not view all the videos; However, all of them belong to the nine groups of students of the 21 first-semester groups who took the Biochemistry I course. The ages of the students range from 18 to 21 years. The evaluation was carried out during the fall semester 2019 at the BUAP School of Medicine (the evaluation period was five business days).

Tabla 2. Número de estudiantes que visualizaron los videos

Video	Número de estudiantes	Género de los estudiantes
1	479	35% Femenino 65% Masculino
2	395	32% Femenino 68% Masculino
3	345	31% Femenino 69% Masculino

Fuente: Elaboración propia

Description of activities prior to the satisfaction evaluation

During the evaluation period, the following activities were carried out:

Activity 1. Internet page design with videos and satisfaction evaluation instrument

The FCC-BUAP professors designed an internet page where the links for the three videos are displayed (namely, <https://sites.google.com/view/bioquimica-fm-buap/p%C3%A1gina-principal>), as well as the links for the satisfaction evaluation instruments. It should be mentioned that the same satisfaction evaluation instrument was applied for each video, which was designed by the teachers of the FCC-BUAP and corresponds to a questionnaire implemented on the Google platform. Forms (https://www.google.com/intl/es_mx/forms/about/). The purpose was that after each student used a video, they would respond to the associated instrument; this would yield three sets of responses.

It should be noted that before the students viewed the videos on the website, the FM-BUAP teachers were asked to use the checklist shown in table 3 for each video. The

verification elements correspond to an adaptation of those described in Velázquez, Rodríguez, Muñoz, Cardona, Silva, Hernández and Cechinel (2015). Also, as there were no comments or suggestions regarding colors or contrast, it was assumed that these items were found to be adequate. Only until all the six teachers verified all the elements was the satisfaction evaluation carried out.

Tabla 3. Lista de verificación valores promedio de satisfacción de los tres videos

No.	Aspecto de verificación	Cumple	No cumple
1	El video fue fácil de encontrar		
2	El video se cargó rápidamente		
3	El video estuvo disponible		
4	Fue fácil llegar a cualquier parte del video		
5	La información del video estuvo organizada		
6	La información del video fue veraz		
7	El nivel de dificultad de los contenidos fue apropiado		
8	La estética (colores utilizados, tipo de letra, colocación de los elementos gráficos) fue adecuada		
9	La información presentada fue adecuada y suficiente		
10	El video me ayudó a aprender		

Fuente: Elaboración propia

Activity 2. Design and application of a diagnostic evaluation instrument

The FM-BUAP professors designed a diagnostic evaluation instrument to obtain information on the students' previous knowledge about the acid-base balance topic. Before the professors presented the subject in the groups, they gave the students the test instrument. diagnostic evaluation in printed form for a response within 15 minutes. A fragment of the instrument is shown in figure 3.

Figura 3. Fragmento del instrumento de evaluación

DEPARTAMENTO DE BIOQUIMICA-FM-BUAP

EVALUACIÓN DE CONTENIDOS DEL OBJETO DE APRENDIZAJE SOBRE EL TEMA EQUILIBRIO ÁCIDO-BASE

INSTRUCCIÓN: subraya la respuesta correcta a las siguientes preguntas.

- Es conocido como la unidad de medida del grado de acidez o basicidad de una sustancia.
 - Ácido
 - Base
 - Amortiguador
 - pH
- Sus valores oscilan entre 7.35 y 7.45.
 - pH fisiológico
 - pH urinario
 - pH del cuerpo humano
 - pH de la saliva
- Son sustancias que aceptan iones.
 - Ácidos
 - Bases
 - Amortiguadores
 - Óxidos
- Es una manifestación de la disminución del pH.
 - Disminución del tono simpático
 - Retracción de la pupila

Fuente: Elaboración propia

Activity 3. Follow up instructions

The same day of class that the diagnostic evaluation instrument was delivered and after having collected it and answered it, each teacher wrote on the blackboard the internet address to access the videos and the links for the satisfaction evaluation instruments. Then, each teacher indicated that they had a maximum of three days to review the three videos (it was intended that those days coincide with the weekend, that is, days when there are no classes) so that they could respond to the satisfaction evaluation instruments corresponding, although some students — as shown in Figure 4— began to view the videos immediately.

