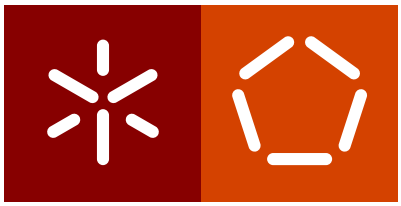

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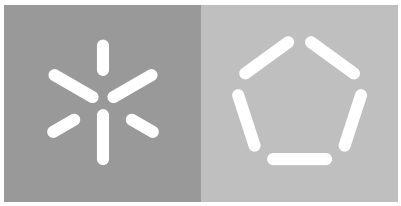

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Adequacy Analysis of Learning Resources in Adult Education

Master dissertation
Integrated Master in Informatics Engineering

Dissertation supervised by
Pedro Rangel Henriques (Ph.D.)

Workplace Supervisor
Cristiana Esteves Araújo (M.Sc.)

June 2021

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

- Diana Ribeiro Barbosa

ACKNOWLEDGMENTS

Desde o início do desenvolvimento desta tese até ao dia em que a dei por completa, pude contar sempre com o apoio inabalável de várias pessoas a quem quero agradecer.

Aos meus orientadores, Professor Doutor Pedro Rangel Henriques e Professora Cristiana Araújo, pela orientação exemplar e disponibilidade constante para me guiarem e incentivarem durante todo este processo.

À Isabel, ao Filipe e ao Lázaro, por estarem sempre disponíveis para partilharem comigo o seu conhecimento.

Aos Amigos da Aldeia, que tornaram esta caminhada mais leve e divertida.

Ao Vitor, que melhora todos os meus dias. Pelo amor e carinho. Pelo apoio e encorajamento. E por me fazer tão feliz.

À minha família, em particular aos meus pais, ao meu irmão e à minha madrinha por estarem aqui para mim, sempre.

"I am glad you are here with me. Here at the end of all things, Sam."
- J.R.R. Tolkien, The Return of the King

ABSTRACT

The present document identifies and details the research and development held under the scope of a MSc Thesis pertaining to the scientific area of pedagogic tools for teaching support, ontologies and learning resources. This masters thesis in Informatics Engineering was developed in the University of Minho, Braga.

The purpose of the project is to study the learning process of adults and how it connects to Learning Resources (LRs) in order to understand if a learning resource used to teach Computational Thinking (CT) to children, is suitable for adult learners. This approach ought to take into account adult learning theory to set its requirements, as well as CT principles and learning resources classification.

To this end, an approach to the Adequacy of Learning Resources in Adult Education was created which comprises the ontology OntoAL that describes in detail the domain of Adult Learning (AL) including the theory of AL and a classification of both the adult learner and the learning resources. This ontology was developed in OntoDL and Prolog. In addition, we analyze the experiment conducted as part of the validation of this approach and the OntoAL ontology.

Therefore, in this document, it is presented the state of the art pertaining to this field, exploring the concepts of learning resources, computational thinking, ontologies and adult learning and education. Furthermore, it is rendered an introduction of the subject and the project, detailing the context of the problem, the objectives to be accomplished and the research hypothesis of said thesis. Next, it is presented the state of the art regarding Computational Thinking, Adult Learning and Education, Ontologies and Learning Resources. Thereafter, it is put forward the work proposal. Then it is introduced the OntoAL ontology in both OntoDL and Prolog (detailing the process of its development and the choices made), the questionnaires that were created as well as the analysis of the responses that we obtained. Lastly, there are listed the conclusions and the future work.

Keywords: Computational Thinking, Learning Resources, Ontology, Adult Learning, Game-Based Learning, OntoDL, Prolog.

RESUMO

O presente documento identifica e detalha a investigação e desenvolvimento realizados no âmbito de uma tese de mestrado relativa à área científica de ferramentas pedagógicas de apoio ao ensino, ontologias e recursos educativos. Esta tese de mestrado em Engenharia Informática foi desenvolvida na Universidade do Minho, Braga.

O objectivo do projecto é estudar o processo de aprendizagem dos adultos e como este se relaciona com os Recursos Educativos (RE), de modo a compreender se um recurso educativo utilizado para ensinar Pensamento Computacional (CT) a crianças, é adequado para alunos adultos. Esta abordagem deve ter em conta a teoria de ensino de adultos para estabelecer os seus requisitos, bem como os princípios de CT e a classificação dos recursos educativos.

Neste sentido foi criada uma abordagem à Adequação de Recursos Educativos na Educação de Adultos que contém a ontologia OntoAL que descreve em detalhe o domínio do Ensino de Adultos (EA) incluindo a teoria de EA e uma classificação tanto do aluno adulto como dos recursos educativos. Esta ontologia foi desenvolvida em OntoDL e Prolog. Para além disso, analisamos a experiência levada a cabo como parte da validação desta abordagem e da ontologia OntoAL.

Por conseguinte, neste documento, é apresentado o estado da arte neste campo, explorando os conceitos de recursos educativos, pensamento computacional, ontologias e educação de adultos. Além disso, é feita uma introdução ao tema e ao projecto, detalhando o contexto do problema, os objectivos a alcançar e a hipótese de investigação da referida tese. A seguir, é apresentado o estado da arte em matéria de Pensamento Computacional, Ensino e Educação de Adultos, Ontologias e recursos educativos. Em seguida, é descrita a proposta de trabalho, a ontologia OntoAL desenvolvida em OntoDL e em Prolog (detalhando o processo do seu desenvolvimento e as escolhas feitas), os questionários que foram criados, e a análise das respostas obtidas. Finalmente, são listadas as conclusões bem como o trabalho futuro.

