# MIDOAA: *Inclusive Model of Development of Accessible Learning Objects*

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***Abstract*— This paper presents the Inclusive Model for the Development of Accessible Learning Objects developed to assist students with Hearing Impairment. Previous studies have demonstrated the importance of using Accessible Learning Objects to support the educational process of students with disabilities. The Inclusive Model was designed to attend the needs of higher education teachers in computing. This model was designed and implemented with emphasis on the constructivist paradigm, and using the pedagogical model with the support of the techniques of Requirements Engineering and the computational model, using the PDCA and SCRUM Methodology. The proposal of development of the inclusive model has as main objective to attend Students with Special Educational Needs. Accessible Learning Objects was evaluated through of educational, usability, and informatics in education specialists. Also, was realized a case study in the Computer Science class, wich had a student with Hearing Impairment, which participated of the study. The results showed that the Accessible Learning Objects are appropriate for requirements previously defined bi teachers of the disciplines and are promising for the inclusive education.**

***Keywords*— *Accessible Learning Objects, Students with Special Educational Needs, Hearing Impairment.***

## I. INTRODUCTION

Education is a right provided by law that ensures the teaching, access and participation of all people in schools and universities at all levels of education. In this sense, the education ensure Students with Disabilities (SWD), the exercise of fundamental rights and liberty on an equal footing, thus promoting social inclusion and citizenship. For [1] is important that public and private education institutions, start investiments, and develop projects turned to SWD from basic to higher education.

Over a billion people, about 15% of the world's population, have some form of disability, in accordance with World Health Organization [2].

Research related to the use of technology in education has received growing attention from scholars in recent years [3]. One of the biggest changes is about diversity in the classroom. Teachers are being challenged to teach students with a wide variety of skills and needs. In this sense, we can cite the increase of students with disabilities in the classroom, thus promoting the inclusion education process.

According to [4], empirical studies on the well-being of Students with Special Educational Needs (SEND) are scarce, therefore, the authors recommend give more attention to designing and implementing to supports improve the well-being and school satisfaction of students who identify themselves as SEND or SWD. In accordance with [5] "for these students to succeed, it is imperative that their specific academic needs be recognized and addressed".

The inclusive education at various levels is co-learning in regular classes of students of different classes, ages and abilities to attend the diverse characteristics of students. Higher Education Institutions are constantly adopting Information and Communication Technologies to improve and enhance the learning process [6].

MIDOAA is an inclusive model based on the work proposed by [1], developed to attend a rising demand of SWD. The term 'model' in this article, therefore, represents both the place as the procedure used for inclusive education. In this work, the model includes concept, purpose, content, resources, processes, techniques, design, accessibility, learning and evaluation.

The objective of this research was to develop a model that mixes the instructional design (pedagogical model) and the software development process (computational model). Therefore, Requirements Engineering (RE) was used as strategy to generate learning, accessibility and usability requirements well-structured. Considering the standards and accessibility guidelines proposed by [7].

Requirements Engineering is a sub-area of Software Engineering that studies the process of defining the requirements for produce an artifact. Requirements Engineering always has recognized as a critical area in software development, but of notable relevance in the success of projects. Their study in educational environments offers research opportunities, because is a growing area. In this way, the use of the requirements engineering process contributed of the evolutionary way to the consolidation of the model.

In this sense, it is important to emphasize that the Learning Objects (LO) by being digital can be treated like software products, can thus benefit the good practices of the processes of software development. This research is characterized as an

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exploratory study, and utilized the qualitative approach, whose research method used was the case study.

This proposal is aligned with the production of Accessible Learning Objects (ALO) and the effective contribution of learning, challenge presented both for Education and Computing.

Of course, there are many groups of students that could potentially if benefit from this inclusive model, students with diverse learning needs [5], but the main focus of this work is to present a SWD proposal for hearing impaired students.

## II. METHODOLOGY

First, we realized a bibliographic research involving topics related to this study, such as: Inclusive Model, Accessible Learning Objects, Requirements Engineering, Software Engineering, SCRUM and Plan, Do, Check, and Act (PDCA). The MIDOAA proposal was elaborated based on related works and possible gaps in the literature.

The proposal is supported by the theoretical basis raised on the subject, in the inclusive model presented by [1], and in the results obtained through the application of case studies and by the practical experiences with the development of Learning Objects and Accessible Learning Objects.