Figura 4. Visualización de videos por estudiantes de la FM

Fuente: Elaboración propia

Activity 4. Knowledge assessment

On the fourth day, at the beginning of class and without having exposed any of the topics explained in the videos, the students were again asked to answer the same diagnostic assessment instrument mentioned in activity 2. The intention was to evaluate the acquisition of knowledge in a moment after using the videos. Figure 5 shows a group of students completing this instrument. The results of the diagnostic evaluation before and after the use of the videos are not part of the scope of this study.

Figura 5. Estudiantes de la FM-BUAP contestando el instrumento de evaluación diagnóstica



Fuente: Elaboración propia

Satisfaction evaluation

Since the content of the videos is supported by bibliographic references from recognized sources and has been reviewed by experts—that is, Biochemistry I professors—the satisfaction evaluation is aimed at collecting information related to the design and presentation of the text, audio and images of the videos. This section describes the methodology implemented in which the students described in table 1 participated.

As mentioned in the description of activity 1, section 3.2, in the satisfaction evaluations for each of the three videos, the same instrument was used, consisting of the three sections described below:

Section 1: Present the title and subtitle of the video.

Section 2. Collects the following personal information from students: registration number, full name and section number of the course. Along with personal

information —which is used under confidentiality criteria and only for the analysis of results—, in section 2 a question was also inserted in which students are asked to indicate how they consider that they learn more easily: “listening” , “Seeing” and “doing” (words associated with auditory, visual or kinesthetic learning styles, respectively).

Section 3 contains the ten-question questionnaire shown in table 4.

Tabla 4. Cuestionario de la sección 3: instrumento de evaluación de satisfacción

Pregunt a	Descripción
1	¿Considera que la cantidad de información que se incluye en el video es demasiada?
2	¿Piensa que existe una adecuada relación entre el audio, las imágenes y el texto presentado?
3	¿Los textos resultan fácilmente legibles?
4	¿Las imágenes y animaciones presentadas son de buena calidad?
5	¿El video expone los temas a una velocidad adecuada?
6	¿La pronunciación y entonación es entendible?
7	¿Considera que los efectos de sonido se están utilizando adecuadamente?
8	¿Considera que hay silencios incómodos durante la exposición del video?
9	¿Le gustaría contar con más videos que le apoyen con otros temas de este curso?
10	¿Compartiría este video con alguien?

Fuente: Elaboración propia

In the questionnaire instructions, the students were asked to answer each question by selecting one of the five values from the following Likert scale (values are presented with an orientation from negative to positive):

- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4) and
- Strongly agree (5)

Table 5 shows the averages obtained in the satisfaction evaluation of video1: introduction.

Tabla 5. Valores promedio de satisfacción de los 479 estudiantes con respecto al video 1

Pregunta	Promedio	Interpretación
1	2.3	En desacuerdo con que la cantidad de información que se incluye en el videos demasiada.
2	4.2	De acuerdo con que existe una adecuada relación entre el audio, las imágenes y el texto presentado.
3	4.3	De acuerdo con la calidad de las imágenes y animaciones presentadas.
4	4.1	De acuerdo con que los textos resultan fácilmente legibles.
5	3.9	De acuerdo con que el video expone los temas a una velocidad adecuada.
6	3.8	De acuerdo con que la pronunciación y entonación es entendible.
7	3.8	De acuerdo con que los efectos de sonido se están utilizando adecuadamente.
8	2.6	Ni de acuerdo ni en desacuerdo con que hay silencios incómodos durante la exposición del video.
9	4.7	Totalmente de acuerdo con que les gustaría contar con más videos que le apoyen con otros temas de este curso.
10	4.4	Totalmente de acuerdo con que compartirían este video con alguien.
Promedio	3.8	

Fuente: Elaboración propia

The 479 students who viewed the video agreed with the design and presentation of the text, audio, and images. It is worth highlighting the average result of question 9, where students indicate their great interest in having more videos of this type to support learning. In general, they show a very high degree of satisfaction for video 1, so the probability that they recommend it to others is also high.

Table 6 shows the averages obtained in the satisfaction evaluation of video 2: shock absorbers.