Keywords: Pensamento Computacional, Recursos Educativos, Ontologias, Ensino de Adultos, Ensino baseado em jogos, OntoDL, Prolog.

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1

INTRODUCTION

1.1 CONTEXT AND MOTIVATION

The area of Informatics is sought after not only by young students but also by adults trying to reconvert from their current professional area to the one in question. In this case the difficulties that emerge will be different and unique over the ones that pertain to teaching the youth.

For this reason, it is necessary to study and understand the differences between Children and Adult Learning as well as the ins and outs of the learning process of adults. This is especially important in order to know how to more efficiently teach the adults the Computational Thinking necessary for their professional reconversion.

Furthermore, since the majority of the Computational Thinking Learning Resources (LRs) and materials have not been created to support adult learners (Zapata-Rivera et al., 2019), educators of adults are sometimes left to resort to other options such as using existing resources designed for k-12[1] students. In those situations, it is necessary to understand if the learning resources available are appropriate for the adult audience.

However, it is also important to note that not all adults are equal, they differ in an extensive range of different parameters when it comes to education. Those parameters such as age bracket, literacy, level of schooling, motivation to learn and so on influence the context of the learning experience and will impact the suitability of the LRs to the learners as the LRs characteristics do.

1.2 OBJECTIVES

The purpose of this master's thesis is to study the learning process of Adults versus Children and learn how to adapt Learning Resources used to teach Computational Thinking so that they can be used on Adults. In order to successfully complete this purpose the following goals must be achieved:

- Identifying the differences of the learning process of Adults when compared against Children.
- Understanding the impact of diverse factors on the effectiveness of Adult Learning.
- Studying and analysing relevant Computational Thinking initiatives (materials and curricula).

1 The K-12 system stands for "from kindergarten to 12th grade".

- Understanding the concept of ontologies and how they can be used and analyse the ontology OntoCnE.
- Understanding the concept of Learning Resources and how they can be used and classified.
- Formulating a theory on how to classify Learning Resources and Adult Learners related to the teaching of Computational Thinking.
- Creating an ontology through the developed theory.
- Conducting experiments that consolidate the proposal.

1.3 RESEARCH HYPOTHESIS

It is possible to effectively identify if a Learning Resource (LR) used to teach Computational Thinking (CT) to children, is suitable for Adult Learners, taking into consideration: the Adult Learner, Adult Learning theory, CT principles, and learning resources classification. Additionally, if a LR is not appropriate, it is possible to identify the motive, therefore, facilitating the adaptation if need be.

1.4 DOCUMENT STRUCTURE

In Chapter 2 we present the state of the art, namely, we introduce the concepts of Computational Thinking, Adult Learning and Education, Ontologies and Learning Resources, as well as recent and relevant works in those areas. In Chapter 3 we formulate the work proposal. Afterwards, in Chapter 4 we present the OntoAL ontology as well as her versions in the languages OntoDL and Prolog. Next, in Chapter5 we explain and show the questionnaires that were developed during the course of this dissertation in addition to analyzing the results. Lastly, in Chapter 6, we draw the conclusions and present the future work.

2

STATE OF THE ART

In this chapter we will present the State of the Art concerning the areas of most relevance for this Research and Development project.

The focus of this dissertation is in the areas of Adult Education, Learning Resources and Computational Thinking. Thus, for its realization we carried out an extensive study and literature research in order to analyze the situation of the research topic and gain a deeper knowledge in these areas. This is the key to understanding where our contribution will fit and what it should be. This stage of the process involved scientific publications, books, websites of official organizations, and news, among others.

On the other hand, regarding the development of the project, it required the study of Ontologies since some ontologies were developed and analyzed for the Adequacy Analysis, which grants them special importance.

Thus, in this chapter we will dedicate a section to each of these four subjects.

2.1 COMPUTATIONAL THINKING

In the year 2006, Jeannette Wing wrote an article that argued that Computational Thinking (CT) should be taught to every child as a vital ingredient of Science, Technology, Engineering, and Mathematics learning (Shuchi Grover, 2013) . She defined CT as the thought processes involved in formulating a problem and expressing its solution in a way that a human or machine can effectively carry out.

Certain approaches characterize Computational Thinking: Tinkering, Creating, Debugging, Persevering, and Collaborating (CCEA, 2018). Mastering these approaches facilitates accomplishing difficult tasks through CT since it helps to organize thoughts and to put them into practice. These approaches are defined as follows (CCEA, 2018; Ozcinar et al., 2017):

- **Tinkering:** Playing and exploring iteratively a problem. For children, Tinkering is the play-based exploration and experimentation stage of learning; for teenagers and adults, it is purposeful exploration, often by means of trial and improvement.
- **Creating:** planning, designing, making and evaluating something. It provides an opportunity for being creative and thinking outside of the box. It also allows for formulating approaches to solve problems and accomplish tasks instead of listening or observing.
- **Debugging:** finding mistakes and taking the necessary steps to fix them. This approach requires systematic analysis and evaluation of the problem at hand to find errors, and skills to predict and verify outcomes.

