# Mobile Application Prototype for the Development of Phonological Awareness in Children's School

**Adriana León-Pesantez and Catalina Astudillo-Rodriguez**
Education School, Computer Science Engineering School
Universidad del Azuay, Cuenca, Ecuador
aleon@uazuay.edu.ec, cvastudillo@uazuay.edu.ec,

**Esteban Crespo-Martínez**
LIDI, Engineering of Production School, Computer Science Engineering School,
Universidad del Azuay, Cuenca, Ecuador
ecrespo@uazuay.edu.ec

**Fabian Carvajal**
LIDI, Computer Science Engineering School,
Universidad del Azuay, Cuenca, Ecuador
fabianc@uazuay.edu.ec

## Abstract

This document exposes a technological tool to support the learning of Phonological Awareness skills, built under the guidelines proposed by Jiménez and Ortíz and aims to train high school children in the acquisition of this metalinguistic skill through a variety of activities (syllabic, intrasyllabic, and phonemic awareness) and immediate feedback, to acquire an excellent reading-writing process. The tool obtained is an application for the Android operating system that is easy to install, learn and configure by the therapist. For the construction of the software prototype, we have chosen to follow a methodology based on: i) the ADDIE instructional model (Analysis-Design-Develop-Implement-Evaluate), ii) the agile development methodology SCRUM, iii) the Methodological Guide for the creation of developments accessible virtual curricula; and iv) the Technology Acceptance Model (TAM); with the contribution of a multidisciplinary team made up of experts in information and communication technologies, linguistic rehabilitation, education, and graphic design. During the five phases of the methodology, the users' requirements were considered.

## Keywords
Phonological awareness, School children, Linguistic rehabilitation, ADDIE, and TAM

## 1. Introduction

More than 617 million children and adolescents are not reaching minimum proficiency levels (MCLs) in reading, according to new estimates from the UNESCO Institute for Statistics (UIS). The latest data points to a significant loss of human potential that could threaten progress toward the Sustainable Development Goals (SDGs). The total rate of children and adolescents who do not read competently in Latin America and the Caribbean is 36% (UNESCO Statistic Institute, 2017).

These reading difficulties are presented as dyslexia, whose prevalence is estimated between 5-10%, even reaching 15%, a situation that can cause difficulties in the child's academic and personal development. Therefore, prevention, early detection, and timely intervention are essential (Tamayo Lorenzo 2017). Dyslexia can be presented by a phonological deficit that causes difficulties in segmentation, repetition of pseudowords[1] and infrequent letter

[1] Grouping of letters that do not constitute a word, therefore, they do not allow to represent an idea or concept

combinations, difficulties in short-term verbal memory, rapid naming, and attentional problems (Tamayo Lorenzo 2017).

Phonological awareness or better known under the term phonological awareness has been studied by several authors such as Uribe (2008), who mention that phonological awareness is the ability to segment spoken language into its sound units and understand that the orthographic structure of our language is based on this division, that is, that the student can manipulate the words, syllables, and phonemes that make it up.

According to Bravo et al. (2004), phonological awareness has three essential components: a rhyme factor, a syllable factor, and a phoneme factor. For their part, Ramos and Cuadrado (2006) distinguish four levels of phonological knowledge, which are listed according to their level of complexity from lowest to highest: i) knowledge or sensitivity to rhyme and alliteration, ii) knowledge syllabic, iii) intrasyllabic knowledge and iv) phonemic knowledge.

This phonological knowledge evolves in the different stages of child development. In this sense, Bizama et al. (2011) maintain that "phonological awareness develops between 4 and 8 years old and goes from syllabic awareness to culminate with the management of phonemic skills once children learn to read and write". In this exact ideas order, Uribe (2008) refers that in the first instance, the child acquires the ability to segment words into phrases, later words into syllables, then detects and creates rhymes, identifies initial or final sounds in words, and finally analyzes and synthesizes the phonological sequence. In this regard, studies that have compared syllable and phoneme levels have shown that "syllabic awareness precedes phonemic awareness" (Jiménez and Ortiz 2000).

As mentioned in previous paragraphs, phonological awareness is considered the foundation of reading, so research by authors such as Jiménez and Ortiz (2000) and Vargas and Villamil (2007) suggest that the absence of this metalinguistic ability causes different difficulties in the reading process, with its possible repercussions in school failure. Likewise, they show that children who acquire a correct development of their phonological awareness have better performance when learning to read. The authors Calderón et al. (2006), Defior and Serrano (2011) and Núñez Delgado and Santamarina (2014) speak of the importance of phonological awareness; they pose it as a "relevant facet" that facilitates phoneme-grapheme correspondence processes, since the more significant the awareness of oral language, the greater the ease it will have the child to associate graphemes with their corresponding phonemes.

