

Use Khan Academy in the mathematics teaching-learning process

Uso de Khan Academy en el proceso de enseñanza-aprendizaje en matemáticas

MOTA-MACÍAS Silvia Elena*†, HUIZAR-RUVALCABA, Diego, TRUJILLO-GARCÍA, Fabricio Raúl and SOLANO-PÉREZ, Gabriel

Centro Universitario del Norte de la Universidad de Guadalajara, Mexico.

ID 1st Author: *Silvia Elena, Mota-Macías* / **ORC ID:** 0000-0002-0098-4295, **Researcher ID Thomson:** X-3109-2018, **PubMed Autor ID:** ebf4bdf1b14lbbf6b36b6972e40892ce1208, **CVU CONACYT ID:** 953357

ID 1st Co-author: *Diego, Huizar-Ruvalcaba* / **ORC ID:** 0000-0001-7063-5579, **Researcher ID Thomson:** X-2941-2018 **PubMed Autor ID:** 33040dc75ac 995545d8elbc86d3536252008, **CVU CONACYT ID:** 953304

ID 2nd Co-author: *Fabricio Raúl, Trujillo-García* / **ORC ID:** 0000-0001-7265-6656, **Researcher ID Thomson:** GXH-3907-2022, **PubMed Autor ID:** 8c4c36718cac07cf8fc2c94db87ffcad2709, **CONACYT ID:** 1190830

ID 3rd Co-author: *Gabriel, Solano-Pérez* / **ORC ID:** 0000-0002-9467-6508, **Researcher ID Thomson:** GXH-3527-2022, **PubMed Autor ID:** e6fb56096d82364e8cbeb7cf9d4aa7abe09, **CVU CONACYT ID:** 176361

DOI: 10.35429/EJS.2022.17.9.21.29

Received July 25, 2022; Accepted December 30, 2022

Abstract

The technology platforms implementation in the educative field such as Khan Academy (KA), has increased in a significative way due to the pandemic for learning management, which implies a significant change in content approach for both students and teachers. This paper's objective was to analyze students' experience using KA within three dimensions: motivation, learning, and innovation. From a methodological perspective, it was designed a descriptive investigation based on the quantitative analysis that describes perceptions (attitudes) about the use of the mathematics teaching-learning platform in two educative programs from Centro Universitario del Norte (CUNorte). The results obtained show that the majority of interviewees felt motivated to learn, considering that the platform's use advantages of their learning, it allows them to develop math skills, improved their grades, and learned in an innovative way. In addition, it will allow assessing the benefits and limitations in order to improve the application of the platform in the teaching practice.

Resumen

La implementación de plataformas tecnológicas en el ámbito educativo como Khan Academy (KA), se incrementó de manera significativa con la emergencia de la pandemia para la gestión de los aprendizajes, lo que implica un cambio significativo en el abordaje de contenidos tanto de docentes como de estudiantes. El objetivo del trabajo fue analizar la experiencia de los estudiantes en el uso de KA en tres dimensiones: motivación, aprendizaje e innovación. Desde la perspectiva metodológica, se diseñó una investigación descriptiva basada en un análisis cuantitativo que describe las percepciones (actitudes) sobre el uso de la plataforma en la enseñanza-aprendizaje en matemáticas en dos programas educativos del Centro Universitario del Norte (CUNorte). Los resultados obtenidos muestran que la mayoría de los entrevistados se sintieron motivados por aprender, considerando que el uso de la plataforma favorece sus aprendizajes, les permite el desarrollo de habilidades en matemáticas, mejoró sus calificaciones y aprendieron de forma innovadora. Además, permitirá valorar los beneficios y limitaciones para la mejora en la aplicación de la plataforma en la práctica docente.

Implementation, Platforms, Innovation, Significant

Implementación plataformas, Innovación, Significativo

Citation: MOTA-MACÍAS Silvia Elena, HUIZAR-RUVALCABA, Diego, TRUJILLO-GARCÍA, Fabricio Raúl and SOLANO-PÉREZ, Gabriel. Use Khan Academy in the mathematics teaching-learning process. ECORFAN Journal-Spain. 2022. 9-17:21-29.