- **Persevering:** keep going, being determined and resilient, not giving up in the face of a challenge, or after failing one or more attempts at solving a problem. Persevering implies remaining on a course of action despite adversity or delay in achieving success, which is especially important when trying to accomplish complex tasks (e.g. computer programming).
- **Collaborating:** working together to achieve better results, that is teamwork. Collaborating is a requirement for many jobs and activities to achieve desirable results.

Moreover, the necessary concepts that one should use in the process of thinking computationally are the following: (CCEA, 2018; Ozcinar et al., 2017):

- **Logic:** reasoning, predicting and analyzing a situation or problem.
- **Algorithms:** making steps and rules to describe functioning or constraints.
- **Decomposition:** breaking problems into smaller more manageable parts.
- **Patterns:** spotting similarities and differences to replicate and apply strategies used in similar.
- **Abstraction:** determining the significant elements of a situation and removing unnecessary detail to simplify a problem, and therefore its resolution.
- **Evaluation:** making objectives judgments to effectively chose the best solution for a problem.
- **Programming:** writing a correct set of instructions that a machine can understand, in order to solve a problem or accomplish a task.

Lastly, the attitudes that one must have while employing Computational Thinking that optimize the process for a greater chance of success are the following (Hunsaker, 2016).

- **Confident:** a confident attitude means that the individual believes in their capability to overcome the problem or accomplish the task at hand.
- **Communicative:** this attitude implies a desire to communicate with others during problem-solving to achieve better results, and the skill to do so adequately.
- **Flexible:** being flexible translates into adapting smoothly when change occurs in any situation and dealing with it in the most effective way. Similarly, dealing effectively with open-ended problems.

There are tremendous benefits to be had from learning Computational Thinking. Firstly, due to its approach to problem-solving of drawing on concepts fundamental to computer science, it teaches skills needed for every computer programmer (Hunsaker, 2016; Wing, 2006). Furthermore, on a larger scale, it can be used by students across disciplines to better solve problems and improve understanding of the role of computing in modern society (Sysło and Kwiatkowska, 2015). Aditionally, it is also a skill of great relevance to adults in the 21st century (Zapata-Rivera et al., 2019). Hence, taking the aforementioned information into consideration, it becomes clear the importance of teaching Computational Thinking to adults in professional reconversion to the field of Informatics, as is the focus of this dissertation.

2.1.1 *Computational Thinking initiatives in the European Union*

In today's world, computer programming has become an increasingly relevant skill both economically and academically and the demand surpasses the supply when it comes to computing jobs, with significant job growth projected for the foreseeable future[1] and it is estimated that by 2020, Europe may experience a shortage of more than 800,000 professionals skilled in computing/informatics (Anja Balanskat, 2015). Therefore, many governments are taking action implementing programs with the purpose of introducing coding in the schools curricula. According to the European Schoolnet[2] report "Computer programming and coding Priorities, school curricula and initiatives across Europe"(Anja Balanskat, 2015):

- 16 countries integrate coding in the curriculum at national, regional or local level: Austria, Bulgaria, the Czech Republic, Denmark, Estonia, France, Hungary, Ireland, Israel, Lithuania, Malta, Spain, Poland, Portugal, Slovakia and the UK (England).
- Countries such as Belgium Flanders, the Czech Republic, Ireland, Malta and Poland refer to Computational Thinking as a key competence to be acquired when integrating coding in the curriculum.
- Malta and Poland are planning to make coding compulsory for all students, as "Computational Thinking is a fundamental skill for everyone, not just computer scientists".

The portuguese project Computação na Escola (CnE) aims to teach Computational Thinking to students from the 1st to the 12th year of school, by developing tools and resources that will be available for teachers of all subjects to use in classes. The purpose of this project is to facilitate the learning process of programming by preparing students to think in a more abstract and problem solving way needed to succeed in this area (Araújo et al., 2019b).

2.1.2 *Computational Thinking and Google for Education*

Under the scope of the Google for Education initiative, Google created the program "Exploring Computational Thinking" which provides several resources to support the teaching and learning of Computational Thinking throughout the world. The program comprises two main components: the Computational Thinking for Educators online course[3] and the Exploring Computational Thinking resource repository[4].

Firstly, the "Introduction to Computational Thinking for Every Educator" was developed by the International Society for Technology in Education (ISTE) with support from Google. It is an online course for educators to learn how they can integrate CT throughout subject areas and grade levels. The course is 15 hours, free, asynchronous, and manages to be individualized through the continuous support of an instructor.

Regarding the course syllabus, the course is divided into the five following modules (ISTE, 2019):

1 Bureau of Labor Statistics (2018). Occupational outlook handbook. Retrieved from https://edtechbooks.org/-yr
2 European Schoolnet is the network of 34 European Ministries of Education, based in Brussels.
3 Available at https://www.iste.org/learn/iste-u/computational-thinking
4 Available at https://learn.iste.org/d2l/lor/search/search_results.d2l?ou=6606&lrepos=1006

1. Introducing Computational Thinking
2. Exploring Algorithms
3. Finding Patterns
4. Developing Algorithms
5. Final Project: Applying CT

Secondly, the Exploring Computational Thinking resource repository was also developed by the ISTE and contains 141 public resources. The resources are described as Learning Objects (LO), and full access to all the LO requires registration and posterior login on the website.

