

# Microlearning Method for Building Learning Capsules for Older Adults

Priscila Cedillo<sup>a</sup>, Daniel Gómez<sup>b</sup>, Daniela Prado-Cabrera<sup>c</sup>, Alexandra Bermeo<sup>d</sup>  
and Lourdes Illescas<sup>e</sup>

*Department of Computer Science, Universidad de Cuenca, Cuenca, Ecuador*

**Keywords:** Microlearning, Micro-content, Method, Learning Capsules, Older Adults.

**Abstract:** Education is a universal process that acts on human beings throughout their existence, including their aging stage. In this sense, older adults can learn, communicate, and exchange information through technological applications. However, learning platforms often do not address the specific requirements and special needs of older people. Therefore, it is necessary to have methods and tools that allow the creation of software artifacts, so this sector of the population can acquire new knowledge according to its learning needs. Given these considerations, this document proposes a method for creating learning capsules in the field of microlearning, taking into account accessibility criteria and andragogic techniques that support the learning process of the older adult; it also considers a diffusion plan for apprentices to know and access structured micro-contents. Besides, to show this proposal's use, the step-by-step of creating a learning capsule to be used by older adults is presented.

## 1 INTRODUCTION

Currently, technological progress has allowed professionals and researchers in the computer science area to find, develop, and innovate solutions for society's different problems. These are oriented to different domains, including access to learning content, information exchange, communication, and relationships with people online (Sanchez & Luján, 2013). However, in the education area, technological developments do not usually consider the specific needs of older adults in developing teaching-learning methods and techniques that allow obtaining artifacts that consider the needs of this sector of the population (García & Bermejo, 2004). The Pan American Health Organization (2019) states that services must be adapted to older people's needs in today's society. This population requires much more effective management, which improves their survival and maximizes their functional capacity, and reduces the years of dependence on others.

In the learning field, it is necessary to emphasize that education is a process that acts on the human being throughout their entire existence, counting on the necessary tools to face its challenges day by day (Girón, 2014). Education focused on the elderly can give way to new opportunities for economic security, health, and social participation, which promote active aging and the improvement of the quality of life in the social, cultural, economic, and political spheres (Ojeda, 2018). In this sense, there is a series of andragogic techniques, defined by Knowles (1980) as the art and science of helping adults to learn, providing the opportunity for older adults to participate in their educational process actively and to intervene in the planning, programming, conducting and evaluating learning activities on an equal footing with fellow participants and instructors. Those andragogic techniques can be included in technological support tools for the teacher, the same ones that integrate modes of interaction with the

<sup>a</sup> <https://orcid.org/0000-0002-6787-0655>

<sup>b</sup> <https://orcid.org/0000-0002-8250-5867>

<sup>c</sup> <https://orcid.org/0000-0003-1241-1782>

<sup>d</sup> <https://orcid.org/0000-0002-2697-7528>

<sup>e</sup> <https://orcid.org/0000-0002-0027-439X>

elderly and contemplate aspects and themes to improve their lives.

In this context, the problem is evident when the elderly use online learning tools because they face existing barriers in terms of accessibility, intention to use, and the adoption of information and communication technologies (ICT) (Luna, Mendoza, & Álvarez, 2015). Thus, it is necessary to generate technological learning spaces that allow the generational digital gap to be reduced, so older people acquire new knowledge through tools that allow them to adapt and integrate into the digital society (Moral, 2015; Sunkel & Ullmann, 2019).

Thus, this paper presents the first step towards a methodological approach in software engineering with instructional considerations, that allows the construction of learning capsules focused on older people. This method allows designers to build learning capsules under the concept of microlearning. To show how the methodology works, a learning capsule has been built, in the topic of measures of prevention for COVID-19 for older adults.

This paper is structured as follows: Section 2 presents fundamentals and related work; Section 3 addresses the microlearning method and its activities and tasks; Section 4 illustrates the implementation of a learning capsule using the proposed method. Lastly, the conclusions and further work are included in Section 5.