Tabla 6. Valores promedio de satisfacción de los 395 estudiantes sobre el video 2

Pregunta	Promedio	Interpretación
1	2.5	Ni de acuerdo ni en desacuerdo con que la cantidad de información que se incluye en el video es demasiada.
2	4.1	De acuerdo con que existe una adecuada relación entre el audio, las imágenes y el texto presentado.
3	4.2	De acuerdo con que las imágenes y animaciones presentadas son de buena calidad.
4	4.1	De acuerdo con que los textos resultan fácilmente legibles.
5	3.7	De acuerdo con que el video expone los temas a una velocidad adecuada.
6	3.7	De acuerdo con que la pronunciación y entonación es entendible.
7	3.9	De acuerdo con que los efectos de sonido se están utilizando adecuadamente.
8	2.8	Ni de acuerdo ni en desacuerdo con que hay silencios incómodos durante la exposición del video.
9	4.7	Totalmente de acuerdo con que le gustaría contar con más videos que le apoyen con otros temas de este curso.
10	4.3	Totalmente de acuerdo con que compartiría este video con alguien.
Promedio	3.8	

Fuente: Elaboración propia

The 395 students who viewed video2 agree with the design and presentation of the text, audio, and images, although it is worth noting that the minimum satisfaction value corresponds to question 1, referring to the amount of information. In relation to this element, it should be explained that through direct questions with the students in another class session after the delivery of the assessment instrument, it was determined that the topic of video 2 was more complex for them than that explained in video 1, which implies that the amount of information was not what was expected.

Table 7 shows the averages obtained in the satisfaction evaluation of video 3: acid-base balance alterations.

Tabla 7. Valores promedio de satisfacción de los 345estudiantes que usaron el video 3

Pregunta	Promedio	Interpretación
1	2.2	En desacuerdo con que la cantidad de información que se incluye en el video es demasiada.
2	3.7	De acuerdo con que existe una adecuada relación entre el audio, las imágenes y el texto presentado.
3	3.7	De acuerdo con que las imágenes y animaciones presentadas son de buena calidad.
4	3.7	De acuerdo con que los textos resultan fácilmente legibles.
5	3.3	Ni de acuerdo ni en desacuerdo con que el video expone los temas a una velocidad adecuada.
6	3.3	Ni de acuerdo ni en desacuerdo con que la pronunciación y entonación es entendible.
7	3.4	Ni de acuerdo ni en desacuerdo con que los efectos de sonido se están utilizando adecuadamente.
8	2.2	En desacuerdo con que hay silencios incómodos durante la exposición del video.
9	4.1	De acuerdo con que le gustaría contar con más videos que le apoyen con otros temas de este curso.
10	3.8	De acuerdo con que compartiría este video con alguien.
Promedio	3.3	

Fuente: Elaboración propia

The minimum value indicated by the students who used video3 was obtained in question 1 (as it happened in video 2). It is inferred that the complexity of the information could be the reason why they assigned low values. On the other hand, the maximum value obtained was obtained in question 9, which indicates that there is a very high probability of recommending the third video.

Table 8 shows the averages obtained in the satisfaction evaluation of the three videos. The purpose is to identify the elements with unsatisfactory averages, in addition to showing both the question and the average on the Likert scale and indicating which value is closest. It is observed that the opinion of the videos regarding nine of the ten questions is, in general, positive. The only opinion that could not be evaluated as favorable or negative is for question eight, related to the detection of uncomfortable silences during the exposure of the video.

Tabla 8. Valores promedio de satisfacción de los tres videos

Pregunta	Promedio del video				En la escala Likert es más cercano a
	1	2	3	de los 3	
1. ¿Considera que la cantidad de información que se incluye en el video es demasiada?	2.3	2.5	2.2	2.3	En desacuerdo
2. ¿Piensa que existe una adecuada relación entre el audio, las imágenes y el texto presentado?	4.2	4.1	3.7	4	De acuerdo
3. ¿Los textos resultan fácilmente legibles?	4.3	4.2	3.7	4	De acuerdo
4. ¿Las imágenes y animaciones presentadas son de buena calidad?	4.1	4.1	3.7	3.9	De acuerdo
5. ¿El video expone los temas a una velocidad adecuada?	3.9	3.7	3.3	3.6	De acuerdo
6. ¿La pronunciación y entonación es entendible?	3.8	3.7	3.3	3.6	De acuerdo
7. ¿Considera que los efectos de sonido se están utilizando adecuadamente?	3.8	3.9	3.4	3.7	De acuerdo
8. ¿Considera que hay silencios incómodos durante la exposición del video?	2.6	2.8	2.2	2.5	En desacuerdo y Ni de acuerdo ni en desacuerdo
9. ¿Le gustaría contar con más videos que le apoyen con otros temas de este curso?	4.7	4.7	4.1	4.5	De acuerdo
10. ¿Compartiría este video con alguien?	4.4	4.3	3.8	4.1	De acuerdo
Promedio general				3.6	De acuerdo

Fuente: Elaboración propia

Table 8 also shows the general average of the three videos (that is, 3.6), this indicates that student satisfaction turned out to be between the values “neither agree nor disagree” and “agree”, closer the latter, which was considered by the experts as an appropriate satisfaction. However, in future work —for updates to the videos or for the generation of similar ones— it will be necessary to consider the amount of information that is exposed, as well as to review the number and moments of silences employed.