The resources can be filtered by school grade (or grade groups such as Grades 9-12), and subjects such as Mathematics, Computer Science, History and Fine Arts.

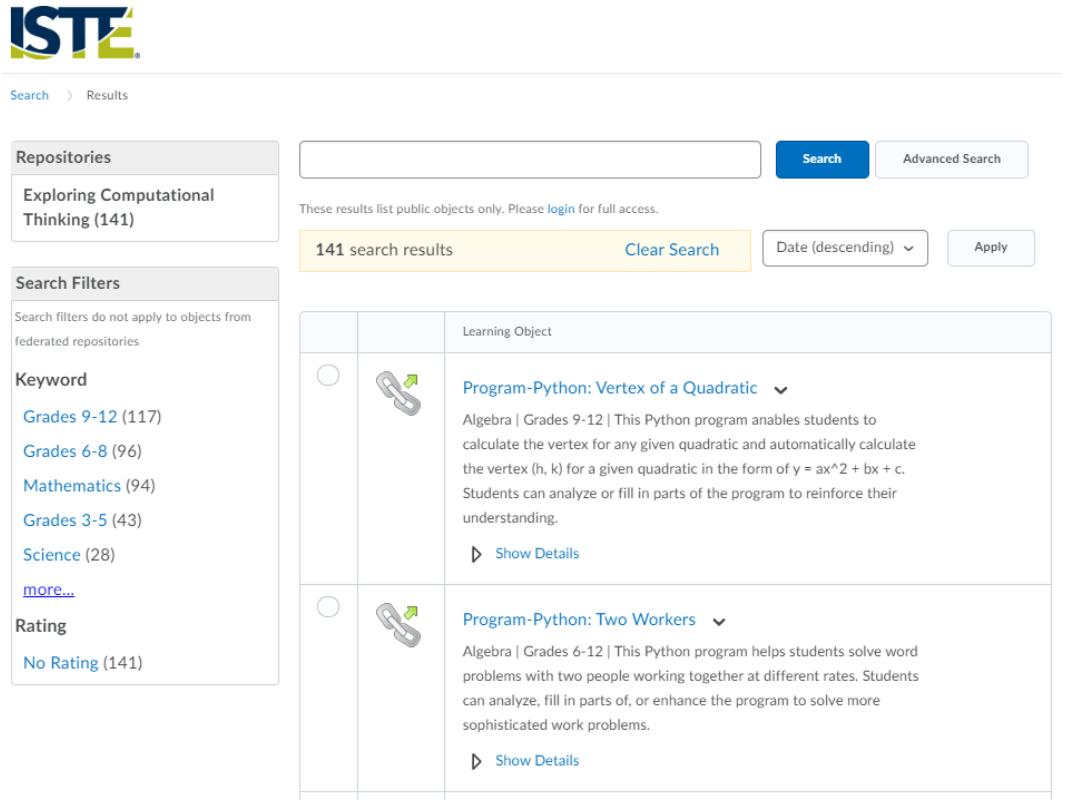

Figure 1: Homepage of the ISTE **"Exploring Computational Thinking"** resource repository.

In Figure 1 we can see the main page of the ISTE Exploring Computational Thinking resource repository. On the left side it is available a tab containing Keywords which allow to filter the resources, as previously explained. It also allows to sort the list of Learning Objects by date and name, as well as open their respective page or preview the resources.

Below, in Figure 2 we can observe the page of the website which concerns the Learning Object "Exploration: Chat Bot".

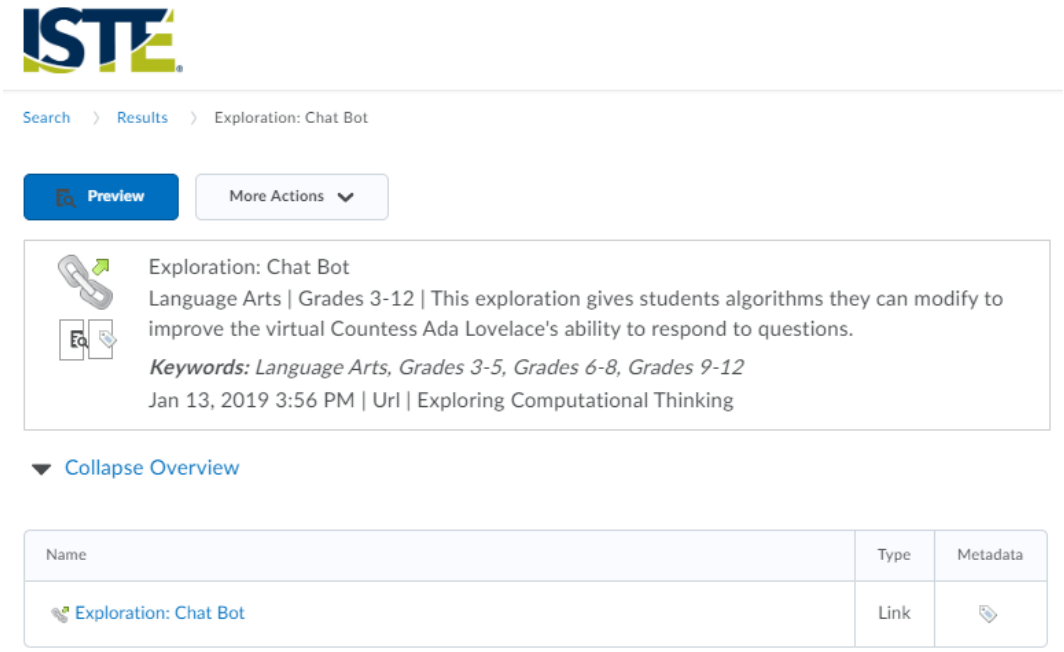

Figure 2: ISTE repository (refer to Figure 1) page for the "Exploration: Chat Bot" learning resource.