Recognizing that a good level of phonological awareness is essential for the acquisition of the reading-writing process, this article presents a mobile application prototype based on the guidelines of the Phonological Awareness (CF) program proposed by Larreategui and Prieto based in Jiménez and Ortiz (2000), present activities with the three essential components of CF (syllabic, intrasyllabic and phonemic awareness), whose objective is to train in the acquisition of this metalinguistic ability and achieve an adequate reading-writing process of children who attend the high school level (5 -6 years). For the development of the prototype of the mobile application, the methodology proposed by Calvache and Peñafiel was followed, which has five phases: i) technical-theoretical analysis, ii) design, iii) development, iv) implementation or deployment, and v) evaluation. This methodology is based on the instructional model ADDIE (Analysis-Design-Develop – Implement – Evaluate) (Branch 2009), the agile development methodology SCRUM (Adi 2015), the Methodological Guide for the creation of accessible virtual curricular developments (Amado-Salvatierra et al. 2015) and the Technology Acceptance Model (TAM) (Davis, 1985), (Lule 2012).

This document is to divide into four sections distributed as follows: i) Introduction: presents a global vision of the project, outlining the objectives to be achieved and the context in which it was too developed; ii) State of the art: different applications oriented to PA are exposed, highlighting the educational software and addressing the results of the interventions; iii) Methodology: where the characteristics and elements for the construction of the prototype to support the development of PA are detailed; iv) Results: include all the activities for the Analysis, Design, Development, Implementation, and Evaluation of the prototype; and v) Conclusions: this section presents the conclusions reached.

## 2. Literature Review

Computer games become important playful mechanisms (Pelosi et al. 2018) that contribute to phonological learning (Guindeira and Gil, 2017). Among the related works in the field of ICT, computer games and phonological awareness are those described below: Guindeira and Gil (2017) developed a digital resource called "Digital educational games

& phonological awareness," which performs a qualitative and exploratory study considering two assumptions: i) a growing increase in difficulties in acquiring reading and writing skills in the first years of elementary school; and ii) the lack of digital resources that fully contemplate the development of phonological awareness.

On the other side, Kartal et al. (2016) investigate the effects of an experimental program, "Training for Phonological Awareness in an Orthographically Transparent Language in Two Different Modalities," designed to develop the phonological awareness skills of beginning readers in Turkey, in which they consider that the use of educational software can be as positive as the instructions issued in a regular class.

In this same order of ideas, there is the work of Oliveira et al. (2010), who developed an application called "Avaliação de um programa computadorizado para intervenção fônica na dislexia do desenvolvimento" (in English: "Assessment of a computerized program for phonetic intervention in developmental dyslexia") that aimed to determine the effectiveness of a phonetic literacy software to promote phonological awareness and graphophonemic correspondences in dyslexics. They conclude that the intervention benefits the reading of people with dyslexia.

Bezanilla et al. (2014) mention that the evaluation of competencies is not easy, forcing universities to integrate this type of purpose into their curricula, applying various strategies and methodologies to achieve these results. To follow a regular academic process, El Kah and Lakhouaja (2018) points out that manual or electronic tools have been introduced to help children with learning problems caused by neurological disorders that affect performance and the natural learning process, manifested through symptoms of dyslexia, dysgraphia, and dyscalculia.

The work of Elimelech and Aram (2020), highlights ways to promote children's understanding of the writing system and demonstrate the effectiveness of a spelling-adapted computer game in promoting basic early literacy skills: i) letter knowledge, ii) phonological knowledge, iii) spelling of words, and iv) word decoding. Díaz and Troyano (2013) sets out that gamification applied to the educational field has potential and that the use of video games becomes essential for the cognitive aspect of the user.

Nshimbi et al. (2020), conduct a study to determine the effects of using a phone-based mobile literacy game (Graphogame) to improve literacy skills in children and adults in rural family settings. The findings showed that children exposed to the Graphogame performed better on literacy tests than the control group. In addition, the parents' performance in the tests improved after the intervention. The findings suggest that technology can improve literacy skills in both children and adults in rural Zambia.

## 3. Methods

For developing the software prototype that helps stimulate phonological awareness in children from 5 to 7 years of age, the adaptation was made to a methodology based on the ADDIE instructional model (Branch 2009), the SCRUM framework (Adi 2015), the Technology Acceptance Model (TAM) (Davis 1989), and the methodological guide for accessible virtual curricular developments (Amado-Salvatierra et al., 2015). Figure 1 (SPEM 2.0 (OMG 2008)) visualizes the methodology adapted by Calvache and Peñafiel, applied in the construction of the prototype. This methodology was made up of five phases: i) the Analysis phase, ii) the Design phase, iii) the Development phase, iv) the Implementation or deployment phase, and v) the Evaluation phase.

