Article **Journal Computer Technology**
December 2022, Vol.6 No.17 11-21

Methodology for mechanical design using augmented reality as a learning tool

Metodología para diseño mecánico utilizando realidad aumentada como herramienta de aprendizaje

FERNÁNDEZ-PÉREZ, Vladimir Damián†*, MIRANDA-SÁNCHEZ, Francisco Javier and FERNÁNDEZ-GÓMEZ, Tomas

Tecnológico Nacional de México - Instituto Tecnológico de Orizaba, Department of Metal-Mechanics, Ote 9 Num 1852, Col E. Zapata C.P 94320, Orizaba, Veracruz, Mexico.

ID 1st Author: *Vladimir Damián, Fernández-Pérez* / **ORC ID:** 0000-0002-3790-9352, **Researcher ID Thomson:** fernandez_gt@yahoo.com **CVU CONACYTID:** 699327

ID 1st Co-author: *Francisco Javier, Miranda-Sánchez* / **ORC ID:** 0000-0002-0311-5001, **Researcher ID Thomson:** qQeu179m1C0dMYjrGocgNKdk3mTImeaz, **CVU CONACYT ID:** 781882

ID 2nd Co-author: *Tomas, Fernández-Gómez* / **ORC ID:** 0000-0001-7119-1703, **Researcher ID Thomson:** fernandez_gt, **CVU CONACYT ID:** 65262

DOI: 10.35429/JCT.2022.17.6.11.21 Received: July 15, 2021; Accepted December 30, 2021

Abstract

Augmented Reality is a tool that is being gradually developed in university institutions based on the boom caused by the use of mobile devices and Internet access from almost anywhere.

Education, Tools, Augmented reality

Resumen

La Realidad Aumentada es una herramienta que está siendo desarrolla gradualmente en las instituciones universitarias partiendo del auge provocado por el uso de los dispositivos móviles y el acceso a Internet desde casi cualquier sito.

Educación, Herramientas, Realidad aumentada

Citation: FERNÁNDEZ-PÉREZ, Vladimir Damián, MIRANDA-SÁNCHEZ, Francisco Javier and FERNÁNDEZ-GÓMEZ, Tomas. Methodology for mechanical design using augmented reality as a learning tool. Journal Computer Technology. 2022. 6-17:11-21.

* Correspondence to the author (E-mail: fernandez_gt@yahoo.com)
† Researcher contributing as first author.

Introduction

Current trends in education recognise the importance of integrating Augmented Reality (AR). It is a tool that is gradually being developed in university institutions due to the boom caused by the use of mobile devices and access to the Internet from almost anywhere.

Therefore, the changes significantly affect the teaching processes, at this moment the incorporation of novel methodologies that seek to exploit ICT is presented. This is due to an important fact which is the new degree of ease with which educational content, or objects of study, are presented for the creation of more realistic, creative, motivating and collaborative learning environments.

Now, AR is defined as a tool that allows us to enrich our environment by combining digitally generated information with physical information in real time, by means of instruments such as tablets or smartphones. The modern world is preparing for the entry of technology into the consumer sector and presents great potential for its application within the educational sector in the coming years.

For a proper evaluation of the effects of this new method in educational and teaching-learning environments, it can be argued that through detailed monitoring of students, the level of effectiveness of AR, as well as ICT, can be determined. In this way it can be concluded that it is possible to measure the performance of the new methodologies oriented to the instruction of topics within the study grid.

Nowadays, new generations are growing up immersed in technology, therefore we can point out the importance of understanding the teaching processes within Mobile Learning and Augmented Reality. This implies that teachers will have to leave behind the traditional ways of teaching, incorporating new ways of transmitting information.

Situation and trends

They identify 2 trends that can be achieved within the study centres. It derives from the progress in the learning process in universities, thanks to the technological improvement of the present Morales, Bellezza, & Caggiano. Achieving flexibility and driving innovation, with a collaborative approach capable of creating solutions in higher education, considering digital literacy as the problem to be solved.

A virtual framework is developed with the intention of standardising and implementing online resources with the aim of improving key skills specific to emerging technologies, seeking to detonate the application of new digital resources such as Augmented Reality in educational environments, with the aim of promoting a greater degree of use of the knowledge acquired by students. Identifying qualified teachers for an innovative, effective pedagogy, solving the problem of school deficiency, with a universal approach.