This resource is suitable for use in grades 3 through 12 in art and language-related subjects, and promotes the knowledge and understanding of algorithms (one of the fundamental concepts of Computational Thinking).

2.2 Adult Learning and Education

Given that the subject of this thesis is the teaching of adults, there are two important concepts that must be analyzed in order to obtain a broad understanding of the domain. Such concepts are adult learning and adult education. Therefore, it is important to distinguish them.

Adult Education refers to the teaching of adults, that is, instructing/giving lessons to adult students with the involvement of a teacher and according to a curricular program, guide or plan of education. On the other hand, **Adult Learning** refers to the continuous process of learning and developing skills and knowledge throughout an adult's life.

Starting with Adult Education, it is important to identify the student's level of literacy in order to be able to apply the best education program more suited to his skills. To that end, the OECD's (Organisation for Economic Co-operation and Development) PIAAC study (Programme for the International Assessment of Adult Competencies) distinguishes three key information processing skills (OECD, 2019):

- **Literacy:** ability to interpret, retrieve and apply information from written texts in diverse contexts to achieve goals and develop knowledge and potential. Literacy is essential for the development of higher-order skills and positive economic and social outcomes.

- **Numeracy:** knowledge and skill in understanding, applying and communicating mathematical information and ideas. Numeracy is a parallel skill to Literacy and also of great relevance in today's world due to the growing volume and wide range of quantitative and mathematical data in people's lives.
- **Problem Solving in Technology Rich Environments:** possessing the skills needed to acquire information through technology (e.g digital technology, communication tools, and networks); ability to critically think and decide which information is needed for the tasks at hand, evaluating it and employing it on problem-solving. This information processing skill is particularly important in today's world due to the limitless information available online and the intersection of technology in everyday life.

For the skill of literacy the PIAAC study defined 5 proficiency levels, as follows (OECD, 2019):

- **Level 1:** Lowest level of literacy. People at this level must be able to recognise basic vocabulary, determine the meaning of sentences and read short texts.
- **Level 2:** Ability to make matches between the text and information, paraphrasing or low-level inference.
- **Level 3:** Knowledge and skill in interpreting and constructing meaning across dense or lengthy texts; identifying, interpreting and evaluating pieces of information at various levels of inference.
- **Level 4:** People who display ability to integrate, interpret, synthesise, infer from complex or lengthy texts; apply background knowledge and identify and understand non-central ideas in texts.
- **Level 5:** Maximum level of literacy. Knowledge and skill in searching for, integrating, synthesising and selecting key information across multiple dense texts; making high-level inferences.

Let us now consider Adult Learning. According to (Lasker, 1980) Adult Learning is most frequently advanced by theorists as possessing the following two unique characteristics: the **adult's autonomy of the direction in the act of learning** and the **use of personal experience as a learning resource**. These characteristics are unique in the way that they do not apply to the most common student, that is, the youth. Children, teenagers and young adults (eighteen to twenty-one year olds) do not have the life experience of older adults nor are they used to take full responsibility and charge of their life and decisions (e.g. education is mandatory up to adulthood and for the most part so is the school curriculum).

Therefore, it is of considerable importance when teaching adult students, in this case adults looking to change professional fields, to have in mind that it carries its own set of difficulties and challenges distinct from the ones that occur in regular education. In Section 2.2.1 we will analyze the differences between how children and adults learn in order to highlight the assumptions regarding adult students.

2.2.1 *Children vs Adult learning*

There are two main models of learning assumptions upon which educators can base and mold their teaching practices and school curricula to best teach students of all ages: Pedagogy and Andragogy. Pedagogy (from the greek meaning *"child leading"*) is defined as the art and science of teaching children and Andragogy, in opposition, is defined as the art and science of teaching adults.

When educators base their lessons with adult learners on the pedagogical model, it often results in unsuccess due to the students believing the purpose of the subjects to be insufficient and resisting the pedagogical teaching strategies (e.g. fact-laden lectures, assigned readings, quizzes) (Knowles et al., 1980).

Moreover, Knowles compares Pedagogy's and Andragogy's assumptions regarding the concept of the learner, the role of the learners' experiences, readiness to learn and orientation to learning. Table 1 (adapted from the book), illustrates said comparison.

Regarding:	Pedagogy	Andragogy
Concept of the learner	The role of the learner is, by definition a dependent one. It is the teacher's responsibility to make the decisions regarding the class and the teaching.	Learner matures from dependency to self-directedness with the teacher's encouragement.
Role of learners' experience	The learner's experience is of reduced importance. It relies on the experience of the teacher and the experts who developed the learning materials through transmittal techniques (lectures, presentations, reading and the likes).	The learner's experience is valued. Adults attach more meaning to learning they gain from experience (i.e. experimental techniques such as laboratory experiments, discussion, problem-solving cases, simulation exercises and field experience).
Readiness to learn	Students are willing to learn what is decided they should, and most are capable the same learning that of their peers with the same age. The appropriate learning program is standardized curriculum with a step-by-step progression.	Students are willing to learn that which will help them on their real-life problems, and educators should help them discover their "needs to know". The appropriate learning program is organized around life-application categories and sequenced according to the learner's readiness to learn.