The methodology used for the development of the artifact was specified in the four steps specified by the PDCA cycle: Plan, Do, Check, and Act, as described below.

In the "Plan" phase, were realized planning meetings, where the tasks were defined, and converted into goals in accordance with the schedule, and was elaborated the pedagogical design of the Accessible Learning Objects, using the techniques of: storyboard, map of empathy and requirements report. Another phase is "Do", where the tasks planned in the previous phase were performed, through the implementation of ALO using educational tools whose software licenses are offered by the University. In the "Verify" phase the results obtained in the Accessible Learning Objects were analyzed and validated. Finally, in the "Act" phase, we anticipate and realized actions corrective, preventive and improvement in the Accessible Learning Objects, considering the criticisms, suggestions, positive and negative points shows in the previous phase. In addition, the Accessible Learning Objects were added in a repository developed for this purpose.

Teachers with academic formation in Computer Science and Degree in Computer Science, who work in public and private Higher Education Institutions in the State of Amazonas - Brazil, participated and validated the project, processes and stages defined for the development of the Inclusive Model.

The MIDDOA was validated through a case study with students of the Computer Science course, in the discipline of Programming Logic, composed of 42 students, where only one student presented the profile of SEND, with hearing impairment. A questionnaire was applied with students and specialists in the area of pedagogy, usability and informatics in education. Specialists during their point-of-view assessments recorded the level of teaching and learning achieved by students, as well as the accessibility and usability of Accessible Learning Objects.

## III. BACKGROUND AND RELATED WORKS

The summary review of the relevant literature on inclusive education has suggested that management of education for students with special needs is required at all levels [1], [2], [4] and [5].

Inclusive Education is an educational process proposed to deal with the diversity presented by students [4], [5]. In this sense, it is seen as a process of humanization, which provides for respect, participation and coexistence between individuals. One of the fundaments of inclusive education is Equality.

According to [2] 466 million people in the world live with disabling hearing. Hearing impairment is also known as hearing loss or deafness, and refers to partial or total hearing impairment. Its cause originates from birth or comes from a disease. In this sense, deafness can be classified as moderate (from 41 to 55 decibels), accentuated (from 56 to 70 decibels), severe (from 71 to 90 decibels), deep (over 91 decibels) and total deafness.

Research concerning the use of technology in education has received increasing attention from scholars in recent years [3]. This recent attention has impacted in the development of educational materials. By the same token, like they are planned and evaluated. Besides that, the ease of create learning objects and acessible learning objects have contribuited increasingly, to support the teaching process and learning.

As per [6] teachers need to be instructed on how to generate accessible documents. In this work, authores presents an initiative promoted by inclusive project, looking to improve accessibility in higher education, through the definition of systematic methodological processes.

In accordance with the description of the Learning Technology Standards Committee of the Institute of Electrical and Electronics Engineers (IEEE) the learning objects is defined as: "Any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" [8]. And can be used for teaching. For example: multimedia and instructional content, and instructional software and software tools.

In face of, the process of creating learning objects, according to the literature can be treated similar to the process of Software Engineering [3],[13]. The Software Engineering is a method for developing and maintaining systems, it allows for effective quality control, and it fosters the planning, and the management of activities.

In this line, processes and methods for development the learning objects and acessible learning objects, were investigated considering the specific requirements [3], [9], [10], [11], [12] and [13].

Table 1, presents a description and analysis (pedagogical and computational) of LO and ALO development methodologies found in the literature and of relevant contribution to this research.

TABLE I. METHODOLOGIES AND PROCESSES FOR THE DEVELOPMENT OF LEARNING OBJECTS AND ACESSIBLE LEARNING OBJECTS.