They have as their main objective long-term trends. to obtain a suitable innovation, for higher education institutions which seek to structure forms that give malleability, creativity and motivation to the student body, achieving new approaches, as well as methodologies based on models that stimulate the change of analysis, being implemented in a wide range of collective environments, using technology as a catalyst to initiate a more widespread culture of discovery, without losing sight of the profitability during the implementation of these new techniques.

In higher education, students are considered as consumers, for this reason there is a need to improve their expectations by achieving an evolution of their behaviour or student achievement, within the different areas of knowledge that are taught in university careers. A change is promoted through the use of technologies that are part of everyday life such as smartphones, extending them to learning, as this is a necessity in today's global environment.

ISSN 2531-2197

The technology oriented teaching-learning process in higher education classrooms has strengthened the trend towards open communities. Administrators and faculty alike have recognised that collective action is needed to achieve capable and sustainable methods to support the improvement of specialised ICT-oriented infrastructure, enhancing collaboration between universities, recognising collective social work as a sustainable method of human growth, and providing an opportunity for the adoption of AR.

At this time there are medium-term trends in an expanding interest in the use of new sources of information, with the aim of personalising the learning experience, making ongoing formative assessment of instruction reach optimal levels of performance. The key element to master is learning analytics to achieve an analytical application that can harness the vast amounts of existing data and extrapolate it into new applications for student learning within the classroom of higher education institutions.

Nascent development of models aimed at universities raises the level of bet that is given to innovation aimed at the new digital environments that currently exist, which are considered as advantages when providing new ideas, products, services or methodologies for the application of augmented reality, combined approaches were found that can be of great use in the classroom; it can be considered that students can achieve advantages by implementing learning materials through the use of virtual environments.

New teaching processes require the creation or adaptation of spaces that meet current requirements necessary to implement new trends in education.

Universities provide emerging models, rearranging student environments for more active development. Accommodating scenarios that facilitate project-based interactions with attention to mobility, flexibility and the use of multiple devices by creating smart rooms.

Emerging issues

The digital society is marked by changes that lead to new ways of communicating, transmitting or constructing knowledge information, this implies that educational institutions should not be left behind or static, this means that they must make changes that meet the requests that today's society demands.

Higher education institutions cannot ignore the need to integrate into the so-called digital revolution. For this it will be important to take into account the information systems that society currently possesses, this implies that time and resources must be invested in ICT, in order to facilitate the correct adaptation of education to the needs of students, aiming to draw an achievable future using the tools available to achieve significant progress.

Technological trends within the educational area depend on the degree of adoption or incorporation of ICT in training processes. Triggering organisational or didactic changes that enable students to obtain quality learning, which are combined with the so-called formal education. Responding appropriately to digital literacy trends.

Educational possibilities

Augmented Reality currently has a wide field of implementation in the area of knowledge. This implies that the educational sector is the one that benefits the most from the application of new currents of thought. This means that there are possibilities of application within universities. This technology undoubtedly constitutes a new resource in the classroom.

Therefore, this technology provides a degree of ease within the development of constructivist teaching-learning methodologies, the idea being that the student becomes an active part of the process, making his or her own discoveries, making a connection with previous knowledge, generating ideas or carrying out experiments. At this point it is essential that teacher training seeks the application of emergent knowledge.

ISSN 2531-2197

The objective is to know and analyse the needs for its correct incorporation, to investigate the resources that are given to teachers through the application of Augmented Reality, since there is an opportunity to implement new technologies within the educational area, analysing the statistical results to demonstrate the possible training benefits that can be achieved.

Benefits of the application of augmented reality

The use of AR, as a strategy for the development of learning, manages to create an interaction between the physical world and the virtual one, allowing inclusion in education by implementing the so-called self-learning, enhancing the intellectual connection with the physical experience, improving the assimilation and understanding of information.

Augmented Reality, when included in educational teaching, provides a number of benefits such as increased interest on the part of students. Achieving self-learning, this enhances the interaction in real time with the information to be developed within each subject, allowing a connection between the physical and the theoretical. This tool is aimed at working in a practical way in the classroom, producing extra motivation in the students.