Orientation to learning	Learns are subject centered in their orientation to learn. Education is seen as a process of acquiring subject matter content, most of which they understand will be useful only later in life. Curricula should be divided into subjects and follow the subject logic (e.g. simple to complex science).	Learners are performance-centered in their orientation to learn. Education is seen as a process of developing skills to better their life. Learning programs should be organized around competency development.

Table 1: A Comparison of the assumptions of Pedagogy and Andragogy. [Adapted from (Knowles et al., 1980). Pages 43-44.]

From Table 1 we can gather highly relevant information concerning Adult Learning theory, specifically characteristics of adults learners and that which they value in their learning experiences. This information is vital to build the OntoAL ontology with a solid theoretical basis.

2.2.2 *Game-Based Learning in Adults*

Nowadays games have been increasingly used in the educational field as a Learning Resource, in the so called Game-Based Learning (GBL). This approach to teaching can be described as a type of game play with defined learning outcomes (Shaffer et al., 2005).

Focusing on the area of interest of this dissertation, Adult Education, this method has also been used with great success benefiting both learners and facilitators (Caffarella and Daffron, 2013). In fact, interest in the use of GBL in adult students has been growing, although most research done in this field is focused on younger learners, namely children, adolescents and young adults (Charlier et al., 2012). The ever-growing interest can be attributed to factors such as the increasing use of technology in people's daily lives, the rise in life expectancy, as well as the rising number of adults involved in Adult Education experiences (Teixeira et al., 2020a).

With the application of this technique come several advantages and benefits. In fact, several studies conducted in this field indicate that Game-Based Learning can be more motivational and more effective for most students to retain knowledge (Gee, 2008; Sung and Hwang, 2013)

Such an approach, however, also entails certain challenges that need to be overcome. When applying Game-Based Learning to adult to students, some of the most pertinent challenges that may arise are the following:

- Difficulty for older adults in accepting this method since playing games may also imply having too much "fun" and lack of seriousness in the classroom (Anderson et al., 2009).
- Moreover, adults with mobility or visual impairments may have difficulties using certain devices and interfaces, particularly those with small buttons or writing (Charlier et al., 2012).

- Finally, there can be a need to a considerable period of adaptation since "Adults who have not been familiar with the computer in their youth and who are not scientifically oriented tend to be a little overanxious about using one" (Jarvis, 1995).

In addition, part of the work developed in this thesis concerning this subject resulted in a scientific paper entitled *"Improving Game-Based Learning Experience through Game Appropriation"* which focused on the use of Game-Based Learning as an approach to teach Computational Thinking. This paper was presented on the seminar "First International Computer Programming Education Conference (ICPEC 2020)" (Teixeira et al., 2020a).

2.3 ONTOLOGIES

The word "*ontology*" comes from the Greek term "*ontologia*" which means "*talking about being*". Associated for centuries to philosophy, Ontology is defined as *the science of existence*, or *the study of being* (Cimiano, 2006), that is, the philosophical discipline dedicated to the study of attributes innate to things due to their nature (Guarino et al., 2009).

In computer science, an ontology is a means of storing and describing knowledge. Each ontology contains the specification of one or more entities and how they are connected, i.e. it lays out the properties of an entity, the relations it has with other entities and the category's to which belongs. As Guarino puts it, "*computational ontologies are a means to formally model the structure of a system, i.e. the relevant entities and relations that emerge from its observation, and which are useful to our purposes*"(Guarino et al., 2009).

In order to describe knowledge using this type of representation, one can resort to the creation of the following types of elements: classes, attributes, relations, individuals (instances of objects), restrictions, rules and axioms. The Figure 3 [adapted from OntoCnE, refer to Subsection 2.3.1] illustrates a simple example of an ontology with five different concepts (classes) and the relations between them.

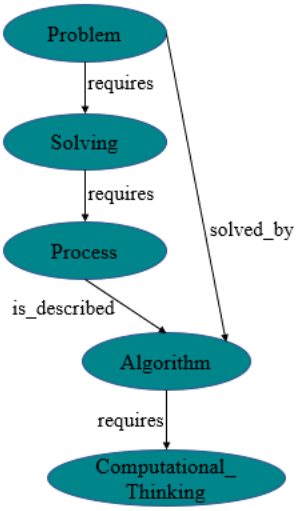

Figure 3: A fragment of the OntoCnE.

According to (Kalibatiene and Vasilecas, 2011), the four most popular languages used to represent knowledge by ontologies are `KIF` (*Knowledge Interchange Format*), `OWL` (*Web Ontology Language*), `RDF` (*Resource Description Framework*) + `RDFS` (*Resource Description Framework Schema*) and `DAML` ((*DARPA agent markup language*) + `OIL` (*Ontology Inference Layer* or *Ontology Interchange Language*)).

Furthermore, one of the advantages of working with ontologies is the possibility of inferring knowledge, that is, to deduce conclusions not explicitly stated from the existing statements and therefore expand the knowledge base. Said conclusions are, in practice, new relationships between concepts.