* Author's Correspondence (E-mail: silvia.mota@cunorte.udg.mx)

† Researcher contributing first author.

Introduction

This work was developed at the University Center of the North (CUNorte), as a dependency of the University of Guadalajara, which is present throughout the state of Jalisco, through 15 University Centers, is a multi-thematic center, where 12 educational programs are offered at the undergraduate level and 6 graduate programs in various disciplinary areas.

CUNorte carries out its activities based on the educational model of the University of Guadalajara (2007), where academic activities are centered on the student, their ways of being and learning to be, to know, to do, to live together and to undertake. Consequently, its implementation is based on the constructivist perspective that proposes the search for new ways of working with greater flexibility adjusted in a pertinent manner for the development of competencies, abilities, skills, aptitudes and attitudes necessary for personal fulfillment.

With the emergence of the pandemic generated by COVID-19, teaching was affected in a disruptive way in the approach to the thematic contents, going from a face-to-face modality to a totally online one; where it was necessary the implementation of diverse tools and educational platforms to strengthen the students' learning. Therefore, students found the need to experience the use and management of educational platforms with the guidance of the teacher, among them Khan Academy (KA), so it is relevant to know from the student's perspective, the impact of the use of the platform in the generation of learning. In such a way that it invites the teacher to investigate and innovate the approach to content with the incorporation of technological tools understood not as an end but as a means.

In relation to KA, it is an educational platform to strengthen learning in mathematics, benefits have been identified on its use as those made by Murphy (2014), suggesting that its use is positive and better results were obtained in the tests applied as well as greater confidence in the individual capacity of students.

Research conducted by Brijaldo (2016), indicates the benefits of the use of the platform in the autonomous promotion of student learning, likewise in their KA site document the research conducted by Alberson Family Foundation (2018), in which they point out that students who complete 60% of mathematics in their grade increase 1.8 their expected growth in the NWEA MAP test, conducted for the evaluation of academic progress.

On the other hand Ramirez, and Vizcarra (2016), point out that students when using this tool increased their academic performance, at the same time anxiety is decreased when feeling evaluated in mathematical processes, this due to considering it as an academic game.

The present study is carried out from a descriptive quantitative approach, which has allowed us to know the perceptions of CUNorte students about the use of the KA platform for teaching and learning mathematics with respect to three dimensions: motivation, innovation and learning.

As a result, the question is answered: in what way does the use of the KA platform motivate and innovate the generation of learning of CUNorte students in mathematics? The knowledge derived from the research will allow us to find the benefits and limitations that improve the application of the tool in practice.

Background

ICT in education

Information and Communication Technologies (ICT) have had an impact on the educational field for years, and their integration seeks to improve the effectiveness of teaching and learning in educational organizations.

In this regard Rueda and Guzmán (2018) state that the use of ICT in the educational field allows pedagogical innovation, digital literacy for students and teachers, knowledge management, strengthening the teaching-learning process and educational quality.

Hence, great advances have been evidenced in educational processes due to the incorporation of ICT, in this regard Herrera, "apud Rueda and Guzmán" (2018), states that they are opening an era of change in the teaching-learning process allowing to propose innovative strategies that facilitate the development of professional competencies.

Currently there is a great variety of tools and platforms of free access in the educational field, in recent years their use has been increasing, which has allowed new ways of learning. Students are the ones who manage their learning in a free and spontaneous way through the use of ICT, which implies a greater degree of responsibility and autonomy in the generation of their learning.

ICTs in the teaching-learning of mathematics

The incorporation of ICT in the teaching of mathematics is relevant for learning processes, there is the possibility of greater motivation on the part of students and also allows diversifying teaching methods by the teacher, Soler et al., 2017 "apud Grisales" (2018), state that teachers should update teaching methods and incorporate new strategies and technologies, to generate motivation in students and invite them to investigate, about the scopes that mathematics has in situations of their professional and practical life. In other words, the incorporation of ICT in the teaching of mathematics is fundamental, because they make it easier to understand some processes and abstract concepts of mathematics.