## 2 BACKGROUND

Microlearning refers to a didactic approach that uses digital means to deliver short-topics, coherent, and autonomous educational content for learning activities in a short time (Göschlberger & Bruck, 2017). Among the materials most used to implement these capsules are educational videos, infographics, educational packages and online courses, which allow the transmission of knowledge in a reduced time (Perrusquia, 2006). They consider andragogic techniques (Knowles, 1980) and accessibility characteristics focused on the elderly, which intervene in: i) the brevity of the solution, ii) the approach of the thematic and additional characteristics of the learning capsules, and iii) the availability of these capsules (Jahnke, Lee, Pham, He, & Austin, 2019).

There are applications of technologies that were created for education and learning fields, such as Massive Open Online Courses (MOOC) or Learning Management System (LMS). There are several solutions proposed to create learning platforms for

older adults (Beltran, Cedillo, Rodriguez-Ch, & Bermeo, 2018; Sanchez & Luján, 2013; Tutoky, Babič, & Wagner, 2013). They are oriented to the analysis of specific accessibility considerations when using online courses for older adults; also have created the need to have tools with usability and accessibility options specific for this age range (Sanchez & Luján, 2013). However, these solutions are applied in online courses for older adults, but do not address micro-content creation through learning capsules. These capsules refer to media and/or tools that are used to impart short-term academic content on a specific topic (Ledo, Vialart, Sánchez2, & González, 2019). Moreover, most research published in microlearning has been done for an academic environment and groups of users, mostly adolescents, adults under 65, and the general public. Therefore, it is needed to generate new research and microlearning contributions focused on older adults (Baldauf, Brandner, & Wimmer, 2017; Dearman & Truong, 2012; Horst & Dörner, 2019; Jahnke et al., 2019).

The difference of this research with previous proposals is in the extension and the purpose; characteristics that will allow the generation of limited learning capsules, with a short theme and duration. These capsules are aimed at older adults, taking into consideration the specific characteristics needed for reaching this population.

## 3 THE MICROLEARNING METHOD

To construct learning capsules oriented to older people, it is necessary to present a guide that contains the required steps to follow. According to Zelkowitz, Shaw, & Gannon (1979), software engineering is "the study of principles and methodologies for developing and maintaining software systems." Also, Sommerville (2011) defines software engineering as "an engineering discipline that is interested in all aspects of software production, from the initial stages of the system to the maintenance of the system." This study's purpose is to create software artifacts oriented to learning techniques for older adults. Therefore, the method proposed has been designed to consider the mix of software engineering guidelines with instructional aspects that can support older people's learning process. According to Bruner (1969), instructional design deals with planning, preparing, and designing materials and environments needed to carry out a learning process. There are several instructional models, such as the Successive

Approximation Model (SAM) and the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation).

First, the SAM model proposes to perform different versions of the learning products until it reaches the desired version (Rimmer, 2016), while the ADDIE model performs this process through an iterative flow (Aldoobie, 2015). Due to the characteristics of the learning capsule, based on microlearning concepts, the proposed methodology is aligned to a hybridized version of the ADDIE model, with specific characteristics of the SAM model, which allows an iterative workflow between its phases, with the option to test the design of the learning capsule through a prototype. Thus, the proposed method considers the inclusion of andragogic techniques, accessibility criteria, and multimedia elements, also called micro-contents, to elaborate a capsule as a solution for a specific context. They are included to support older people's learning process in their aging phase and as a source of microlearning for the fundamental processes and activities of today's society. This method presents a flexible solution adapted for any specific situation.

The activities in this method, its tasks, and each of its components is presented below. Also, the context of the learning capsules, objectives, andragogic strategies, development, and evaluation.

### 3.1 Activities of the Method

This section presents each activity, input, output, and guideline that is part of the method. An overview of the general method is illustrated in Figure 1.