The elimination of barriers in education can be achieved through AR. This means that experiments can be carried out in virtual reality that are not possible in the physical world because of their costs, dangers or risks. In this way, the elements are supported with technological features which, generated by software, help with the analysis of different points of view that were previously not possible to achieve.

What is augmented reality?

We can define Augmented Reality as an innovative tool capable of providing virtual objects embedded in an existing environment, through technological devices, therefore, it is stated that it allows to complement the scenario, without replacing it, through a virtual environment with the benefit of presenting relevant information increasing the development of the individual.

They show that AR in conjunction with virtual reality facilitates the entry of universities into the digital era, by being able to apply and present knowledge using emerging technologies. The aforementioned authors point out that the relevance that both terms have currently achieved is thanks to their wide implementation within today's society, through different digital applications that can be manipulated in their daily lives, achieving a generalisation, becoming tools, therefore, their implementation in higher education cannot wait.

They describe AR as a virtual experience that can be understood as a technology that seeks to implement a combination of digital information in conjunction with physical objects or data in real time, allowing users to see and interact with an environment superimposed on the world. In this situation, the subject coexists in a complementary environment, this indicates that there is a relationship that is achieved through the use of mobile devices, such as smartphones or tablets, facilitating their incorporation into the educational sector, as a motivating tool that seeks to increase academic development.

They are able to describe some basic characteristics of Augmented Reality. The first condition speaks of the ability to integrate a real environment in conjunction with a virtual one. As a second issue it indicates that it must be real time and as a third consideration it must be applied in a three-dimensional space generating a precise embedding between the elements. In this sense it allows a combination that transfers information to the individual's visual perception.

4 levels

In the area of Augmented Reality it can be stated that the technology has managed to mature and reached a point where it is possible to achieve a widespread application in all areas of professional training, in this way this tool managed to enter the education sector where it is positioned as a valuable tool used in teaching methodologies.

ISSN 2531-2197

Currently we can define that Augmented Reality is composed of 4 levels of immersion as it can be expressed. As shown in table 1. It is observed that for its correct application it is necessary to take into account the elements that make up this system, so this can be expressed that the necessary parts for a correct application are shown in Table 2. It should be stressed that it is important to know that if any of the elements is missing, its application will not be possible.

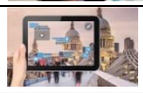
Level 0: Hyperlinks in the physical world	
Level 1: Marker-based augmented reality	
Level 2: Augmented reality without markers	
Level 3: Augmented Vision	

Table 1 Levels of augmented reality
Source: Own elaboration

Physical Reality	Perceived by the observer as dependent on a perspective or physical location in reality
Camera	Capture the real environment or images of the environment to be integrated with the virtual objects
Software	Interprets real world information captured by the camera, processes the information or virtual objects to be superimposed on the virtual world.
Activating Element	Device that triggers the augmented reality process examples: QR codes, markers, images, objects, compasses or GPS.
Screen	Device or element where we can visualise the content of physical reality by integrating augmented reality elements
Observer	Target audience for the digital experience, it is important to determine characteristics such as age, technical knowledge or special abilities, to define how it will be displayed on the screen or device.

Table 2 Elements of augmented reality
Source: Own elaboration

In accordance with the existing levels as they say. It can be concluded that with its generalised use it is possible to obtain information on specific data, such as its history, name or transcendental data, which, in accordance with the existing levels, strategies can be suggested which make use of applications oriented towards information management and knowledge management within the universities.

With markers

It is called with markers those objects that are presented in the form of printed symbols, this means that there is a superimposition of 3D digital information on a conventional 2D medium that when recognised by a camera undera software can be seen embedded information in a conventional medium.

This level is referred to as marker-based. The information will be displayed by means of a trigger, which is that graphic part, which can be a symbol, book, photograph, magazine, infographic, or an image that with the support of a smartphone or tablet will be able to detect the exact place or the information to be displayed, thus to launch the digital experience. The reproduction of this content will be appreciated by means of the electronic device used to read the activating object.

With the advancement of technologies the markers can be designed in a simple way, without highlighting or affecting the aesthetics of the research design that may be present Abularach, Gallardo, & López, (2017). Since generally the applications used for this purpose seek to be flexible, QR symbols, images and objects with characteristics that can be detected can be used to achieve an optimal presentation of the information.