2.3.1 *OntoCnE*

In the context of the project *Computação na Escola* (translated from portuguese as *"Computing at School"*) and under the scope of the subsequently mentioned work of the *Micas* project (Section 2.4.1), it was developed the *OntoCnE* ontology. Its main purpose is to classify and catalog the Learning Resources inserted in the Micas web platform so as to facilitate the process of searching for and identifying the adequate resource(s) for a specific context and subject during a class.

Going into detail on the ontology and its concepts, since the purpose of the Learning Resources it specifies and represents is to teach Computational Thinking (CT), the concepts describe the domain of the the problem (CT) Araújo et al. (2019a). For instance, some of the possible categories are language, computer, activity, digital device, strategic thought, abstraction, among others.

Secondly, the relationships between the concepts are described by means of triples with the structure (”Subject”, ”Predicate”, ”Object”). The first and third elements of the triple (subject and object) are concepts of the ontology and the second element (predicate) is the relationship between them. An example of such a triple present in the OntoCnE ontology is `Computador =[ isa=> DispositivoDigital]`, that is, *computer is a digital device*.

Additionally, OntoCnE describes the concepts to be taught in every school year and the necessary physical devices needed for the classes in general, for instance, a computer. Below is an example of such classification.

```
Triplos{
    ano2 =[
        desenvolve=> PensamentoComputacional,
        desenvolve=> RaciocinioLogico,
        desenvolve=> Abstraccao,
        apresenta=> Problema,
        reforca=> Algoritmo,
        reforca=> Instrucao,
        reforca=> Programa,
        reforca=> DispositivoDigital,
        reforca=> LingGrafica,
        introduz=> Decomposicao,
        intsince groduz=> Variavel,
```

```
        introduz=> Depuracao,
        cria=> Programa,
        usa=> Computador,
        usa=> Robot,
        usa=> Teclado,
        usa=> Monitor
    ];
}
```

At present, 2021, OntoCnE is under major revision aiming at consolidating the initial triples and including new concepts, relations and triples.

Figure 4 presents the OntoCnE ontology.

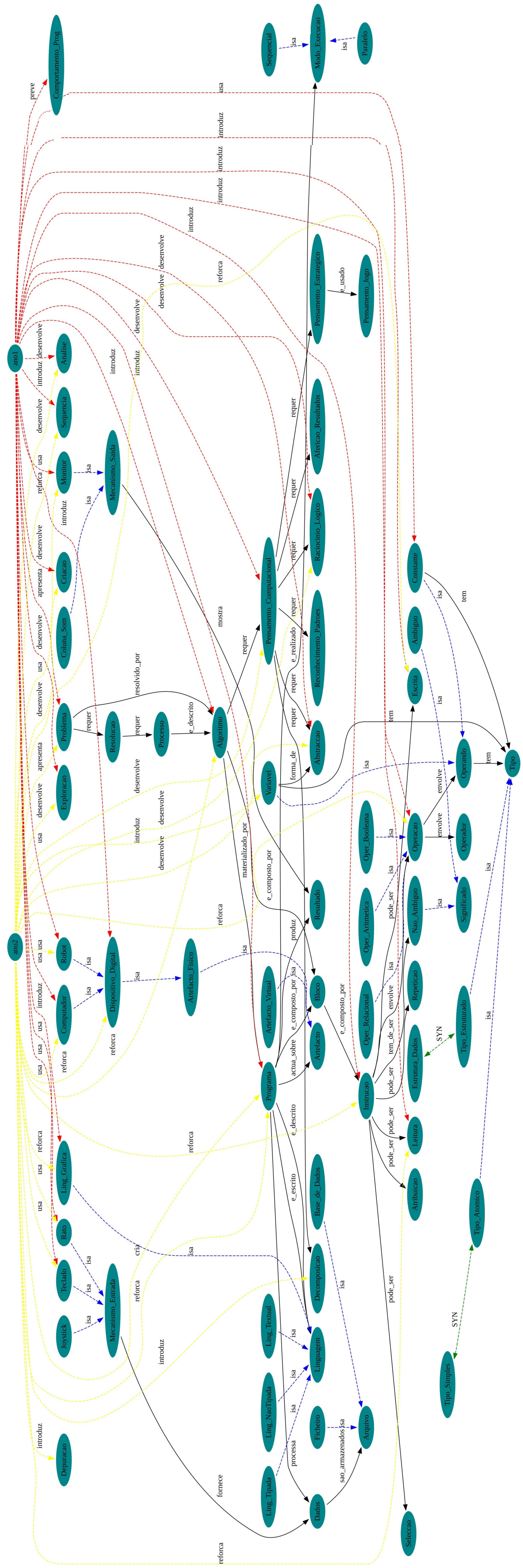

Figure 4: Visual representation of the OntoCnE ontology.

2.3.2 *OntoJogo*

The OntoJogo ontology was also developed under the scope of the project CnE - Computação na Escola and its purpose is the classification of games. This ontology is particularly relevant for this dissertation since games are a very important Learning Resource in teaching, including Adult Education. In addition, the uniform classification of games allows to take better advantage of the games, as well as to assist in research work that focuses on their use (Teixeira et al., 2020b) as is the case of this thesis.