#### 3.1.1 Analysis

This activity (shown in Figure 1, part 1) aims to describe the problem to be addressed and propose the solution to be implemented to generate a requirements specification document. Its sections are i) the learning capsule context, which includes a description of the problem to be addressed, the proposed solution, the apprentice's description as an older adult, and the environment of use. The Project Coordinator performs this task, along with the Instructional Designer and the Subject Matter Expert; ii) instructional analysis, performed by the Instructional Designer; the learning requirements of the older adult, the andragogic definition in terms of techniques and strategies are defined; and, iii) technological analysis, the functional and non-functional requirements needed for the learning capsule are defined. The Software Engineer is

responsible for performing this task, along with the Project Coordinator and Subject Matter Expert.

#### 3.1.2 Design

For this activity, the following aspects are considered (Figure 1, part 2): i) the Instructional Designer and the Subject Matter Expert, with the supervision of the Project Coordinator, establish the objectives and learning outcomes, under the instructional analysis included in the requirements specification document, ii) definition of the learning capsule, which is performed by the Instructional Designer and the Subject Matter Expert, the learning capsule and its sections is described, also, the self-assessment process for the apprentice; iii) for the definition, the Subject Matter Expert, with the help of the Media Specialist identify the multimedia elements that will allow representing the contents of each of the sections of the learning capsule; iv) a prototype of the learning capsule, which is done through a computer prototype design software, with the Software Engineer and Media Specialist's teamwork. Here, the accessibility criteria, following the requirements, is also identified. Finally, v) all the personnel analyse the generated prototype to validate the design. The main difference of this method against traditional design is the consideration of accessibility criteria for older adults, a guide to the most commonly used multimedia elements in the context of microlearning, and the generation of a prototype to evaluate the design.

#### 3.1.3 Development

This activity, shown in Figure 1 (part 3), aims to implement the result of the Analysis and Design stages to produce microlearning contents. This activity contains: i) establishing the production plan, meaning how the learning content will be produced; ii) selection and preparation of production technologies (e.g., cameras, microphones, computer editing programs) depending on the type of multimedia materials to be defined; and, iii) production and post-production of multimedia micro contents. The Media Specialist carries out these tasks in collaboration with the Project Coordinator and the Instructional Designer. The Media Specialist may include additional people to the development team to produce microlearning content.

#### 3.1.4 Implementation

This activity's objective, shown in Figure 1 (part 4), is to structure the learning capsule according to the micro-contents elaborated in the development