Marker less

Augmented Reality called marker less is based on the recognition of images, objects or GPS locations, without the need for a specific visual indicator that triggers the experience, therefore, the world becomes an interactive canvas, in which practices are presented without limitations that facilitate the control of the experience.

ISSN 2531-2197

The so-called level 2 or marker less. To activate these resources, images, objects or GPS locations are used, there is no specific visual indicator that activates the experience. In this context it is concluded that the environment around us becomes a space in which we can appreciate relevant information free of limitations. Allowing the user greater control of their learning, achieving an immersive experience.

In accordance with the levels that currently exist within Augmented Reality, strategies can be suggested in which it is possible to visualize applications directed or oriented towards the handling and management of knowledge information, achieving a motivating immersion that drives the search for knowledge by students, obtaining measurable benefits in the teaching-learning process.

Mobile applications

The digital revolution achieved a technological advance capable of modifying psychosocial interaction, this implies that the way of interacting with the environment has changed, since, thanks to the massification of electronic devices, we are now able to use tools that communicate through the internet no matter where they are located.

They express that Augmented Reality is able to adapt effectively to the new methodologies used within the teaching process. It implies that students demand knowledge effectively created by this technology, being this the starting point for the development of innovative teaching practices, focused on academic training. Through the use of Android or IOS applications, which have gained popularity by delivering unparalleled flexibility, concentrated in a single digital device that seeks to group different tools in one place.

There are now professionals focused on the creation of infrastructures and interfaces, aimed at the integration of hardware and software in new generation devices. This vision turns an emerging technology into a current tool that seeks Augmented Reality as a perfect way to interact with virtual layers that surround the user, providing an environment conducive to educational improvement.

Learning tools

Information and communication technologies

Nowadays, conventional teaching processes are being displaced by new teaching methodologies based on the implementation of Information and Communication Technologies. They originate from the projection of contents or objects of study through the creation of realistic, creative, motivating and collaborative learning environments.

Within this new context it can be seen that teaching methods are used to achieve a high educational development thanks to the innovation presented by the application of ICT in conjunction with the use of Augmented Reality. This means that there has been a remarkable increase in the advancement of a technology that promises to provide possibilities of interaction capable of significantly transforming the learning process by creating new pedagogical techniques.

Evolution is a word commonly used in the field of education, due to the different stages that have occurred over time, which are closely related to the needs that arise in teachers or students over the years. Therefore, it will always be convenient to apply methodologies and strategies in conjunction with ICT management, with the aim of adapting to the new technological tools present today within the so-called digital society.

Simultaneously, the progress made in the development of the internet has allowed the evolution of numerous technological instruments such as tablets, smartphones or applications that provide the opportunity to access virtual environments. These types of environments can provide new forms of interaction based on the combination of virtual and real elements, due to AR, thanks to this new technique society is able to obtain intellectual benefits with greater ease of interpretation.

ISSN 2531-2197

Augmented reality and mobile technology

We consider that from the year 2000 presented a rapid advance in mobile technology, leading to significant investments in the education sector, giving students or teachers access to these new tools, which combined with AR allows a more effective teaching-learning process.

This new teaching methodology, managed to increase the benefits obtained by educators or students, through the extended use of existing devices such as smartphones, which are currently relatively simple tools to use, this allows to improve didactics by merging theory with practice. But this brings with it economic disadvantages due to a lack of resources to acquire the necessary equipment for the correct application of AR, together with a lack of knowledge on the part of teachers to achieve its implementation in the classroom.

Nowadays, the so-called technology society has a facility to own technological devices that allow an internet connection 24 hours a day, which means that these tools have become an essential part of everyday life. Therefore, augmented reality is gaining more acceptance within education as it allows combining these technologies in order to improve teaching within universities.

Mobile devices

Nowadays, the progressive popularity of these devices, such as Android or iOs worldwide, has led to their generalised use in the daily life of modern society, which is why their impulse to reach the educational sector was imminent, since thanks to these instruments, the generalised use of AR in mobile devices has become a growing phenomenon.