Also, for Quintero and Jerez (2019) the work with ICT becomes important, because they develop certain key points to talk about the student as the protagonist of their learning, which allows to increase motivation by awakening the interest to learn and understand, they allow the immediacy of transmission and reception of information. In this sense, their use must be oriented to the understanding of mathematical processes and not to the performance of routine activities, i.e., we must seek to achieve meaningful learning of mathematics through the use of ICT. Therefore, they are an ideal tool for teaching mathematics.

Khan Academy in the teaching-learning of mathematics

KA is a freely accessible platform for interactive learning support in science subjects. It offers more than 10,000 online educational videos, each topic includes exercises and problems with real-time solutions. The platform has four main components: data, videos, exercises and a user community that allows users to interact and leave comments on the solution process. On the other hand, Rodriguez, Light and Pierson (2014), mention that, in relation to the teaching of mathematics, positive changes were observed on how students learn and their ability to generate their learning processes in an active way.

This web platform was created in 2006 by Salman Khan and contains lessons in mathematics, art, programming, economics, physics, chemistry, biology, medicine and finance, among others. It is a tool that allows interactivity, promotes student motivation. In addition, it allows the accompaniment of the student, that is, the teacher can simultaneously monitor the process of students virtually and in real time, because KA courses are based on the practice of self-assessment exercises, which are deployed according to the demonstration of previous knowledge, the development of areas of opportunity, and the achievement of mastery of new knowledge.

The courses begin with a diagnostic test that allows recognizing which are the mathematical skills consolidated by the student, then presents exercises to be solved according to a logical mathematical sequence, from lower to higher level of complexity, to form and strengthen different mathematical skills (Ramirez and Vizcarra, 2016).

The self-evaluating exercises allow the teacher to make a diagnosis of the student's academic situation, in a specific mathematics topic and from there a learning path can be designed to strengthen the acquired knowledge.

In this sense, the use of the KA platform increases the motivation of students, because it allows them to learn at their own pace, in addition to having the possibility of reviewing the lessons as many times as necessary, thus consolidating their knowledge while practicing with a variety of exercises, i.e., the activity can be programmed so that they are always different exercises.

Hence, being a flexible platform, it can be used as a support and complement to classroom work, or it also allows anyone to access and work on their own. So it can be an element of support for the teacher and for students who have other ways of learning through visual and interactive activities for the understanding of a lesson.

In addition, the use of KA allows students to acquire meaningful learning and boosts competencies in the area of mathematics, basically it is an innovative strategy to learn and practice based on video tutorials or quizzes with their respective feedback with the objective that the student is able to solve mathematical problems. While the teacher allows him to give a punctualized follow-up to each student and feedback on the topics identified as the most difficult for the students.

Thus, KA is a platform that provides a free digital educational environment easily accessible to develop different activities related to mathematics topics and other areas. It is able to identify pre-knowledge, strengths and weaknesses of each student because it is based on an artificial learning system. It is a platform that allows users to manage their learning.

Methodology

The research was conducted from a quantitative approach, descriptive non-experimental cross-sectional cut, which according to Hernández, Collado and Baptista (2014), seek to specify the properties, characteristics and profiles of people, groups, communities, processes, objects or any other phenomenon that is subjected to an analysis (p. 80). The Instrument to obtain the information was implemented in the first semester of the year 2021.

It was oriented to the knowledge about the use of the KA platform, with the intention of improving its implementation in the teaching of mathematics at the higher level, considering the dimensions of motivation, learning and innovation in the teaching-learning processes, according to the approaches of Jara, Cancino and Casillas (2019).

The fieldwork consisted of collecting data directly with the students, through a survey using a structured questionnaire applying the Likert scale, which according to Matas (2018), is a psychometric instrument in which the interviewee indicates agreement or disagreement on a statement, item or reagent, which is done through an ordered and unidimensional scale, (p.30).