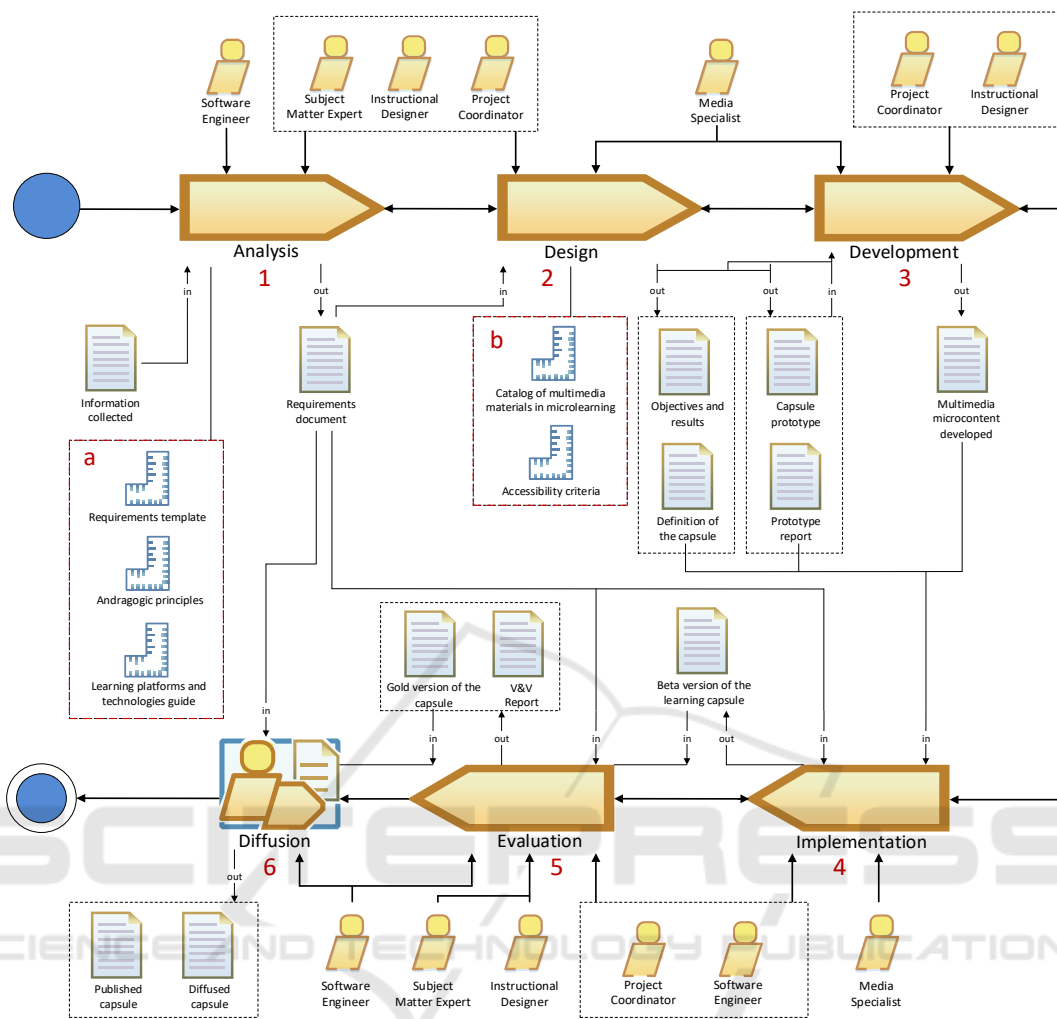


Figure 1: Main Microlearning Method to Building Learning Capsules for Elderly People. Source: Own elaboration.

activity and install it on the target platform selected in the Analysis activity. For these purposes, this activity contains i) preparation of the deployment environment, where the Software Engineer, with the Project Coordinator's supervision, prepares the hardware and software resources to deploy the learning capsule, according to the type of device and platform to be used; ii) organization of multimedia micro-content, where the Media Specialist with the collaboration of the Software Engineer, structure the content according to the definition of the learning capsule; and, iii) deployment of the learning capsule, where the Software Engineer displays the structured content on the selected platform. Depending on the selected technologies for deployment, in some cases, websites or mobile applications must be developed, or platforms configured for the deployment of content to form the learning capsule.

### 3.1.5 Evaluation

This activity is shown in Figure 1 (part 5); here, the main task corresponds to the learning capsule's verification and validation. The beta version of the learning capsule will be evaluated so that it complies with the requirements established in the requirements specification document and validates the learning capsule with the participation of the elderly. This activity is supported by the Project Coordinator, the Instructional Designer, the Subject Matter Expert, and the Software Engineer.

### 3.1.6 Diffusion

The last activity for the construction and deployment of learning capsules focused on older adults corresponds to diffusion. This phase (Figure 1, part 6)

includes: i) publishing the constructed learning capsule, so it is available to the selected population; and, ii) disseminate the learning capsule by applying a diffusion plan, or external marketing plan, thus that the learners can learn about the existence of the learning capsule and access it.

### 3.2 Method Artifacts

In addition to its activities, the method is composed of artifacts or work products, which correspond to inputs used to perform a task or activity, and outputs produced.