It must be remembered that young students currently have a competitive advantage which is described as the massive use of devices such as tablets, smartphones or the internet, thus achieving a digital integration that spans from their private life to their education, therefore, higher education institutions cannot miss this trend. Discovery-based learning is often established with this technology, which, combined with AR, allows contextualised learning experiences to be explored by chance or on one's own initiative.

Therefore, the technological means that give users the opportunity to interact, partially or totally, through a mobile device, in an environment that allows mixing the digital with the real, have the hardware and software necessary to achieve together with Augmented Reality a usable tool in training, which have focused on applications for educational environments.

The internet of things

Nowadays, individuals present an ease never seen before to obtain technological devices, with the purpose of having an internet connection, obtaining digital applications that allow us to develop with greater disposition in daily tasks, becoming an essential part of daily life both in the private and in the educational or work segment-.

It is pointed out that the use of digital devices is used by students not only to communicate, but also to manipulate them in an infinite number of educational and leisure applications, all made possible by the use of internet connection which provides unprecedented information management, due to the evolution of the digital era which allows access to online resources from anywhere, through the use of mobile devices.

There are several voices, which point to the fact that universities must take the responsibility to prepare their teachers in order to be able to adopt new technologies that allow them to take advantage of the immense flow of information that exists within the internet and to improve the conditions of the educational infrastructure.

Augmented reality and education

Technologies are capable of innovating in the educational field, generating evolution in the way subjects are taught. The way of relating processes with tools changes, seeking to improve the productivity of the individual, as well as the methodology used in the teaching-learning process. The changes therefore point in the direction of the progress that training must be willing to undergo.

ISSN 2531-2197

Not all subjects implement the new sets of techniques to the same extent, detecting that this method is still poorly linked to the formation of learning, identify curricular areas that make contributions to augmented reality: engineering, architecture, urban planning, mathematics-geometry, art, history, physics, design, technology or even medicine. We can therefore confirm that there are fields of opportunity for future research, which motivates the development and focus of this work.

The development of so-called specialised content, together with technological and methodological progress, within the development of augmented reality in the academy, favours the creation of a creative environment, encouraging the development of projects related to each professional functional area. Adapting learning approaches, as well as the type of interaction that subjects can use.

Intellectual capital

It was identified that in Higher Education Institutions it is vital to share the intellectual capital generated in the processes of creation, transfer and dissemination of teaching. However, within universities, a system for managing information must be guaranteed. In accordance with the theory of knowledge management on campuses, which identifies three areas of reflection.

A) The identification of research priorities, B) The study of intellectual capital and intangible assets of universities, C) The projection of the institution in its environment to promote the social appropriation of knowledge. Educational institutions are aware that management is a vital element for maintaining competitive advantages, and it is here where information technologies offer tools to achieve strategies for the management of education, that is, to promote student development, achieving a solid structure.

In order to consolidate the scientific value in the field of education, the use of augmented reality is proposed as a means to achieve this, as one of the strategies for consolidating appreciation. In this way achieving a transfer of knowledge under different applied strategies, proposing a use that allows to obtain tangible benefits.

Media strategy

It should be understood that the media strategy is related to the understanding of knowledge management, directly related to document processing, teamwork and basic forms of data visualisation. The perspective that is required is that of a development of platforms capable of building strategies for understanding information.

As a reference, a structure with three categories of knowledge management processes is presented. Firstly, it is said that a value system is needed that contains the consolidation of information, with innovation in processes. Secondly, it is necessary to take into account human capital, in order to facilitate the development of competencies and valuable practices. Third we find instrumental capital which is referred to as the formative knowledge base of research products.

Achieved through mass popular acceptance of the importance of audiovisual communication, which is common nowadays, this means that generating digital teaching material is commonplace, this production has a great pedagogical potential, therefore Augmented Reality makes its way into innovative development in the field of education.

In the field of education

Nowadays, society is immersed in technological changes presented in the last decade, offering challenges in the educational processes according to the plasma in particular, its pedagogical use must be an element with high priority within the instruction and its didactic application in the formative context granting benefits, propitiating a more dynamic learning.
AR allows the creation of inverse environments with virtual layers that allow students to be positioned in a simulation of situations or contexts that can only be possible in real environments. For example, medical students can see the inner organs of the human body in three dimensions, achieving an improved understanding of how they work, through audiovisual material. This feature helps students to acquire the required knowledge more easily.