The three dimensions of motivation, learning and innovation are analyzed through a questionnaire that includes five questions in each of them, with response options: always, almost always, sometimes, almost never and never adapted from Brioso (2020), to find out based on the guiding question of the work about the attitude of students in the use of the KA platform, which according to Oskamp and Schultz (2009), "apud Hernández, Collado and Baptista", an attitude is a learned predisposition to respond coherently in a favorable or unfavorable way to an object, living being, activity, concept, person or its symbols, thus attitudes are related to the behavior that is maintained around what is referred to.

With respect to validity according to Hernandez and Mendoza (2018), three types of validity can be used: content, construct and criterion validity. The validity in the use of KA was taken into consideration the content validity, which is established by the judgment of three experts considering pertinence, relevance and clarity.

Reliability is understood as the capacity to replicate congruent results with the same instrument when a measurement is made again in a similar population (Bernal 2010). To determine it, the Cronbach's Alpha coefficient was used, in which it has been defined that a value above 0.80 is acceptable, therefore, a value of 0.962 was obtained, which gives a high reliability to the instrument.

The study group was made up of 40 students from two undergraduate programs at the Centro Universitario del Norte of the University of Guadalajara, as shown in the following table:

Academic programs	Learning units	Population	Sample
Electronics and Computers	Pre-calculus	30 students	12 students
	Integral Calculus		12 students
Education	Mathematical Problem Formulation I	10 students	6 students

Table 1 Study group in the use of KA

Source: Own elaboration

Regarding the sample space, it was formed by the students who answered the instrument voluntarily. A total of 30 of them accepted the invitation and answered the questionnaire, which represents 75% of the population.

The information obtained was processed using Excel for the representation of the data and corresponding graphs. The following table shows the operationalization which, according to Carrasco (2006), consists of describing the form or method of how the variable is measured based on its conceptual definition, indicating the terms in which it should be measured.

Variable	Concept	Operational definition	Measuring level	indicators	
Use of Khan Academy	It is the use of didactic strategy through a digital platform based on b-learning for the study of mathematics and the improvement of their learning (Jara et al., (2019).	The use of Khan Acaemyes evaluated in terms of the dimensions Motiva-tion, Learning and Innovation	Ordinal	Never (1)	Under
				Almost never (2)	
				Sometimes (3)	Medium
				Almost always (4)	High
				Always (5)	

Table 2 Operationalization

Source: Own elaboration

Results

In the implementation of the instrument for the evaluation of the dimensions of motivation, learning and innovation on the use of the platform, the following results were obtained and are reviewed in each of the dimensions, first in a general way (tables) and in a second moment considering each of the questions (graphs).

Motivation Dimension

This dimension according to Manrique (2004), is necessary for the student to overcome difficulties, to be able to learn by developing self-confidence and to be aware of his capabilities and limitations, it is observed, as the interest shown by the student towards learning mathematics through technological and didactic strategies; motivation was measured in three levels: high, medium and low.

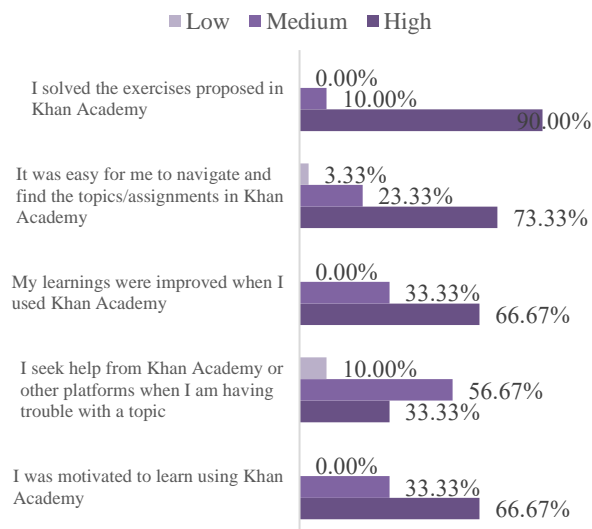
As shown in Table 3, generally considering 30 students, and that each of them would have 5 response options so that the total of responses is 150, taken as a basis for obtaining the percentages in this dimension, we have the levels of motivation in the use of KA. Based on the answers to the five questions, 2.66% have a low level, 31.33% have a medium level and 66% of the respondents have a high level of motivation.