| Methodologies and Process | Development de Learning Objects and Acessible Learning Objects | |
|---|---|---|
| | *Description* | *Pedagogical and Technical Analysis* |
| ADDIE | It is one of the oldest and most used methodologies of Instructional Design to develop products (instructional materials) [14]. | It has higher pedagogical approach and great deficiency in technical quality and reuse. |
| SCRUM | It is a software development process, based on agile methodology, is used to develop software and have recently been used to develop Learning Objects [12],[13]. | It has deficiency in the instructional part, it is focused on the stage of tests and interactive deliveries, and is considered technically complete (quality and reuse). |
| INTERA | It is a process framework that was developed inspired by the ADDIE Model to develop instructional content. Therefore, adherent to any Learning Objects and considers the process as a project based on PMBOK [12]. | This model approach the pedagogical question, and is considered more adequate for technical questions (quality and reuse). |
| LODPRO | It is a process of developing Learning Objects, which uses innovative techniques such as Design Thinking and PDCA cycle[3],[20]. | This model approach instructional design and computational of the quality. |
| Model of Accessible Learning Objects by Colored Petri Nets | It is a model that allows the specification and analysis of the flow of activities of the production of the contents, as well as the sizing of the team and identification of gaps in general production [11]. | This model is focuses on pedagogical questions, evaluating the impact generated by the creation of educational contents. |
| Model of Development and Evaluation of Accessible Learning Objects. | It is a model developed based on the ADDIE Model, consisting of three stages. Considering standards and accessibility guidelines [7] and validated through case studies [1]. | It has a focus on Instructional Design. It was produced by students, and validated by specialists. |
| **MIDOAA** | **It is a model developed based on the model proposed by [1], and inspired by the INTERA model. However, its differential is the use of the PDCA cycle and the Requirements Engineering.** | **This model has a focus on pedagogical and computational issues. It was produced and validated by higher education teachers in computing.** |

The process defined by Software Engineering authors to develop software are enough uilized for the development of learning objects [10]. However, as they were projected for this purpose, they approach only the technical steps of developing the learning objects. Thus, many authors, wich wishing to obtain results in both approaches (pedagogical and computational) choose to merge pedagogical and computational aspects into a single model [12].

Models, methodologies and processes presented above are related to this study. At the last line, is shows the MIDOAA inclusive model and its differential in relation to the other correlated studies.

The present study aimed to demonstrate the applicability of the proposed inclusive model, which utilized all of the previously defined approachs. This model offers guidance to those interested in developing Accessible Learning Objects. Further details on the MIDOAA will be presented in the next section.

## IV. INCLUSIVE MODEL MIDOAA

The MIDOAA proposal is supported by the theoretical basis and results obtained with the application of case studies and experiments focused on Accessible Learning Objects and the use of Requirements Engineering in the software development process.

Inclusive Model proposed in this study, has as goal to support the teaching and learning process of teachers in the area of computing, which teach in private and public Universities located in State of Amazonas - Brazil. The inclusive educational strategy that has been adopted is directly related to stimulating and motivating teachers to develop, reuse and recover appropriate educational material to include SEND, particularly hearing-impaired.

In this research, the concept of Accessible Learning Objects was adopted as any digital material (images, videos, web pages, animations or simulations), since they provide information for the construction of knowledge, specify their pedagogical objectives, attends standards and guidelines of accessibility, and structured so that they can be reused.

Considering the Requirements Engineering one of the most important areas of ES responsible for the success of software projects. We adopted Requirements Engineering as strategy to investigate, analyze and specify in a concise way the pedagogical (learning) and accessibility requirements, required in research and essential for the success of this model.

In educational environment, the Requirements Engineering study offers great research opportunities, for being a rise and growing area. New techniques, processes and tools emerge to support the process and are clearly needed, increasing the relevance of the studies.

For the development of this proposal, the instructional and computational design approach was used. In this way, the Accessible Learning Objects were developed by teachers and validated by expert evaluations (point of view, interview and questionnaire) and the application of case studies.

In face of the, the proposed MIDOAA model is presented in Figure 1 below. Its stages are defined in accordance with the PDCA cycle.