The involved artifacts are described, beginning with those included in the *Analysis* activity: i) Information Collected, which is an input artifact with a series of data previously collected about the context and purpose of the capsule to be developed. This data is the basis for defining requirements in the *Analytics* activity; ii) the requirements document contains the requirements to define, design, and create the learning micro-content included in the capsule to be developed. These requirements will also help implement, deploy, and evaluate the learning capsule at the software level. The requirements document is the input for the next activity.

The *Design* activity produces the following artifacts: i) Objectives and results of the learning outcomes. This artifact contains learning objectives and outcomes, where objectives describe trainees' expected performance or behavior within the learning process. In contrast, the outcomes are statements of what an apprentice is expected to know, understand, and/or be able to do at the end of a learning process. ii) The definition of the capsule. This report features information on the sections and micro-contents to include in the learning capsule. Also, it provides the specification of self-assessment and/or feedback for learners. This artifact will be useful for prototyping the learning capsule and some tasks in the *Development* and *Implementation* activities; iii) the prototype report of the capsule, which is a design or sketch made on a computer, it visually indicates how the microlearning contents will be organized according to the definition of the learning capsule; iv) Prototype report. This report includes a description of the learning capsule prototype. It presents information about how learning micro-contents and accessibility considerations within the capsule will be structured at the design level, according to the learning capsule's definition report.

As the output of the *Development* activity, the multimedia micro-contents developed artifact is obtained. It includes the multimedia materials

produced (e.g., images, videos, animations, podcasts, flashcards), which will be included in the learning capsule. Also, all the artifacts involved in the *Development* activity constitutes the input of the *Implementation* activity.

As the output of the *Implementation* activity, there is a beta version of the learning capsule. This version constitutes the selected platform with structured and deployed micro-contents. With this artifact, the corresponding tests can be performed in the *Evaluation* activity on the learning capsule. The beta version is also the input for the *Evaluation* activity.

The evaluation activity output is (i) the Verification and Validation Report (V&V Report). This report contains the results of the tests performed by all those involved in the *Evaluation* activity on the learning capsule's beta version; also, ii) the Gold version of the learning capsule, which is the final version of the learning capsule. This version meets all the requirements set out in the requirements specification document. With this artifact, the learning capsule can be published and disclosed in the *Diffusion* phase.

Therefore, the *Diffusion* phase provides, on the one hand, the published learning capsule, which is the final version that allows the older adult to use it; and on the other hand, the diffused learning capsule that results from applying an external methodology about content marketing, allowing publicizing the built learning capsule.

### 3.3 Method Guides

The method guides encompass all forms of content intended to provide additional information and supporting illustrations. Given this contextualization, the guides that support this method for the construction of older adult-oriented learning capsules are presented below:

#### 3.3.1 Requirements Template

This guideline is a base template for performing the requirements specification document in the *Analysis* phase. In the studies reviewed for the elaboration of this methodology, no such templates have been found for the context of microlearning that considers instructional aspects and software engineering activities. Thus, it is proposed to those involved in the project that this document included sections: 1) Context Specification, 2) Instructional Analysis, and 3) Technological Analysis, considering the standard document for the requirements specification of the



Department of Electrical and Electronical Engineers (IEEE) software requirements and the analysis section of Piskurich's (2015), Guide to Instructional Design.

### 3.3.2 Andragogic Principles

This guide is one of the main advantages of this method for building learning capsules for older adults. This guide presents a few techniques used in different contexts to support the older adult's learning process effectively. Table 1 shows andragogic techniques to develop professional development knowledge, according to Attebury (2015).

### 3.3.3 Learning Platforms and Technologies Guide

For a technological analysis task that allows establishing the requirements specification document's functional and non-functional requirements, it is necessary to consider the platforms, software, and hardware requirements within the non-functional requirements. In this regard, this guide provides a list of the learning platforms and hardware devices commonly used in microlearning.