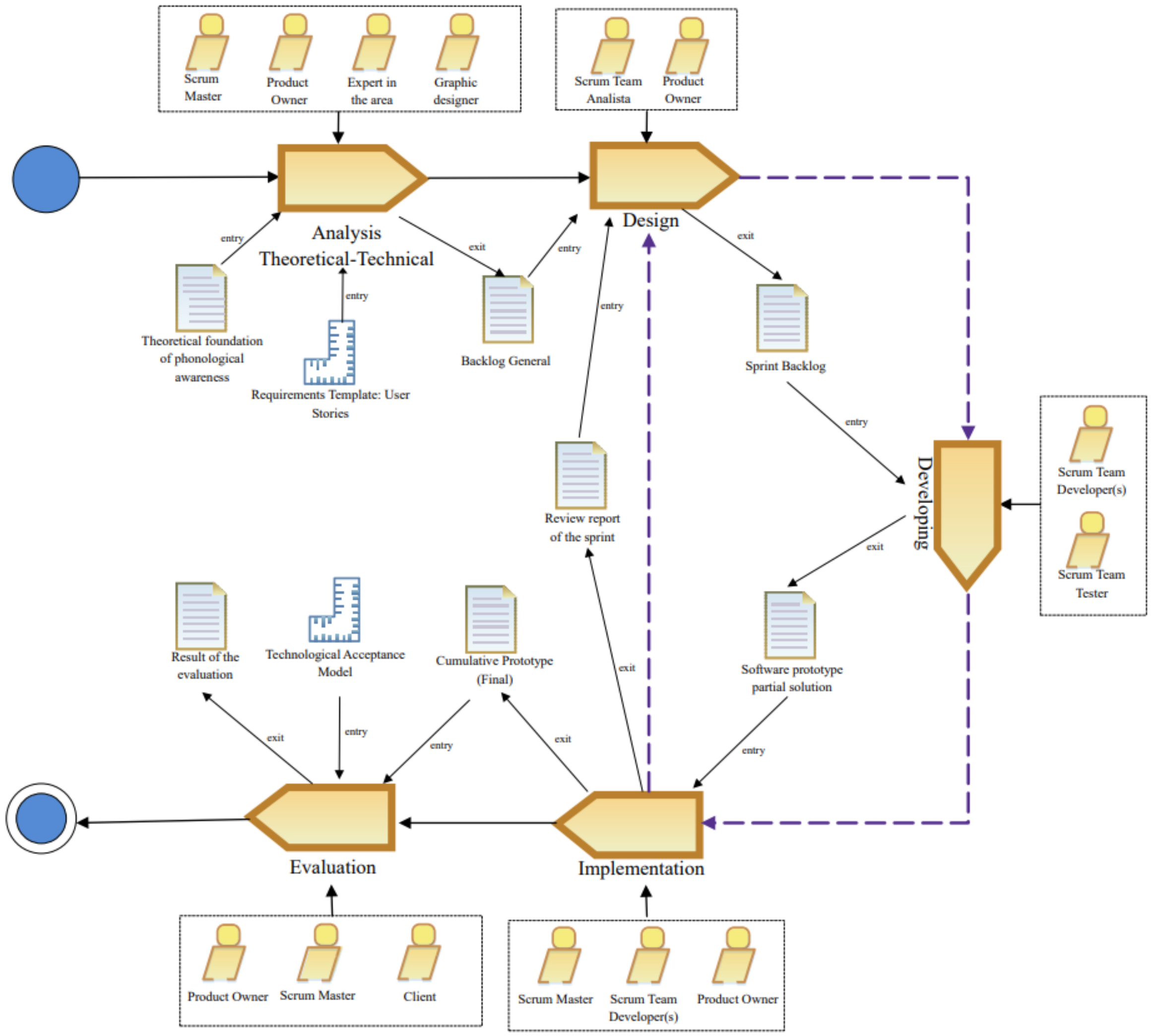



Figure 1. Applied method

## 4. Results of the instantiation of the Methodology

### 4.1 Analysis phase

The analysis phase unfolds in a unidirectional manner between three activities adapted to the domain of this study (Amado-Salvatierra et al. 2015), i) definition of educational objectives and content, which includes: defining the phonological awareness program and formulating the objectives to be achieved, ii) definition of techniques that includes: identifying the activities to be carried out, defining the rules to be followed to guarantee accessibility/usability, and selecting or creating graphic and multimedia resources, and iii) definition of technical requirements that implies: defining tasks, identifying the mandatory and optional technical requirements.

Achieving these activities determine the skills, abilities, and knowledge to be imparted by collecting information (Cheung 2016), which allows identifying the necessary resources for the stimulation of phonological awareness at the levels of Syllabic Synthesis, Comparison of syllables in words, and Phonemic Synthesis (Kartal and Terziyan, 2016). Also, determine the platform (Ionic, Angular, and the Visual Studio Code IDE) for implementing a mobile application compatible with the Android operating system. As an output of this phase, the General Backlog was defined based on the user stories template (Adi 2015) as shown in Tables 1 and 2.