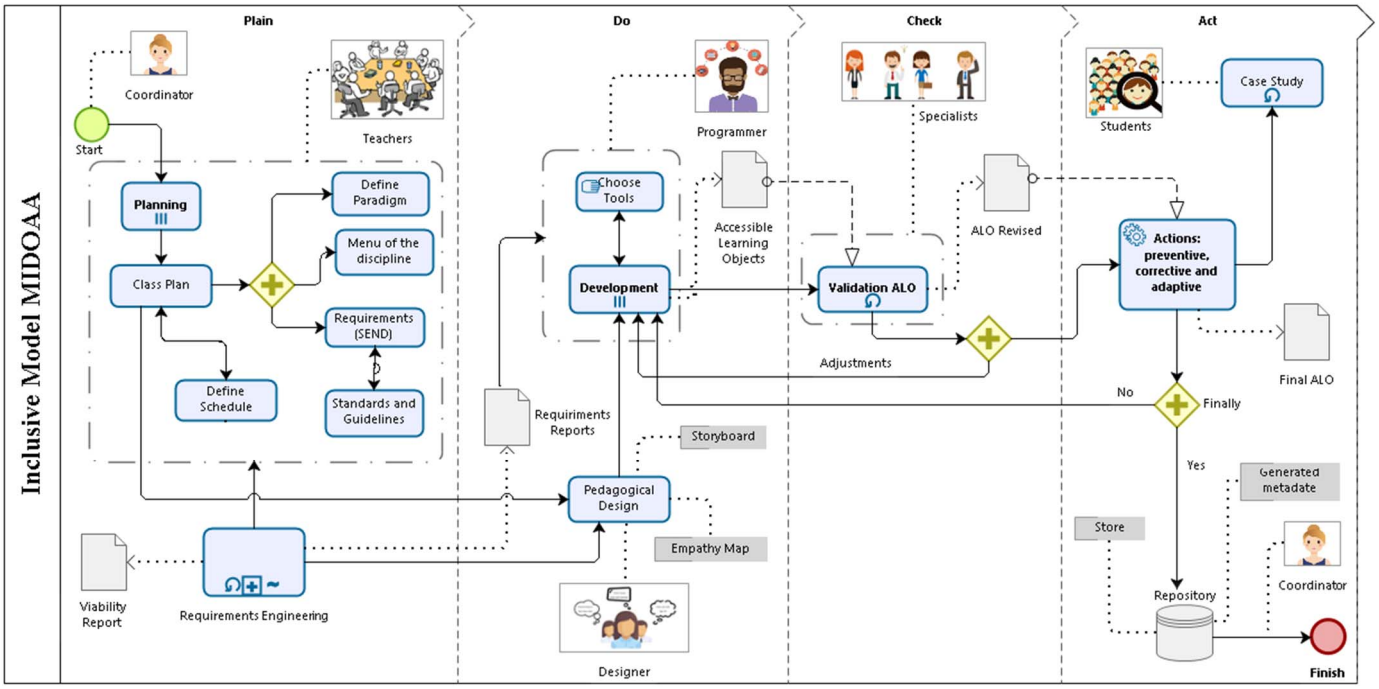


Fig. 1. Inclusive Model MIDOAA.

MIDOAA is an Inclusive Model developed based on the results obtained by the work proposed by [1]. However, MIDOAA brings as a differential the development of Accessible Learning Objects by teachers, validated through expert evaluations (point of view, interview and questionnaire) and application of case studies. Also, the use of a complete approach to attend pedagogical and computational aspects, the use of ER, the PDCA project cycle and Scrum as differential factors.

Because it is an Inclusive Model developed wich consider Requirements Engineering, Learning Objects and Accessibility, MIDOAA is considered an innovative contribution to the computational and educational area for higher education in computing.

In addition, the proposal was adapted to be produced and used by a team specializing in the production of educational resources. In this way, the model can be used to attend the demand of other courses in the Universities.

Tasks defined as goals were performed based on the steps in the PDCA cycle[20]: Plan, Do, Check, and Act, described below.

1 – **Plan**: Step Plan: In this stage, the Requirements Engineering acts as support for the realization of a viability study that generates a report containing the obtained information, as to cost, risk and viability of development and implementation of the project. Next, the requirements elicitation techniques (questionnaire, interview and empathy map) were used in order to obtain user and system requirements. In this way, the information contained in the content of the discipline, the number of students with disabilities and the types of disability were used as parameter, in the consultation of standards and guidelines of accessibility and in the type of pedagogical approach to be used.Thus, it is possible to elaborate the teacher's lesson plan, the project schedule and the pedagogical design.

2 – **Do**: In this stage, were utilized the tools defined to develop Accessible Learning Objects. We used the requirements report generated in the planning stage as a guide and reference to validate the implementation of the requirements. The implementation considering accessibility standards and guidelines.

3 - **Check**: in this stage, were realized three evaluations: evaluation of learning and teaching, accessibility and usability. The responsible were specialists in the area of pedagogy, usability and informatics in education. After the criticisms and suggestions of the experts, the Accessible Learning Objects were analyzed and corrected to attend the evaluations realized.

4 - **Action**: in this final stage, are realized actions: corrective, preventive and improvement. And later the Accessible Learning Objects are added in repository, created for this purpose. The repository was developed to attend the project, being managed by intelligent agents, to facilitate the search, recovery and reuse of educational contents.