### 3.3.4 Catalogue of Multimedia Materials in Microlearning

When defining the learning capsule in the Design phase, which allows structuring the sections and materials to be used, it is necessary to consider those materials to represent the learning micro-content. This guide provides a list of multimedia materials commonly used in microlearning to use. Thus, those involved in this activity can analyse the most appropriate materials to transmit the apprentices' knowledge.

### 3.3.5 Accessibility Criteria

Nowadays, there is a need to ensure that technological advances are accessible to all people on the spectrum of capabilities (Ballantyne, Jha, Jacobsen, Scott Hawker, & El-Glaly, 2018). One of this method's aggregate values corresponds to the inclusion of accessibility criteria that considers the older adult's possible limitations (e.g., vision loss, hearing loss, memory and learning difficulties, cognitive limitations). Therefore, it is essential to consider the POUR principles (Perceivable, Operate, Understandable, Robust) established by the World Wide Web Consortium (W3C) (2008) for both web

and mobile applications, as well as the analyses of Sanchez-Gordon & Luján-Mora (2016), and Ballantyne et al. (2018) for this guide.

Table 1: Andragogic techniques. Source: (Attebury, 2015).

Theory	Description
Transformational learning	Learning is performed through the phases initiated by the "disorienting dilemma." This dilemma leads to self-examination.
Communities of practice	Community-owned apprentices increase their knowledge and skills through discussion and reflection. This discussion can increase knowledge at the group and individual level.
Instructional learning	This approach provides a systematic approach to professional development through an instructional process—for example, the ADDIE instructional model: Analysis, Design, Development, Implementation, and Evaluation.
Experience learning	The essence of learning is supported through experiences. This process is based on adults learning better when they are direct "experimenting," setting aside memorization processes and book definitions.

Table 2: POUR Accessibility Principles (Perceivable, Operate, Understandable, Robust). Source: (World Wide Web Consortium (W3C), 2008).

Principle	Description
Perceivable	User interface information and components must be presentable to users in ways they can perceive. The main senses in this category correspond to the senses of vision and hearing.
Operate	User interface and navigation components must be operable. In this case, for operable needs, users normally use the keyboard and mouse to enter information, navigate, and interact with the contents.
Understandable	The information and operation of the user interface should be understandable. Users can easily understand the content presented or manage a graphical user interface.
Robust	The content must be robust enough to be reliably interpreted by a wide variety of user agents, including assistive technologies. This principle also indicates that users can access content with technologies of their preference.

## 4 BUILDING A LEARNING CAPSULE USING THE PROPOSED METHOD

For this process, the six activities of the proposed method have been followed to build a mobile-accessible learning capsule that in a didactic manner presents to the older adult importance of self-care biosecurity measures at home during COVID-19. These activities have been established from a high-level perspective; however, future research provides an in-depth analysis of each method's activities. The steps followed for the construction of this learning capsule are presented in Annex-Figure 1a-f.

The annex with the steps taken to build the learning capsule is located in the following link: [shorturl.at/fnprO](http://shorturl.at/fnprO).

## 5 CONCLUSIONS

The method proposed in this paper to build learning capsules has been designed considering the fundamental principles of microlearning, focused on the older adult. Instructional characteristics have been considered with instructional aspects and specific processes belonging to the field of software engineering. This method also showed the need to develop a diffusion plan, according to a learning capsule's objectives, so that the target audience can know the learning materials generated and acquire new knowledge through them.

A learning capsule's anatomy may vary depending on the context in which it was developed or according to the multimedia micro-contents used for the learning process. However, these capsules generally include three cognitive activities: learning, practicing, and evaluating; each capsule's size is small and autonomous.

The method is an adaptable and flexible solution, as it can be applied to create a learning capsule for any context aimed at the older adult. The work products generated from this method can give way to new opportunities for economic security, health, and social participation, all these activities aimed at education in older adults allow to foment active aging and promote the improvement of the quality of life in the social, cultural, economic and political spheres of today's society.