ISSN 2531-2197

AR improves generic competences in university environments, through the integration of active methodologies, understanding complex processes from the inverse possibilities, the use of this technology presents high indicators of motivation and satisfaction, improving the results. This means a qualitative leap in teaching, transforming students' perception of physical reality.

RA technology in educational practices

Current trends within the higher education sector recognise the importance of the integration of teaching-learning with a comprehensive application, making use of methodologies that allow a better understanding of curricular information, in conjunction with methods for the improvement of knowledge instruction.

They formulated a proposal for the improvement of the teaching-learning process based on AR, called "RA4 Educa", creating an innovative didactic resource that emerges from a media experience through the visualisation and interaction with virtual objects superimposed on real entities, reaching curricular contents that constitute a potential improvement for educational development, establishing an active and motivating methodology aimed at the student body.

There are significant improvements in academic performance together with the digital competences that students integrate through Augmented Reality, concluding that the dynamic activities in the academic intervention, make the application possible, bringing benefits in the teaching processes, promoting an innovation of educational improvement with the use of technology.

Context of augmented reality in university education

Nowadays, emerging technologies have become increasingly relevant in educational contexts. AR has been deployed in a large number of research or innovation experiences in the teaching area, which have managed to demonstrate the positive aspect of its use for learning, due to the fact that it combines the real world with the virtual world, providing a mixed view of an element.

Augmented technologies allow an introduction of the individual in a context of practices that help to experience activities of everyday life in the classroom, as well as unconventional experiences, this means that situations are presented without any danger, this provides the student with a visual guide, which helps him to better understand the contents explained in the classroom, which brings the existing reality outside the educational context. This enhances the diversity of representations of a concept.

- Helps in the development of cognitive, spatial, perceptual-motor and temporal skills in students, regardless of age or educational level..
- It manages to reinforce short-term memory, attention, concentration, (mediated memory). By activating cognitive processes in the teaching and learning process, AR is defined as an active technology that allows to confirm, refute or expand knowledge, generating new ideas or opinions about the world.
- It forms attitudes to reflect on educational issues by providing solutions to specific problems.
- It provides an effective communication transfer environment within educational work. Reduces the uncertainty of knowledge around an object of study.
- It increases the positive attitude of students within the learning process, as well as the motivation or interest of the student, reinforcing skills and competences.

Table 3 Main advantages of Augmented Reality in the academic context
Source: Own elaboration

It concludes that the elements, whether positive or negative, managed to converge in the fact that when AR is well used, interest in the curricular content grows, the key element in this case being motivation. In this way, it can be seen that the teacher is in charge of arousing interest in the students both in the application of the contents taught in the classroom and those outside the educational center.

Motivation within the training and learning process

The key element for AR, the so-called motivation, is considered as the necessary variable to achieve school success. The activities to be carried out by teachers to attract the student's attention focus on the set of processes involved in activating, directing, persisting and concentrating attention on a task or activity, these are the indicators of motivation. Motivation can usually be considered to be determined by intrinsic or extrinsic variables, placing information and communication technologies in the second type.

ISSN 2531-2197

It is possible to visualise that there are different works in which they help to know the degree that these awaken on the external variables, marking that their use increases the motivation of the students, looking for as purpose to be able to improve the academic performance, on the other hand they indicate that it is an internal state or condition that directs us towards the action in situations of teaching.

Finally, all the components will have an impact on the creation of satisfaction that establishes the continuation of motivation to undertake. The foundations on which these ideas are based refer to the teaching strategies and methodologies used by the teacher that are perceived as useful by the students to achieve objectives or competences in educational instruction.

Conclusions

The development generated in the last decade, achieved an inclusion of mobile devices in the daily life of society seeking to bring these technologies to the educational field, obtaining an emergence of the diversity of computer applications. They run on a mobile platform, which can enhance the teaching process.

The AR is able to offer possibilities to analyse study entities, be assimilated the advantages offered by this tool in the teaching process, through the use of mobile devices. Its incorporation in the educational area is technically simple, however, the great challenge is the need for teachers to change their traditional pedagogical roles, which are strongly marked by those of transmitter of information and evaluator. Teachers must be trained, at the same time as they are aware of the power of communication and motivation that this tool is capable of endowing them with.