Discussion of results

By way of self-evaluation, gathering of experience and identification of best practices among the authors of this document and developers of the OA-EAB, the following is listed.

Regarding the work team and its organization:

1. The didactic experience of the FM teachers who are experts in the course is essential, since they identified which sections of the topics required more support; that is to say, their mental models, schemes and sketches were indispensable so that the developers could represent the contents in the videos. The participation of FM students during the development of the OA-EAB was fundamental, since they are part of the population of end users or audience to whom this object is directed. In particular, in the analysis and design phase, their collaboration allowed to confirm the training needs and contribute to the graphic design of the elements that helped facilitate learning. At the same time, the effort, commitment and dedication of the collaborating students belonging to the FCC, who invested time and effort to learn the terminology of the selected topics, are recognized.
2. Once the objective of the OA-EAB was agreed, the professors of both faculties worked in several sessions the different levels of complexity and thematic scope, so that it was transformed into a video with a considerable duration to keep the attention of an average student. On the other hand, the FCC-BUAP students focused on representing in digital format the traditional representations available in books, articles and notes, taking the advantage that in the video these representations would have a certain dynamism.
3. The availability, dedication and collaboration of all the participants was required to maintain clear and constant communication that would allow us to achieve the proposed objective.
4. At the beginning of the project, a work plan was drawn up describing the duration of the main activities, those responsible and the expected products of each activity, as well as the forms and mechanisms for monitoring and control. It was relevant to have initially considered the times for the design of the instruments and the times of application.

Regarding the results obtained, the following can be perceived:

1. The amount of information included is considered adequate, but attention should be paid to awkward silences during video exposure. For the latter, perhaps the exposure time of an image can be reduced, analyze if it is necessary to say something or definitely delete an image. This must be decided with the help of the experts.
2. The relationship between the audio, the images and the text is adequate, the texts are easily legible, the images and animations presented are of good quality.
3. The video exposes the topics at a suitable speed, the pronunciation and intonation is understandable and the sound effects are being used properly; however, the quality of these aspects can be improved, for example, by changing the voice, modifying the speaker speed or inserting sound effects; according to the preferences and recommendations of the experts.
4. The duration of the videos allowed to keep the attention of the students (no video was longer than five minutes).
5. The inclusion of the reference list at the end of the videos was well received by the students.
6. It should be noted that 71% of the students who used the videos indicated that their best ways of learning included listening or watching (that is, they chose listening-seeing-doing; listening-watching; seeing-doing; watching). These same students said they would like more videos for other topics in the course. With respect to 21.5% of the students who used the videos and who indicated that their best way of learning is only by doing, practically all of them indicate that they would like to have more videos than to support other topics in the course. This affirms that this type of learning support resources is well accepted by students, no matter the best way they have to learn.

Conclusions

This article presented the satisfaction evaluation of a LO designed to support the learning of undergraduate students in Medicine. The content of this OA deals with topics related to acid-base balance, which are exposed in three videos made with information and communication technologies, and distributed under the terms of open access policies.

The videos were produced in phases such as analysis, design, development, implementation and evaluation. The collaboration and participation of medical students, computer students, the knowledge and experience of research professors from the FM-BUAP and the FCC-BUAP were fundamental in all phases. This article presented the methodology to estimate the satisfaction evaluation of the videos produced for the OA-EAB; The data were collected using questionnaires that were answered by at least 345 students belonging to nine Biochemistry I courses in the first semester of FM-BUAP. The results indicate a high degree of satisfaction and indicate areas of opportunity to produce similar LOs.

The elaboration of multimedia elements in the courses of higher education institutions such as the one described in this document is aimed at positively influencing the teaching-learning processes. As future work, it is proposed to take into account the results of the evaluation that came out lower and to look for alternatives for their improvement; for example, reducing the time of the longest videos, reviewing the awkward silences to avoid them, etc., all always in collaboration with the experts in the subject that is being addressed. Another possibility would be to create them in English, so the scope of these could be expanded.

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