In future work, each of the proposed activities will be studied to expand and detail each of the associated activities and artifacts within the microlearning area. On the other hand, it is proposed to carry out an

evaluation process with a sample of software engineering professionals to refine the proposed method for a particular case. It is also proposed to evaluate the learning capsule developed on COVID-19 prevention measures in older adults, considering the constructs of the Technology Acceptance Model (TAM) methodology: perceived usefulness, perceived ease of use, and intention of future use.

## ACKNOWLEDGEMENTS

This work is part of the following research projects: "Fog Computing applied to monitor devices used in assisted living environments; case study: platform for the elderly people", "Design of architectures and interaction models for assisted living environments aimed at older adults. Case study: playful and social environments" and "Integration of New Technologies for the Design of Cognitive Solutions in Ambient Assisted Living for Elderly People: Evaluation of Attention and Memory Areas". Therefore, we thank DIUC of Universidad de Cuenca and CEDIA for its support.

## REFERENCES

- Aldoobie, N. (2015). ADDIE Model Nada. *American International Journal of Contemporary Research ADDIE*, 5(6), 68–72.
- Attebury, R. I. (2015). Adult education concepts in library professional development activities. *New Library World*, 116(5–6), 302–315. <https://doi.org/10.1108/NLW-08-2014-0100>
- Baldauf, M., Brandner, A., & Wimmer, C. (2017). Mobile and gamified blended learning for language teaching - Studying requirements and acceptance by students, parents and teachers in the wild. *ACM International Conference Proceeding Series*, 13–24. <https://doi.org/10.1145/3152832.3152842>
- Ballantyne, M., Jha, A., Jacobsen, A., Scott Hawker, J., & El-Glaly, Y. N. (2018). Study of accessibility guidelines of mobile applications. *ACM International Conference Proceeding Series*, 305–315. <https://doi.org/10.1145/3282894.3282921>
- Beltran, P., Cedillo, P., Rodriguez-Ch, P., & Bermeo, A. (2018). MOOCEP: Towards a method for building massive open online courses for elderly people. *Proceedings - 2017 International Conference on Information Systems and Computer Science, INCISCOS 2017, 2017-Novem*, 279–286. <https://doi.org/10.1109/INCISCOS.2017.61>
- Bruner, J. (1969). *Hacia una teoría de la instrucción* (Ediciones). México.