It is worth mentioning that the gender and age of the student does not determine the degree of acceptance of AR, as it can be affirmed that the vast majority of students have managed to achieve a significant level of knowledge in the different subjects that were mediated by this technology, its use being very intuitive.

Facilitating the learning processes, allowing to decide the knowledge that will be shown to the user, in this way the content is more attractive, increasing considerably the attention in relation to the teaching.

The implementation of this tool oriented to education needs to train teachers at a pedagogical and technological level because it is necessary to have a guide figure throughout the teaching process. Being able to provide manuals that promote the use of AR by the teacher, this topic should be approached from the technological or content competences for a complete application in the classroom.

References

Abularach, D., A., Gallardo, J., F., & López, K., J. (2017). Realidad Aumentada en la Educación. 9(6), 8–14.

Adell, J., & Castañeda, l. (2012). Tecnologías emergentes, ¿pedagogías emergentes?, Tendencias emergentes en educación con TIC, 13- 32.

Aguirre, R. G., Garcia, D. G., Guevara, C. F., & Erazo, J. C. (2020). Realidad aumentada y educacion en el Ecudador. Revista Arbitrada Interdiciplinaria KOINONIA. http://dx.doi.org/10.35381/r.k.v5i5.1052

Astudillo, M. P. (2019). Aplicación de la realidad Aumentada en las practicas educativas universitarias. Revista Latino Americana de Tecnologia Educativa. 203-218. DOI: http://dx.medra.org/10.17398/1695-288X.18.2.203

Barroso, J. M., & Cabero, J. (2016). Evaluación de objetos de aprendizaje en realidad aumentada: estudio piloto en el grado de Medicina. Revista Enseñanza & Teaching, 34(2), 149-167. http://hdl.handle.net/11441/51387

Berrios, R. (2020). Realidad aumentada: Uso estratégico en Comercialización y Educación. Revista RED MARKA, 24, 217–237. https://doi.org/https://doi.org/10.17979/redma.2020.24.2.7120

ISSN 2531-2197

Billinghurst, M., Duenser, A. (2012). Augmented reality in the classroom. Computer, 45(7), 56-63. https://doi.org/10.1109/MC.2012.111

Blázquez, A. (2017). Realidad Aumentada en Educación. Madrid: Universidad Politécnica de Madrid. Revista Gabinete de Tele-educación.

Cabero, J. & Pérez J. L. (2018). Validación del modelo TAM de adopción de la Realidad Aumentada mediante ecuaciones estructurales. Revista Estudios sobre educación, 34, 129-153.

Cabero, J., & Fernández, B. (2018). Las tecnologías digitales emergentes entran en la Universidad: la Realidad Aumentada y la Realidad Virtual. RIEd: Revista Iberoamericana de Educación a distancia, 21(2), 119-138.

Cabero, J., & García, F. (2016). Realidad aumentada. Tecnología para la formación. Madrid: Síntesis. Pixel-Bit: Revista de Medios y Educación, 49, 241-242. https://recyt.fecyt.es/index.php/pixel/article/view/61727

Cabero, J., Barroso, J., & Obrador, M. (2017). Augmented reality applied to the teaching of medicine. Educacion Medica, 18(3), 203–208. https://doi.org/10.1016/j.edumed.2016.06.015

Cabero, J., Fernández, B., & Marín, V. (2017). Dispositivos móviles y realidad aumentada en el aprendizaje del alumnado universitario. RIED. Revista Iberoamericana de Educación a Distancia, 20 (2), 167-185.

Cabero, J., Vázquez, E., & López, E. (2018). Uso de la Realidad Aumentada como Recurso Didáctico en la Enseñanza Universitaria. Uso de la Realidad Aumentada. Revista Formación Universitaria, 11(1), 25-34. http://dx.doi.org/10.4067/S0718-50062018000100025

Cabero, J., Vázquez, E., López, E. & Jaén, A. (2020). Posibilidades formativas de la tecnología aumentada. Un estudio diacrónico en escenarios universitarios. Revista Complutense de Educación, 31(2), 143-154. https://doi.org/10.5209/rced.61934.

ISSN 2531-2197