Motivation							
Levels	Questions					%	
	1	2	3	4	5		
Under	1	0	0	0	2	0	2.66
	2	0	1	0	1	0	
Medium	3	3	7	10	17	10	31.33
High	4	21	20	17	9	19	66
	5	6	2	3	1	1	

Table 3 Results in motivation
Source: Own elaboration

Next, in graphic 1, each of the questions is shown with the results obtained, for example in question one (Did you solve the exercises proposed in Khan Academy?), based on the response of the 30 students in the low level 0%, medium level 10% and high level 90%.

Motivation



Graphic 1 Levels of Motivation in the use of Khan Academy
Source: Own elaboration

Most of the interviewees feel motivated to learn, solve the exercises proposed by the platform and were facilitated to navigate and find the topics and activities on the platform, basically they feel motivated in their learning and with the use of the platform.

Learning dimension

This dimension refers to the learning obtained using the KA platform through a process of knowledge acquisition; learning is measured in three levels: high, medium and low.

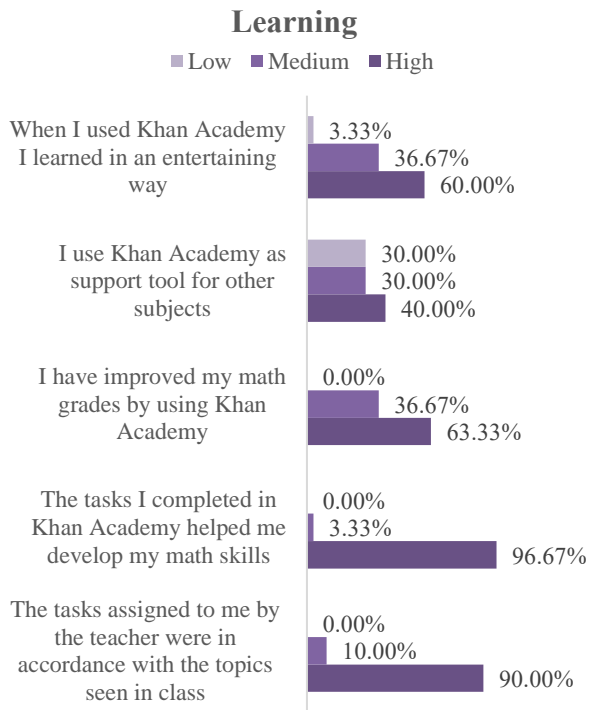
As shown in Table 4, this dimension expresses the levels of learning achieved with the use of KA, which are characterized by a higher proportion of high and medium levels.

Learning							
Levels	Questions					%	
	1	2	3	4	5		
Under	1	0	4	0	0	0	6.66
	2	1	5	0	0	0	
Medium	3	11	9	11	1	3	23.33
High	4	7	8	13	17	6	70
	5	11	4	6	12	21	

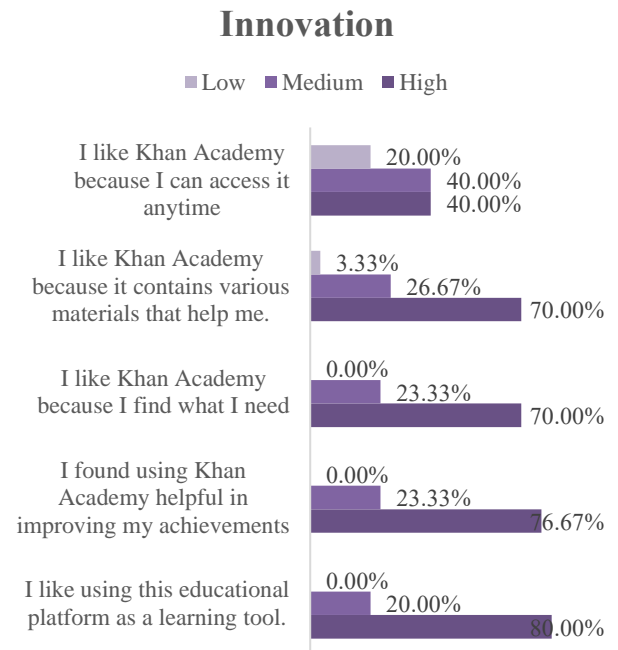
Table 4 Learning results
Source: Own elaboration