Table 1. General Backlog activities list

| Num. | Backlog item | Description |
|---|---|---|
| 1 | Activity 1 | Activity number 1 oriented to syllabic synthesis |
| 2 | Activity 2 | Activity number 2 oriented to the comparison of syllables in words |
| 3 | Activity 3 | Activity number 3 oriented to the comparison of syllables in words |
| 4 | Activity 4 | Activity number 4 aimed at phonemic synthesis |
| 5 | Activity 5 | Activity number 5 oriented to the isolation of phonemes |
| 6 | General interface | General interface of the application |

In Table 2, the general backlog activities list based on the user histories are exposed:

Table 2. General Backlog activities list

| Code | Name | Description |
|---|---|---|
| HU01 | Mobile App | As a teacher I want the software to work as a mobile application |
| HU02 | Images | As a teacher I want preloaded images to be used |
| HU03 | Audio | As a teacher I want preloaded audios to be used |
| HU04 | Feedback | As a teacher I want the software to provide feedback with the sound of the correct answer |
| HU05 | Options per exercise | As a teacher I want activities 1, 2, 3 and 4 to have 3 image options. |
| HU06 | Number of exercises | As a teacher I want activities 1 and 4 to have 4 exercises, activities 2, 3 and 5 to have 2 exercises |
| HU07 | Voice recognition | As a teacher I want the second activity to implement voice recognition (in case of failure, image selection) |
| HU08 | Images selection | As a teacher I want activity 1 to work with image selection |
| HU09 | Randomization | As a teacher I want the images to be loaded randomly in the exercises. |
| HU10 | Colors | As a teacher I want the app to use the same colors and fonts on all pages. |
| HU11 | Header | As a teacher I want the app to use the same header format for activities. |
| HU12 | Draw | As a teacher I want the application to allow drawing in activity 5. |

## 4.2 Design Phase

Taking the General Backlog as input, the design phase was developed unidirectionally between two activities (Amado-Salvatierra et al. 2015) adapted to the domain of this study: i) Temporary planning of activities and effort and ii) Production planning of. In this way, a generic plan of how the software will be built was created, which includes choosing the optimal method or methods of instruction to create objects or materials that help stimulate phonological awareness (Cheung 2016). As an output of this phase, two Sprint Backlogs were developed (Tables 3 and 4) using the Sprint planning template (Adi 2015).

Table 3. Sprint Backlog, Sprint 1

| Sprint week | Total days | Item Backlog: | User histories |
|---|---|---|---|
| 1 | 8 | 1, 2, 3 | HU01-HU09 |

Table 4. Adapted Sprint backlog, Sprint 2

| Sprint week | Total days | Item Backlog: | User histories: |
|---|---|---|---|
| 2 | 7 | 4, 5, 6 | HU02-HU06, HU08-HU12 |

## 4.3 Development phase

Taking as entries both Backlog Sprints, the development phase is performed in the bidirectional form in four activities (Amado-Salvatierra et al. 2015) adapted to the core of this study: i) diary meetings, ii) reuse /adaptation of preexistent material, iii) Development/Modification, and iv) Software bug testing.

As an output of the first sprint, the first version of the software prototype was obtained with the first, second, and third items of the general backlog for review of errors. During the internal tests of the software among the developer members of the Scrum Team, execution evaluations were carried out for each implemented item. Combinations of events that generate errors in the execution time of the software were identified, obtaining the mistakes: the images suffered distortion of size, the audio resources were not loaded at the beginning of each exercise, and overlapped when quickly using the buttons. Once the corrections were made, the prototype was obtained in its first version. Figure 2 exposes the partial solution software prototype.

For the second sprint, the second version of the prototype was obtained as output, which also contained the fourth, fifth, and sixth items of the General Backlog and an improved graphical interface. During the internal tests of the software, execution evaluations were carried out for each item (4, 5, and graphical interface) implemented; in this activity, the developer members of the Scrum Team participated. Likewise, a performance test was planned for each developed item to be executed by the Tester, combining events that can generate errors in the execution time of the software. The errors found in sprint 2 were: i) The exercises of Item Backlog 4 did not start when they were selected, ii) In the exercises of Item Backlog 5, the touch events did not work, iii) The texts of Item Backlog 5 had misspellings, and iv) Colors and distribution had to be standardized of elements in all views.