- Castro Ojeda, R. (2018). Educación especial y personas adultas mayores. Retrieved from Nexos website: <https://educacion.nexos.com.mx/?p=1505>
- Dearman, D., & Truong, K. N. (2012). Evaluating the implicit acquisition of second language Vocabulary using a live Wallpaper. *Conference on Human Factors in Computing Systems - Proceedings*, 1391–1400. <https://doi.org/10.1145/2207676.2208598>
- García, N., & Bermejo, A. B. (2004). Tecnologías de la información y las comunicaciones para las personas mayores. *Universidad Politécnica de Madrid*, 6–43.
- Girón Téllez, D. P. (2014). Elementos andragógicos plasmados en un plan de clase de Informática IV. Retrieved from Universidad Autónoma del Estado de Hidalgo website: <https://www.uaeh.edu.mx/scige/boletin/prepa4/n3/e2.html#nota2>
- Göschlberger, B., & Bruck, P. A. (2017). Gamification in mobile and workplace integrated MicroLearning. *ACM International Conference Proceeding Series*, 545–552. <https://doi.org/10.1145/3151759.3151795>
- Horst, R., & Dörner, R. (2019). Virtual reality forge: Pattern-oriented authoring of virtual reality nuggets. *Proceedings of the ACM Symposium on Virtual Reality Software and Technology, VRST*. <https://doi.org/10.1145/3359996.3364261>
- Jahnke, I., Lee, Y. M., Pham, M., He, H., & Austin, L. (2019). Unpacking the Inherent Design Principles of Mobile Microlearning. In *Technology, Knowledge and Learning*. <https://doi.org/10.1007/s10758-019-09413-w>
- Knowles, M. S. (1980). The Modern Practice on Adult Education. From Pedagogy to Andragogy. *The Adult Education Company*.
- Ledo, M. V., Vialart, M. N., Sánchez, I. A., & González, G. Z. (2019). Cápsulas educativas o informativas. Un mejor aprendizaje significativo. *Educación Médica Superior*, 33(2). Retrieved from <http://www.ems.sld.cu/index.php/ems/article/view/1904>
- Luna, G., Mendoza, R., & Álvarez, F. J. (2015). *Design Patterns to Enhance Accessibility and Use of Social Applications for Older Adults*.
- Moral, T. (2015). El adulto mayor frente a las nuevas tecnologías. Retrieved from La Prensa Panamá website: [https://www.prensa.com/tecnologia/TECNOLOGIA-ABUELO-EDUCACION-INFORMATICA-SOCIEDAD-FAMILIA\\_0\\_4318818254.html](https://www.prensa.com/tecnologia/TECNOLOGIA-ABUELO-EDUCACION-INFORMATICA-SOCIEDAD-FAMILIA_0_4318818254.html)
- Pan American Health Organization. (2019). El número de adultos mayores con necesidades de cuidado a largo plazo se triplicará para 2050 en las Américas, advirtió la OPS. Retrieved from [https://www.paho.org/hq/index.php?option=com\\_content&view=article&id=15474:number-of-older-adults-with-long-term-care-needs-will-triple-by-2050-paho-warns&Itemid=1926&lang=es](https://www.paho.org/hq/index.php?option=com_content&view=article&id=15474:number-of-older-adults-with-long-term-care-needs-will-triple-by-2050-paho-warns&Itemid=1926&lang=es)
- Perrusquia, E. (2006). Contenidos digitales educativos. Una forma diferente para aprender. *22 Simposio Internacional de Educación SOMECE-2006*.
- Piskurich, G. M. (2015). *Rapid Instructional Design - Learning ID Fast and Right* (3rd ed.). Hoboken, New Jersey: John Wiley & Sons.
- Rimmer, T. (2016). An Introduction to SAM for Instructional Designers. Retrieved from Articulate Global website: <https://community.articulate.com/articles/an-introduction-to-sam-for-instructional-designers>
- Sanchez-Gordon, S., & Luján-Mora, S. (2016). Design, Implementation and Evaluation of MOOCs to Improve Inclusion of Diverse Learners. In *Accessibility and Diversity in Education: Breakthroughs in Research and Practice* (1st ed., pp. 115–141). Information Resources Management Association (USA).
- Sanchez, S., & Luján, S. (2013). Web accessibility of MOOCs for elderly students. *2013 12th International Conference on Information Technology Based Higher Education and Training, ITHET 2013*, (October). <https://doi.org/10.1109/ITHET.2013.6671024>
- Sommerville, I. (2011). Ingeniería de Software. In *La Computación en México por especialidades académicas* (9th ed.). Naucalpan de Juárez: Pearson Educación de México.
- Sunkel, G., & Ullmann. (2019). Las personas mayores de América Latina en la era digital: superación de la brecha digital. *Revista CEPAL*, 127, 243–268.
- Tutoky, G., Babič, F., & Wagner, J. (2013). ICT-based solution for elderly people. *ICETA 2013 - 11th IEEE International Conference on Emerging ELearning Technologies and Applications, Proceedings*, 399–404. <https://doi.org/10.1109/iceta.2013.6674466>
- World Wide Web Consortium (W3C). (2008). Web Content Accessibility Guidelines (WCAG) 2.0. Retrieved from <https://www.w3.org/TR/WCAG20/>
- Zelkowitz, M. V., Shaw, A. C., & Gannon, J. D. (1979). *Principles of Software Engineering and Design*. Prentice Halls.