With respect to learning, in general, 6.66 presented a low level, 23.33 a medium level and 70% a high level, which shows the relevance in the use of the platform that allows the development of skills in mathematics, improving their grades and learning in an entertaining way. In other words, in general, the respondents were able to improve their learning.

Following the mechanics established in the motivation dimension, Graph 2 shows each of the questions with the results obtained in terms of learning.



Graphic 2 Learning levels in the use of Khan Academy
Source: Own elaboration



Graphic 3 Levels of innovation in the use of Khan Academy
Source: Own elaboration

Innovation Ddimension

This dimension is based on the use of ICT and didactic strategies with Open Educational Resources offering the opportunity to learn mathematics in a different way; innovation is measured in three levels: high, medium and low.

As shown in Table 5, this dimension shows the three levels of innovation in the use of KA.

Innovation						
Levels	Questions					%
	1	2	3	4	5	
Under	1	0	0	0	0	0.66
	2	0	1	0	0	
Medium	3	6	8	9	7	24
High	4	12	13	11	9	75.33
	5	12	8	10	14	

Table 5 Results in innovation
Source: Own elaboration

As can be seen in the table, 0.66% of the respondents show a low level of innovation, 24% show a medium level and 75.33% consider a high level of innovation. In general, most of the respondents have a high or medium level in this dimension, basically here the interviewee made use of ICT to learn mathematics in a different way, the respondents liked the platform, they found it useful because they found a wide diversity of resources and with easy access.

The following graph shows each of the innovation questions with their respective results.

Discussion

With respect to the results of the research, it is identified that the use of KA in the area of Mathematics allowed learning in an innovative way, that is, the use of the platform represented an alternative for the student to learn in a different way, and to complement or reinforce what was seen in class, the platform has a great variety of resources and activities, allowing the development of capabilities, competencies and skills in students. The findings coincide with some research on the subject:

In the study by Ramirez and Vizcarra (2016) showed that the use of KA in the elementary mathematics course contributed significantly in the learning of the participants, its use allowed them to remember basic knowledge, reinforce their knowledge and learn new things.

According to Ruiz (2018), regarding the use of KA states that the interaction of the students with the TICS was energized, which allowed greater understanding, they went from being passive participants in the classroom to being active agents of their own learning. While in the findings of Chávez (2018) states that the use of learning strategies in obtaining final grades in the subject of mathematics is influenced and improved by the use of Khan Academy.

On their account, Jara, Cancino and Casillas (2019), showed that the use of KA favored the academic performance of the students and they felt motivated when interacting with the activities in KA.

For their part Lou and Jaeggi, "apud en Salvatierra, Romero y Flores", (2021) state that the implementation of KA for learning shows benefits and allows the activation of prior knowledge. In their study it was shown that KA is a platform that allows to consolidate and consolidate the learning of calculus.

Thus, the analysis in the use of the KA platform in the teaching-learning process, allowed observing the perception of students on three dimensions: Learning, Motivation and Innovation, most of the interviewees felt motivated to learn, they solved the exercises proposed by the platform and it was easier for them to navigate and find the topics and activities on the platform, they considered that the use of the platform favors their learning. They stated that the platform allowed them to learn in an entertaining way, develop math skills and improve their knowledge. They also found that the educational platform offered a wide variety of topics and practice exercises that allowed them to reaffirm their learning.

Funding

This work was developed at the University Center of the University of Guadalajara, and no funding was necessary.