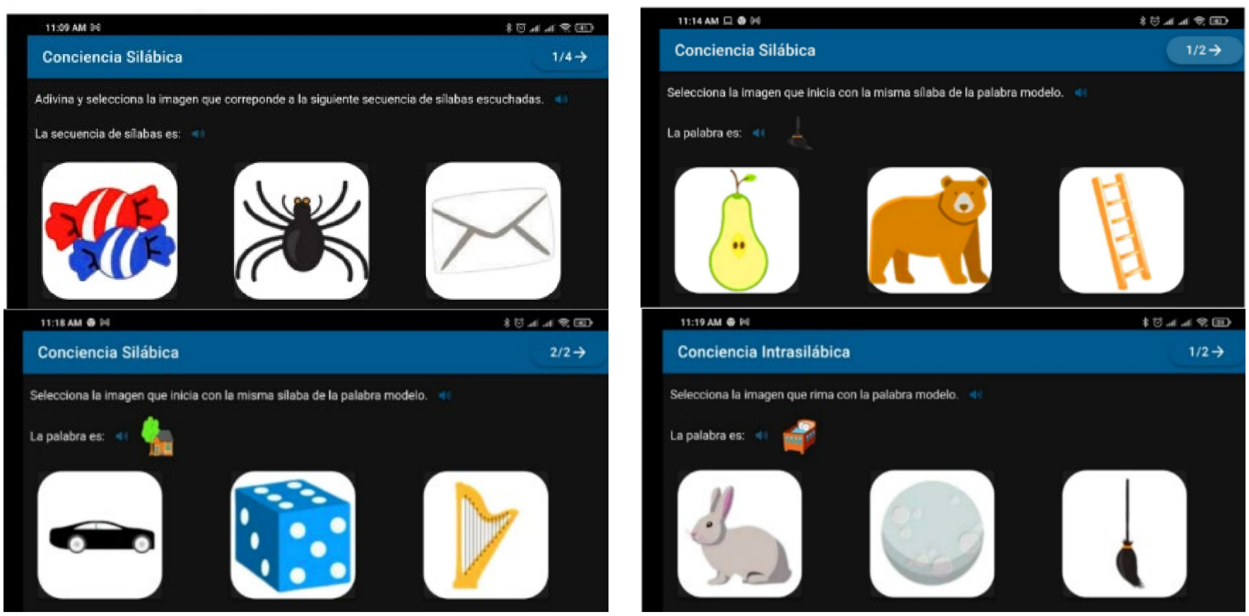
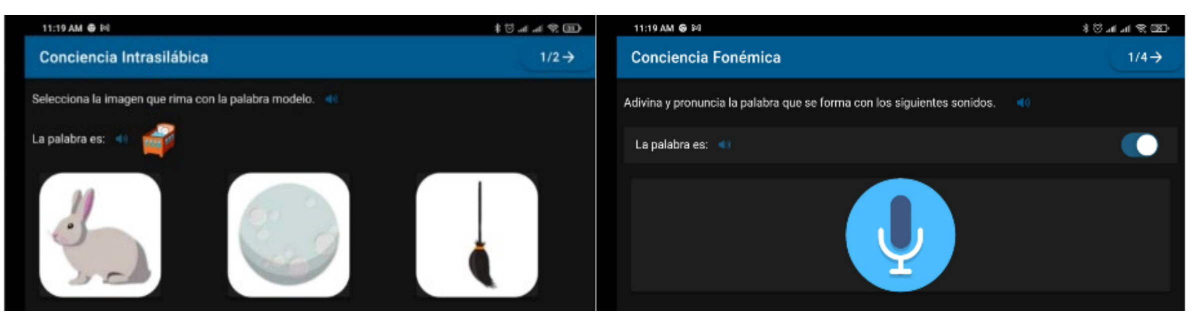



Figure 2. Sprint 1 Partial Solution Software Prototype

After correcting the errors reported by the Scrum Tester, the partial software prototype of the Sprint 2 solution was generated. This is visualized in Figure 3.



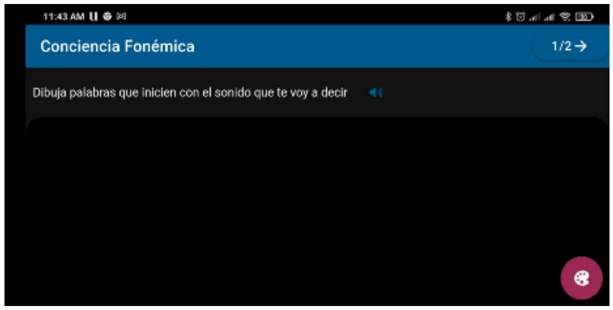



Figure 3. Sprint 2 Partial Solution Software Prototype

### 4.4 Implementation or deployment phase

The implementation phase is executed in a unidirectional way between three activities (Amado-Salvatierra et al., 2015): i) Perform functional tests of the software according to the sprint (on physical devices with Android version 6 and version 11), ii) Organization of technical support, and iii) Retrospective of the Sprint. In this way, the materials built in the Development phase were tested in the field, and the execution of partial tests of the material was coordinated with the Product Owner (Cheung, 2016). As an output of this phase, the Sprint review report and the final cumulative Prototype were obtained.

### 4.5 Evaluation phase

The evaluation phase unfolds in a unidirectional manner between four activities: i) Evaluation planning, ii) Information gathering, iii) Analysis of the information obtained, and iv) Optimization. These activities determine if the software prototype achieves the planned objectives and what changes are necessary for future content construction, in addition to the feedback of all the previous phases (Cheung, 2016).

Evaluation planning: The aspects to be evaluated were established considering the application constructs of the Technology Acceptance Model (TAM) (Lule, 2012): Ease of use, Perceived usefulness, and Intention of use. Asking the following research questions RQ1: Is the phonological awareness training software prototype perceived as easy to use and useful? And RQ2: Is the intention to use the result of the perceptions of the participants? The two research questions were evaluated through the test of several hypotheses. The first question was studied with the following hypotheses that seek to comply with the relationships determined by the TAM model (Davis, 1985).