In traditional methodology the processes are designed and developed without the client participating effectively, the release of the artifact is at the end. There isn't interaction, in addition to the excess documentation that is generated. In the Scrum methodology the approach is interactive and incremental, releases are continuous, can be adapted at any

time, there is cooperation between people and assiduity the designer.

For to attend the computational model, we adopted the Scrum approach in parallel to the PDCA cycle and utilized the instructional model based on the INTERA model proposed by [12] in the cycle stages.

The team members or stakeholders of MIDOAA, as well as their respective roles and responsibilities have defined in the project context, as shows in table 2. According to the SCRUM methodology specifications.

TABLE II. ROLES AND RESPONSIBILITIES

| **Roles (numbers)** | **Team Members or Stakeholders** | |
|---|---|---|
| | ***Responsibilities*** | ***Reference Scrum*** |
| Coordinator /Teacher (1) | • Responsible for the control and management of the project;<br>• Research of educational requirements (learning and accessibility);<br>• Coordinates teams. | Product Ower and Scrum Master |
| Teachers (4) | • Elaborates and reuses didactic content;<br>• Map and specify the content to be implemented, according to the lesson plan;<br>• Participates of all stages of Accessible Learning Objects development. | Clients |
| Students SEND (1) | • Principal interested in the artifact. | Client |
| Students (41) | • Interested in the artifact. | Clients |
| Especialists (3) | • Evaluate Accessible Learning Objects. | Development Team |
| Designer (1) | • Develops educational content in Accessible Learning Objects format. | Development Team |
| Programmer (2) | • Implements Accessible Learning Objects, considering didactic situations, interaction, accessibility and usability. | Development Team |

In this study, we chose to use Scrum, because yours benefits are evident. The Scrum consists of goals that refer to the tasks that were defined in the planning step. Therefore, the smaller piece of the development cycle of a Scrum project is called “sprint” and is defined by iterations that can last 2 to 4 weeks[3]. Thus, improvements are realized in the each new iteration. The structure of the SCRUM consists of people who perform the following functions: Product Owner, Scrum Master, Clients and the Development Team.

In this case study, students participated and did not opine, of these 42 (forty-two) were not SWD, only 1 (one) had hearing impairment. The four collaborating teachers who developed the Accessible Learning Objects participated effectively in the process and stages. The coordinator was the teacher responsible for the project, which meets the three pillars of the Scrum: transparency, inspection and adaptation. Thus, the Scrum team was composed of the coordinating teacher and his development team, composed of two technical experts, one programmer and one designer, and three expert teachers who evaluated the objects. Therefore, all teachers involved in the study are from the computing area, except one evaluator who is from the area of education.

## V. RESULTS AND DISCUSSION

The results obtained are motivating, because it aims to share and stimulate teachers in the use and practice of this inclusive model, providing an innovative teaching environment. The practical experiences contributed positively to the students' better performance in the subject, interaction, social and digital inclusion, improved communication between student-students and teacher-students. Also, teachers felt encouraged to promote inclusive education and to learn more about inclusive educational resources and tools.

Teaching hearing impaired students does not have to be difficult as long as teachers are flexible. When teachers have incorporated inclusive strategies into their teaching practices, chances are they will find a number of students who benefit from their efforts. With experience we have discovered that new strategies work best for teaching SWD.

In this work, was defined the constructivist paradigm, and as requirement accessible hearing-impairment.These definitions came from an initial research on the viability of the project. The viability study generates information for the start of the requirements engineering process [10]. In this way, were answered the objectives of the research and investigative items: operational, technical, pedagogical, schedule and financial viability to develop the Accessible Learning Objects.

In this researched were investigated 34 teachers and 8 higher education coordinators in computing from private and public Universities of State of Amazonas - Brazil.

The requirements of learning, accessibility and usability of user and of objects were elicited using interview techniques, questionnaire, point of view analysis, and empathy map.

Empathy Map is classified as a Design Thinking tool created by Dave Gray. The empathy map was adapted to be applied in the context of MIDOAA.

In this context the empathy map allows the teacher to put himself in the place of the SWD, feeling what the student was experiencing. The goal was to promote a situation experienced by another individual. In this technique, putting yourself in the student's place allows you to better understand your needs. This map was applied only to teachers who worked with SWD.