Conclusions

As a teacher, it should be clear that the implementation of ICT in education is not only about integrating technological tools, it is necessary to transform practices and methodologies in the approach to disciplinary content, to enhance its use and allow student participation in the construction of their knowledge, thus facilitating the acquisition of meaningful learning.

In this sense, there are a great number of technological tools that the teacher can use for the teaching-learning process of mathematics, however, a problem is the fear of change, most teachers are wary of innovating using ICT, making proper use of these, it favors the autonomous learning of students, giving them the opportunity to take an active role and teach them to learn how to learn.

The use of KA in the Precalculus, Calculus and Mathematical Problem Formulation courses allowed innovation, giving the student the opportunity to learn in a different way and complement or reinforce what was seen in class.

The use of the platform, which has a great variety of digital resources and activities, appropriate for the development of skills and competencies in the students, allowed them to improve their learning in mathematics.

The study showed that the use of KA improved the teaching-learning process, the interviewees felt motivated to learn using the platform, it inspired them confidence and also some students used the platform to seek help from other subjects. While in the Learning dimension, the topics reviewed were in line with what they had seen in class, allowed them to develop skills, improve their grades and learn in a fun way, and in the Innovation dimension, they were delighted with the content of the material and the easy access to it.

On the other hand, the scope of the study is limited, it analyzed the experience of one teacher with his groups, however, it makes clear the benefits of its use and invites teachers to use it for its flexibility and diversification in the acquisition of learning in mathematics by students in an innovative way.

References

- Alberson Family Foundation. (2018). *Khan Academy/impact. Obtenido de Learning Gets Personal: How Idaho students and teachers are embracing*. Accessed 27 August 2022: <https://s3.amazonaws.com/KA-share/impact/learning-gets-personal.pdf>
- Bernal Torres, C. A. (2010). *Metodología de la investigación*. (3^{ra} ed.). Pearson Educación de Colombia, S.A. de C.V.
- Brijaldo, M. (2016). Pontificia Universidad Javeriana. Obtenido de "Diseño de una estrategia de enseñanza y aprendizaje bimodal mediada por la plataforma. Accessed 2 September 2022: <http://funes.uniandes.edu.co/10681/1/Bonilla2016Diseño.pdf>
- Brioso Cruz J. (2021). *Influencia del uso de Khan Academy en el aprendizaje autónomo de estudiantes de matemáticas de una universidad privada, 2020* (tesis de maestría). Universidad César Vallejo. Lima-Perú. https://repositorio.ucv.edu.pe/bitstream/handle/20.500.12692/57384/Brioso_CJ-SD.pdf?sequence=1&isAllowed=y
- Carrasco Díaz, S. (2006). *Metodología de la investigación científica: Pautas metodológicas para diseñar y elaborar el proyecto de investigación*. San Marcos.