- H10: The software prototype is perceived as difficult to use, H10= ¬ H11.
- H20: The software prototype is not perceived as a useful tool, H20= ¬ H21

On the other hand, the second question was studied through the formulation of the following hypotheses:

- H30: Perceived usefulness is not determined by perceived ease of use. H30= ¬ H31.
- H40: Intention to use is not determined by perceived ease of use. H40= ¬ H41.
- H50: Intention to use is not determined by perceived usefulness. H50= ¬ H51.

According to the Goal-Question Metric (GQM) paradigm (Basili et al., 1994), the goal of this quasi-experiment was defined as follows: i) Evaluate: the phonological awareness training software prototype, ii) With the purpose of: assessing the users' perceptions regarding the usefulness, ease of use and intention of use when using the created software prototype, and iii) In the context of: a group of 28 students in basic and initial education and 7 professionals in initial education, in Cuenca, Ecuador.

The survey questions were based on the contribution of Cedillo Orellana (2017), considering only the TAM constructs and the causal relationships involved. Five questions were elaborated for the perceived ease of use (PEOU) and six for the perceived usefulness (PU); the attitude towards use (ATU) will be evaluated based on the two previous constructs. In addition, two additional questions allowed the collection of qualitative information that will be used for the optimization activity.

According to Davis (1985), the Attitude Towards Use construct is affected by the Perceived Ease of Use and Perceived Usefulness constructs, so the ATU variable was assessed by averaging the means obtained from the two previous constructs (PEOU and PU).

### 4.5.1 Information collection

A survey was applied that considered five questions for the PEOU and six for PU, the ATU was evaluated based on the two previous constructs. To extract the information, the Google Forms tool was used, using a 5-item Likert scale.

### 4.5.2 Analysis of the information obtained

The statistical analysis process was based on the work of Cedillo Orellana (2017). With the collected results, the validation of the constructs was carried out through Cronbach's alpha, obtaining a value of 0.720 and 0.708 for Perceived Ease of Use and Perceived Usefulness, respectively, since Cronbach's alpha was more significant than 0.7 for the variables evaluated with the questionnaire, they met the internal validity.

To obtain the descriptive statistics through the SPSS v25 software, a value of $\alpha$=0.05 was always used in the respective cases. The results obtained were PEOU (Mean: 4.4629), PU (Mean: 3.8857), and ATU (Mean: 4.1743); all the quantified values are above the mean value (also called neutral for the present study) of the Likert scale, which indicates a positive assessment regarding the influence of the software with respect to the evaluated constructs; that is, there are perceptions about the prototype that indicate that it is easy to use it is valid, and there is a good attitude towards the use by users.

It was determined that the two constructs: Perceived Ease of Use and Perceived Usefulness, have a normal distribution (PEOU Sig: 0.000 and PU Sig: 0.015) through the Shapiro-Wilk test, for which a T-test with the number three as test value, to accept or reject the hypotheses involved (H10 and H20). The T-tests showed a significance well below 0.05 (PEOU Sig: 0.000 and PU Sig: 0.000), showing that the hypotheses H10 and H20 can be discarded, which indicates that the prototype is easy to use (H11) and it is considered a helpful tool (H21).

It was determined that the two constructs: Perceived Ease of Use and Perceived Usefulness, do not have a normal distribution (PEOU Sig: 0.000 and PU Sig: 0.015) through the Shapiro-Wilk test, so a Wilcoxon test was performed with the number three as test value, to accept or reject the hypotheses involved (H10 and H200). The Wilcoxon tests showed a significance well below 0.05 (PEOU Sig: 0.000 and PU Sig: 0.000), showing that hypotheses H10 and H200 can be ruled out, indicating that the prototype is easy to use (H111) and that it is considered a helpful tool (H211).

Then, linear regression analyzes were applied to each of the constructs involved in the different causal relationships: i) H30: PU and PEOU Sig: 0.001, ii) H40: ATU and PEOU Sig:0.000, and iii) H50: ATU and PU Sig:0.000. With these results, hypotheses H30, H40, and H50 were discarded since low significance was found between the constructs, that is, a high level of a causal relationship; therefore, H31, H41, and H51 were accepted.

With respect to RQ1, it was proved that the software is perceived as easy to use and valuable by users (H11, H21 accepted). While for RQ2, it was shown that the attitude towards use was determined by the perceived usefulness and the perceived ease of use through the proven causal relationships (H31, H41, H51 accepted).

### 4.5.3 Optimization

Finally, for the optimization, the suggestions for the quantitative data were collected, which are: implement background music, more graphic elements, more significant visual interaction, better quality of graphic elements, diversity of auditory elements, and implementation of more levels and exercises. These aspects are relevant in video games because they improve the user experience (Crawford, 2000).

## 5. Conclusions

The mobile app prototype to improve Phonological Awareness skills benefits struggling readers and typically developing children between 5-7 years old. It integrates smaller language units with various activities and immediate feedback, achieving positive effects on motivation (Kartal and Terziyan, 2016) , intending to help the early acquisition of reading.