In the viability analysis it was evidenced that the coordination does not inform its teachers about the enrollment of SWD, according to 75% of the teachers. When questioned 60% of the coordinators informed that the institution does not keep them informed, for this reason they can not pass this information on to teachers, 40% stated that they are or at some point were informed and pass on the information to their teachers. When teachers were asked to plan classes to attend SWD, 93.8% said they did not plan. This result has shown that Higher Education Institutions private and public of State of Amazonas - Brazil need to promote more effective actions for inclusive education.

About the factor that we motivated us to direct the case study to students with hearing impaired, it was based on results expressed through the research. Thus, 31.3% of teachers said they had already teach SWD. And in this scenario, the highest index was for hearing impaired students.

Regarding the project, the PDCA cycle was a preponderant factor for the success of the model, in parallel with the use of the SCRUM methodology.

The Accessible Learning Objects were validated through the following evaluation: learning, teaching, usability and accessibility. The research questionnaires were elaborated, considering items related to each type of evaluation, according to the evaluation methodologies focused on learning objects.

**Learning Evaluation**: suggests that the student has already seen the content before applying the accessible learning objects and that the teacher can be active during the process. During the evaluation, was verified the students' knowledge about the content and student learning through the ALO. Figure 2, shows the results obtained in the learning evaluation.

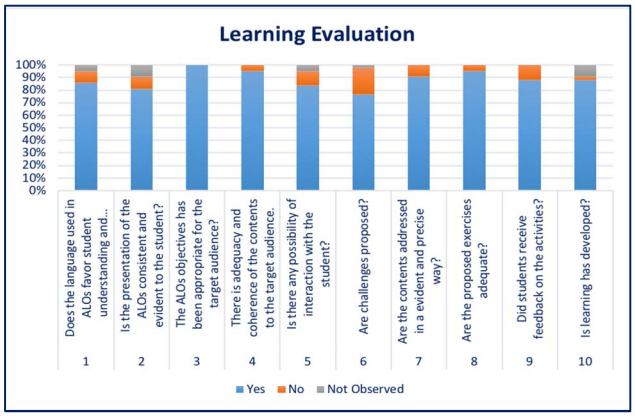


Fig. 2. Questions and percentage gerated in the Learning Evaluation.

In the analysis, was evaluated that in 90%, the learning was developed. The language used favored learning, and content was adequate and coherent in relation to the level of education and SWD. Challenges (activities) were proposed in 78% of accessible learning objects. However, it was found to improve the interaction, and that learning in 90% was developed.

**Teaching Evaluation**: refers to the adequacy of the objectives and contents, reuse and quality of the material developed. Figure 3, shows the results obtained in the evaluation of teaching.

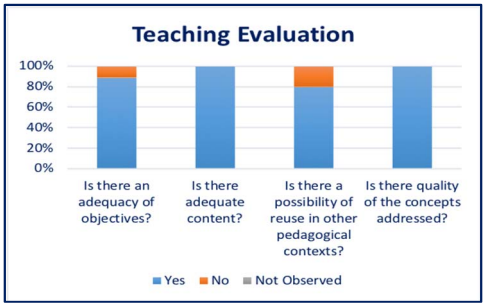


Fig. 3. Questions and percentage gerated in the Teaching Evaluation.

In the analysis, was verified that 90% of the objects are adequate to the defined objectives, 100% present adequacy and quality about the concepts approached and 80% express that there is possibility of reuse in other pedagogical contexts.

**Usability Evaluation**: evaluated the quality of accessible learning objects with respect to items of heuristics aimed at this purpose, in this case defined by [17]. Figure 4, shows the results obtained in the usability evaluation.

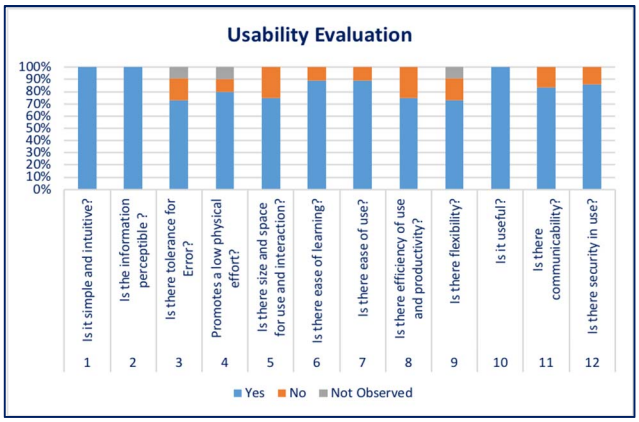


Fig. 4. Questions and percentage gerated in the Usability Evaluation.