- Chávez, L. (2018). Estrategias de aprendizaje y rendimiento académico en la asignatura Análisis Matemático II. *Educación*, 27(53), pp.24-40. <https://revistas.pucp.edu.pe/index.php/educacion/article/view/20304/20257>
<https://doi.org/10.18800/educacion.201802.002>
- Grisales A. A. M. (2018). Uso de recursos TIC en la enseñanza de las matemáticas: retos y perspectivas. *Entramado. Julio-diciembre, 2018. vol. 14, no. 2, p. 198-214.* <https://revistas.unilibre.edu.co/index.php/entramado/article/view/4751/4071>
<http://dx.doi.org/10.18041/19003803/entramado.2.4751>
- Hernández Sampieri, R., Fernández Collado, C., Baptista Julio, P., Méndez Valencia, S., & Mendoza Torres, C. (2014). *Metodología de la investigación* (6^{ta} ed.). McGraw-Hill Education.
- Hernández Sampieri, R., & Mendoza Torres, C. P. (2018). *Metodología de la investigación. Las rutas cuantitativa, cualitativa y mixta.* McGraw-Hill Education.
- Herrera, A. (2015). Una mirada reflexiva sobre las TIC en Educación Superior. *Revista electrónica de investigación educativa*, 17(1), 1-4. Retrieved from: <http://repositorio.uts.edu.co:8080/xmlui/bitstream/handle/123456789/347/GNC%20Khan-Academy%20una%20estrategia.pdf?sequence=1&isAllowed=y>
- Jara, F., Cancino, P. y Casillas, M. (2019). La integración de Khan Academy. Una estrategia didáctica para la evaluación de matemáticas en ingeniería. *Revista Electrónica de Divulgación De Metodologías Emergentes En El Desarrollo De Las STEM*, 1(1), pp.26-49. <http://www.revistas.unp.edu.ar/index.php/redu/article/view/825/716>
- Lou, A. J., y Jaeggi, S. M. (2020). Reducing the prior-knowledge achievement gap by using technology-assisted guided learning in an undergraduate chemistry course. *Journal of Research in Science Teaching*, 57(3), 368–392. <https://doi.org/10.1002/tea.21596>
- Manrique Villavicencio, L. (2004). *El aprendizaje autónomo en la educación a distancia.* Consultado el 7 de octubre de 2022 <https://files.pucp.education/departamento/educacion/2020/02/21174038/lile>
- Matas, A. (2018). Diseño del formato de escalas tipo Likert: Un estado de la cuestión. *Revista Electrónica de Investigación Educativa*, 20(1) 38–47.
- Murphy, R. Gallagher, L. Krumm, A., Mislevy, J., & Hafter, A. (2014). *Research on the Use of Khan Academy in Schools.* Menlo Park, CA: SRI Education.
- Quintero, M. y Jerez, J. (2019). Las Tic para la Enseñanza de la Matemática en Educación Media General. *Revista Electrónica de Ciencia y Tecnología del Instituto Universitario de Tecnología de Maracaibo*, 6(1), pp. 20-36. https://www.researchgate.net/publication/338028224_Las_Tic_para_la_Ensenanza_de_la_Matemática_en_Educación_Media_General
- Ramírez, M. y Vizcarra, J. (2016). Desarrollo de habilidades matemáticas en estudiantes normalistas mediante Khan Academy. *Ra Ximhai*, 12(6), pp.285-293.
- Rodríguez, J., Light, D., y Pierson, E. (2014). Khan Academy en Aulas Chilenas: Innovar en la Enseñanza e Incrementar la Participación de los Estudiantes en Matemática. *En Congreso Iberoamericano de Ciencia, Tecnología, Innovación y Educación* (Vol. 540).
- Rueda, K. & Guzmán, A. (2018) Khan-Academy una estrategia innovadora para mejorar la calidad en la educación superior a través del rendimiento académico de los estudiantes. *Revista de Pedagogía*. 105(39) pp.239-264
- Ruiz, W. (2018). *Uso de la plataforma educativa Khan academy como estrategia didáctica para fortalecer el aprendizaje de las razones trigonométricas en los estudiantes de grado once.* Universidad ICESI Escuela de Ciencias de la Educación: Santiago de Cali. Consultado el 22 de septiembre de 2022 https://repository.icesi.edu.co/biblioteca_digital/bitstream/10906/83936/1/T01550.pdf
- Salvatierra Melgar, A., Romero, S., & Shardin Flores, L. (2021). Khan Academy: Fortalecimiento del aprendizaje de Cálculo I en estudiantes universitarios. *Propósitos Y Representaciones*, 9(1), e1042. <https://revistas.usil.edu.pe/index.php/pyr/article/view/1042/1318>
<https://doi.org/10.20511/pyr2021.v9n1.1042>
- Soler C, Manuel G.; CÁRDENAS SALGADO, Fidel A.; HERNAN-DEZ-PINA, Fuensanta; MONROY HERNANDEZ, Fuensanta. Enfoques de aprendizaje y enfoques de enseñanza: origen y evolución. En: *Educación y Educadores*, 2017, vol. 20, no 1, p. 65 – 88. Disponible en <http://educacionyeducadores.unisabana.edu.co/index.php/eye/article>

Universidad de Guadalajara (2007). *Modelo educativo siglo 21*, Guadalajara, México: Universidad de Guadalajara 2007.