As explained Pelosi et al. (2018), computer-based play games can support activities related to phonological learning. In this sense, the software prototype implements several CF exercises; one of them is phoneme segmentation, considered one of the most challenging skills to acquire for school-age children; previous studies have determined that first-grade students obtain the lowest scores in this skill (Kartal and Terziyan, 2016). The applied methodology included five key aspects: Analysis, Design, Development, Implementation, and Validation, which facilitated obtaining a software prototype to support the development of CF.

Most of the responses to the open-ended questions in the questionnaire were optimistic about using the software prototype in the future. Following this criterion, hypotheses H41 and H51 were confirmed in the execution of the quasi-experiment. There is an awareness that other factors can affect users' decisions when testing software. However, those are factors that cannot be controlled. The objective of this work was to select the most critical factors regarding use, such as perceived ease of use and perceived usefulness (Cedillo Orellana, 2017).

## Acknowledgements

We thank our students Alexander Peñafiel and Sebastian Calvache, who did their degree work in the development of the prototype of the application.

## References

Adi, P., Scrum Method Implementation in a Software Development Project Management, *International Journal of Advanced Computer Science and Applications*, 2015.

Amado-Salvatierra, H. R., Quan Lainfiesta, L. R., and Hernández Rizzardini, R., *Guía metodológica para la creación de desarrollos curriculares virtuales accesibles*, Ciudad de Guatemala: Servicio de Publicaciones Universidad Galileo, 2015.

Basili, V. R., Caldiera, G., and Rombach, H. D., The goal question metric approach, *Encyclopedia of software engineering*, 528-532, 1994.

Bezanilla, M. J., Arranz, S., Rayón, A., Rubio, I., Menchaca, I., Guenaga, M., and Aguilar, E., A proposal for generic competence assessment in a serious game, *Journal of New Approaches in Educational Research*, 42-51, 2014.

Bizama, M., Arancibia, B., and Sáez, K., Evaluación de la Conciencia Fonológica en párvulos de nivel transición 2 y escolares de primer año básico, pertenecientes a escuelas vulnerables de la Provincia de Concepción-Chile, 81-133, 2011.

Branch, R. M., Instructional Design: The ADDIE Approach, *Springer Science & Business Media*, 2009.

Bravo, L., Villalón, M., and Orellana, E., Los procesos cognitivos y el aprendizaje de la lectura inicial: Diferencias cognitivas entre buenos lectores y lectores deficientes, *Estudios pedagógicos (Valdivia)*, 30, 7-19, 2004.

Calderón, G., Carrillo, M., and Rodríguez, M., La conciencia fonológica y el nivel de escritura silábico: Un estudio con niños preescolares, *Límite. Revista Interdisciplinaria de Filosofía y Psicología*, 81-100, 2006.

Cedillo Orellana, I. P., Monitorización de calidad de servicios cloud mediante modelos en tiempo de ejecución (Doctoral dissertation, Universitat Politècnica de València), 2017.

Cheung, L., Using the ADDIE Model of Instructional Design to Teach Chest Radiograph Interpretation, *Journal of Biomedical Education*, 1-6, 2016.

Crawford, C., The art of computer game design. Washington Press University, 1982

Díaz Cruzado, J. and Troyano Rodríguez, Y., El potencial de la gamificación aplicado al ámbito educativo, 2013.

Davis, F., A technology acceptance model for empirically testing new end-user information systems: Theory and results (Doctoral dissertation, Massachusetts Institute of Technology),1985.

Davis, F. D.,Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology, *MIS Quarterly*, 13(3), 319-340, 1989.

Defior, S., and Serrano, F., La conciencia fonémica, aliada de la adquisición lenguaje escrito. *Revista de Logopedia, Foniatría y Audiología*, 2-13, 2011.

El Kah, A., and Lakhouaja, A., Developing effective educative games for Arabic children primarily dyslexics, *Education and Information Technologies*, 2911-2930, 2018.

Elimelech, A., and Aram, D., Using a Digital Spelling Game for Promoting Alphabetic Knowledge of Preschoolers: The Contribution of Auditory and Visual Supports, *Reading Research Quarterly*, 235-250, 2020.

Guindeira, T., and Gil, H., Digital educational games & phonological awareness, *2017 12th Iberian Conference on Information Systems and Technologies (CISTI)*, 1-5, 2017

UNESCO, I.D., *Más de la Mitad de los Niños y Adolescentes en el Mundo No Está Aprendiendo*, 2017.