In the analysis performed 100% reported that the accessible learning objects are simple, intuitive, the information is perceptible and has utility. Approximately 90% registered ease of use and learning. However, 80% indicated that there is communicability and 72% indicated efficiency of use and productivity and as for the factor of tolerance to error stated to be simple and intuitive.

**Accessibility Evaluation**: evaluates best practices for developers, content providers and educators involved in creating products for learning, producing software applications, and accessible content. The principles for accessibility are presented by [19] and were addressed at this stage. Figure 5, shows the results obtained in the accessibility evaluation.

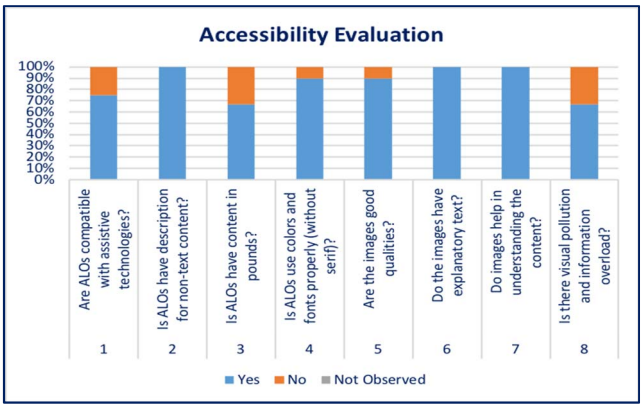


Fig. 5. Questions and percentage gerated in the Accessibility Evaluation.

In the accessibility analysis, 100% of the evaluators reported that the accessible learning objects have descriptions for non-textual content, the images have explanatory text and help in understanding the content. Of these, 90% affirmed that

there is quality in the images and the appropriate use of colors and fonts (without serif) in objects.

Of the objects analyzed, only 75% have compatibility with assistive technologies and 65% have content in pounds, as well as visual pollution and information overload.

The percentage presented to the item not observed refers to the ignorance or non-identification of the item during the evaluation.

In this project, short meetings were realized during each stage, promote iterations and improvements during the releases of the artifacts. In this way, after the evaluations of the specialists realized the continuous corrections. In face of, usability and accessibility evaluations need to be realized in parallel, aiming at minimizing error rates, visual pollution and absence of accessible requirements for the defined deficiency.

The evaluations realized were important feedback for the development team. Therefore, it was possible to measure and identify problems and limitations. The accessible learning objects have been corrected and added to the repository, created to facilitate the search and reuse of these by area teachers. The template generates a metadata and has been set to receive requirements adaptations.

## VI. Conclusion

The present study aimed present the model of the proposed process, which utilized all of the previously defined instruments. This model offers guidance to those interested in developing accessible learning objects.

The PDCA methodology, together with the SCRUM, allowed the definition and accomplishment of the goals within the established deadlines, feedback, corrections, historical, discussions of positives and negatives, promoted the best practices.

The agile approach used in the model generated only the necessary documentation, being very indicated when worked with small teams. The client was present, there was collaboration among all involved in the project, was possible to negotiate goals, items and criteria for design, development and evaluation.

The research revealed that there are three types of approaches to develop learning objects: methodologies that consider instructional design (pedagogical aspects), which consider the software development process (computational aspects) and others that combine both aspects [12]. In face of, this work utilized the model that mixes the instructional design and the software development process, using Requirements Engineering as a process model capable of contributing to the specification, validation and management of requirements in a structured way.

This study was of an applied and practical nature, made use of the bibliographic methodology, case study and the qualitative approach.

MIDOAA has technical aspects (software engineering, design, human computer interface, usability, accessibility, reuse) and pedagogical (educational contents, learning conceptions and pedagogical structure). The artifact met the objectives, standards and guidelines proposed by this research. The inclusion model generated a contribution through a universal inclusion model for the area of Informatics in Education. In this way, it intends to attend students regularly enrolled in higher education courses in the area of computing. The challenge is to promote digital and social inclusion through the use of accessible learning objects, which respond to SWD, initially with hearing impairments.

The case study provided support to improve the inclusive model, aiming to develop an artifact that contributes to the performance and learning of all students, in an inclusion process. The main contribution of this study is the Inclusive Model MIDOAA and the secondary one is to promote the reflection of teachers and coordinators of Higher Education Institutions on the importance of investing in inclusive education (infrastructure and educational resources).