Jiménez, J., and Ortiz, M., *Conciencia Fonológica y Aprendizaje de la Lectura: Teoría, evaluación e intervención*, Síntesis, Madrid-España, 2000.
Kartal, G., Babür, N., and Erçetin, G. (2016). Training for Phonological Awareness in an Orthographically Transparent Language in Two Different Modalities. Reading and Writing Quarterly, 32(6), 550-579,2016.
Kartal, G., and Terziyan, T., Development and Evaluation of Game-Like Phonological Awareness Software for Kindergarteners: JerenAli, *Journal of Educational Computing Research*, 519-539, 2016.
Lule, I., Application of Technology Acceptance Model (TAM) in M-Banking Adoption in Kenya, *International journal of computing & ICT research*, 2012.
Nshimbi, J. C., Serpell, R., and Westerholm, J., Using a phone-based learning tool as an instructional resource for initial literacy learning in rural African families, *South African Journal of Childhood Education,* 2020.
Núñez Delgado, M. P., and Santamarina, M., Prerrequisitos para el proceso de aprendizaje de la lectura y escritura: Conciencia fonológica y destrezas orales de la lengua, *Lengua y Habla*, 72-92, 2014.
Oliveira, D. G. de, Lukasova, K., and Macedo, E. C. D., Avaliação de um programa computadorizado para intervenção fônica na dislexia do desenvolvimento, *Psico-USF*, 277-286, 2010.
OMG, S. and Notation. O., Software & Systems Process Engineering Meta-Model Specification, *OMG Std.,* 18-71, 2008.
Pelosi, M. B., Silva, R. M. P. da, Santos, G. dos, and Reis, N. H., Atividades Lúdicas para o Desenvolvimento da Linguagem Oral e Escrita para Crianças e Adolescentes com Síndrome de Down, *Revista Brasileira de Educação Especial*, 535-550, 2018.
Ramos, J., and Cuadrado, I., Prueba para la Evaluación del Conocimiento Fonológico, PECO, 2006.
Tamayo Lorenzo, S., La Dislexia y las dificultades en la adquisición de la lecto-escritura. Profesorado, *Revista de Currículum y Formación de Profesorado*, 423-432, 2017.
Uribe, C., Aproximación cognoscitiva: Intervención en las dificultades de aprendizaje Capt.3. En L. Quintanar, J. Solovieva, J. Azcoaga, E. Peña, M, Bonilla, G. Yánez, J. Eslava, L. Mejía, R. Rosas, E, Lazaro. V. Reigosa & C. Uribe, Los Trastornos del aprendizaje. Perspectivas neuropsicológicas. (pp. 353-354). Bogotá-Colombia: Magisterio., 2008.
Vargas, A., and Villamil, W., El papel de la conciencia fonológica como habilidad subyacente al alfabetismo temprano y su relación en la comprensión de lectura y la producción escrita de textos, *Pensamiento psicológico*, 163-174, 2007.

## Biographies

**Adriana León** is Professor-Researcher at the School of Initial Education and the School of Basic Education of the Faculty of Philosophy and Human Sciences of the University of Azuay, Cuenca- Ecuador. She is a Medical Technologist with a specialty in Language Therapy, she has a degree in Educational Sciences with a mention in Basic Education. She has a master's degree in Intervention and Early Education. She has participated in several winning research projects from the CEPRA, CEDIA and ERASMUS calls. She collaborates as a senior researcher in the UPS UNESCO Chair. She also participates in research projects with professors from the University of Azuay. Her research interests include Language and Communication, Hearing, Responding to Educational Needs, Technology.

**Catalina Astudillo-Rodríguez** is an Associate Professor-Researcher at the School of Computer Science Engineering and the Faculty of Administration Sciences of the Universidad del Azuay, Cuenca, Ecuador. She is a Computer Engineer. Has a specialty in University Teaching and a master's degree in Multimedia Design, she is currently pursuing doctoral studies in Computer Science at Universidad Nacional de la Plata, La Plata, Argentina. She is linked to multidisciplinary research projects with professors from the University of Azuay, titled projects: development of ERP software for SMEs, Development of online product catalog for SMEs, Linguistic Documentation Project, Socio-linguistic Cartography, Augmentative Systems and Communication alternatives with FOSS technologies and Attentional Processes. Her research interests include programming, usability, user experience, and web applications.

**Esteban Crespo-Martínez** is Computer Engineer, a master's degree in Strategic IT Management, a master's degree in Business Administration, master's degree in Marketing Management and Doctoral candidate at Universidad Pablo de Olavide, Spain, in the Business Management and Administration program. Is an Associate Professor-Researcher at Universidad del Azuay, in Cuenca Ecuador. Is the creator of the ECU@Risk methodology for Information Risk Management. In addition, he is a member of the University Council and Cybersecurity coordinator of the same institution. Many International Certifications like Microsoft International Certificate in Information Security and

Windows Operating Systems. Ethical Hacking Training Certificate issued by The Hacking Day, Scrum International Certificate, and International Certificate in CISCO Network Academy. In 2020, he was also invited professor by METARED and the University of Murcia to teach the Risk and Threat Management module in the First and Second International Chief Information Security Officer (CISO) training course for universities.

**Fabian Carvajal** is an Associate Professor-Researcher at the School of Computer Engineering and the Faculty of Administration Sciences of the University of Azuay, Cuenca, Ecuador. He is an Electronic Engineer. He has a specialty in University Teaching and a master's degree in University Teaching. He is linked to multidisciplinary research projects with professors from the University of Azuay, projects entitled: ERASMUS y Augmentative systems and communication alternatives with FOSS technologies. His research interests include programming, usability, user experience, web applications, IOT, and user interfaces.