Finally, we intend realized other case studies, focused on other deficiencies already identified in the course of this study. Constantly improving the model and apply the MIDOAA for the production of Accessible Learning Objects for to attend other courses in the Universities.

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## Reference

[1] Mourão, Andreza Bastos; Netto, José Francisco M.. (2016). “Inclusive Model of Development and Assessment of Accessible Learning Objects for Higher Education in Computing”. In: Brazilian Congress of Informatics in Education (CBIE) - Brazilian Symposium on Informatics in Education (SBIE), Uberlândia – MG.

[2] World Health Organization, “Disability and health”, 2018. [Online]. Available: http://www.who.int/news-room/fact-sheets/detail/disability-and-health.

[3] Queiros, L. M.; Da Silveira, D. S.; Da Silva, C. N.; Vilar, G.: (2016) LODPRO: learning objects development process. In: Journal of the Brazilian Computer Society. v. 1, n. 22, pp. 1—9, 2016.

[4] Grace Skrzypiec, Helen Askell-Williams, Phillip Slee & Adrian Rudzinski (2015): Students with Self-identified Special Educational Needs and Disabilities (si-SEND): Flourishing or Languishing!, International Journal of Disability, Development and Education.

[5] Abedi, J., & Faltis, C. (2015). Teacher assessment and the assessment of students with diverse learning needs. Review of Research in Education, 39, vii–xiv.

[6] H. R. Amado-Salvatierra and R. H. Rizzardini, "Towards a methodology to inclusive curriculum design: An experience presented within an accessible virtual learning environment," *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, Madrid, 2014, pp. 1-7.

[7] Macedo, Claudia M.S, Ulbricht, Vânia R. (2012). Accessibility Guidelines for the Development of Learning Objects, Procedia Computer Science, Volume 14, 2012, Pages 155-162.IEEE (2002).

[8] IEEE standard for learning object metadata (IEEE 1484.12.1).

[9] Graciotto Silva, M. A., Barbosa, E. F., Maldonado, J. C. (2011). Model-driven development of learning objects. In 41st ASEE/IEEE Frontiers in Education Conference, p. F4E–1–F4E–6, Rapid City, SD, EUA.

[10] Fuggetta, A. (2000). Software process: A roadmap. In 22nd International Conference on Software Engineering, p. 25–34, Limerick, Irlanda.

[11] Barroso, Giovanni Cordeiro et al. (2014), “A Model for the Production of Accessible Learning Objects: Modeling and Analysis by Colored Petri nets.” Cbie (2014).

[12] Braga, J., Dotta, S. Dotta. Pimentel, Edson. (2013). “INTERA methodology for the development of Learning Objects”. Cbie (2013).

[13] Juliana Cristina Barga, Edson Pimentel, Itana Stiubiener, Silvia Dotta, “Experimentation and analysis of undergraduate students performance and satisfaction in a blended model of an introductory computer science and programming course”, IEEE, 2014.

[14] B. Nejmeh and D. S. Weaver, "Leveraging scrum principles in collaborative, inter-disciplinary service-learning project courses," *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, Madrid, 2014, pp. 1-6.

[15] Branch R. M. (2009). Instructional Design: The ADDIE Approach. Springer Science and Business Media, LLC. ISBN: 978-0-387-09505-9.

[16] Borges L. C. L. F., Araujo M. R. R., C. Maciel and E. P. S. Nunes, (2016). Participatory design for the development of inclusive educational technologies: A systematic review. IEEE Frontiers in Education Conference (FIE), Eire, PA, 2016, pp. 1-9

[17] Preece, J.; Rogers, Y.; Sharp, E. (2002) Interaction Design: Beyond Human-computer Interaction. New York, NY: John Wiley & Sons.

[18] A. N. Rodrigues and S. C. dos Santos, "A framework for applying problem-based learning to Computing Education," 2016 IEEE Frontiers in Education Conference (FIE), Erie, PA, USA, 2016, pp. 1-7

[19] IMS GLC. IMS Guidelines for Developing Accessible Learning Applications V.1 (2018). IMS Global Learning Consortium. [Online]. Available: http://www.imsglobal.org/accessibility/.

[20] M. M. Ren, N. Ling, X. Wei and S. H. Fan, "The Application of PDCA Cycle Management in Project Management," 2015 International Conference on Computer Science and Applications (CSA), Wuhan, 2015, pp. 268-272.