OntoJogo allows to classify games according 11 different parameters (Teixeira et al., 2020b; de La Salete Teixeira, 2021):

1. **Progression:** Represents the possible ways to progress through the game.
2. **Player Number:** Represents the categories of the number of players the game allows.
3. **Gaming Platform:** Represents the platform/device that runs the game.
4. **Player Perspective:** Represents the way players view the world of the game.
5. **Input:** Represents the type of input used to identify the player's actions.
6. **Available:** Represents the digital/internet availability of the game.
7. **Genre:** Represents the categories of the gameplay interaction.
8. **Story:** Represents the degree of the importance of the story to the game.
9. **Game Mode:** Represents the mindset with which the player should be playing the game.
10. **Ending:** Represents o the different types of ending in games.
11. **Character choice:** Represents the categories for how the characters are chosen in the game.

Figure 5 presents the OntoJogo ontology and allows to analyze its classes and instances.

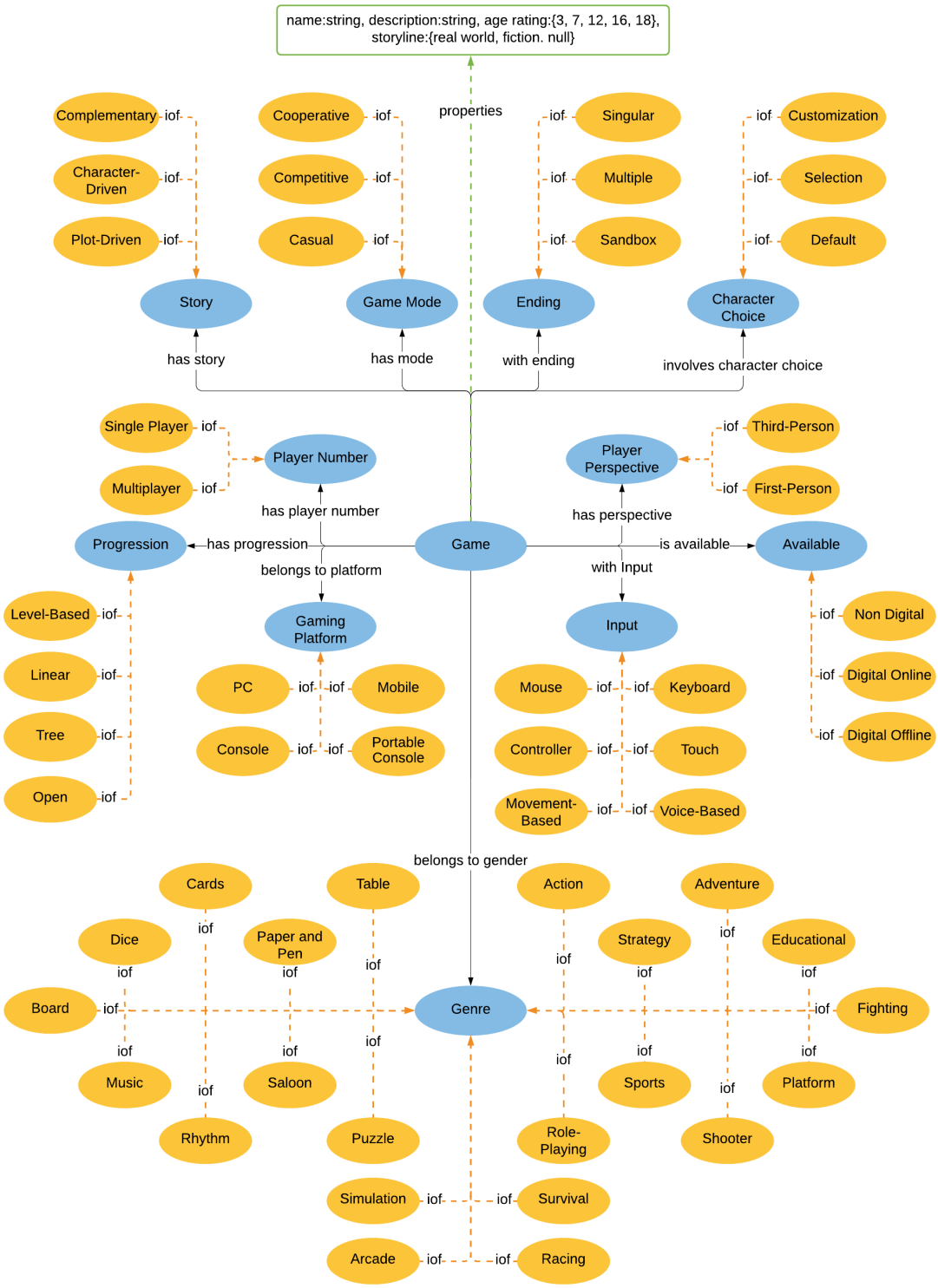

Figure 5: Visual representation of the OntoJogo ontology.

2.4 LEARNING RESOURCES

A Learning Resource (LR) can be defined as a tool (physical or virtual) that can be employed for educational purposes such as teaching, learning or illustrating a particular subject or concept; Otherwise known as educational resources, these tools may improve the learning experience of both the student and the educator (Saskatchewan, 2015).

Examples of Learning Resources include[5]: Textbooks (print and digital), Workbooks, Worksheets, Manipulatives (blocks, beads, etc.), Flashcards, Educator workshops, Non-fiction books, Posters, Educational games, Apps, Websites, Software, Online courses, Activity books, Graphic novels, Reference books, DVDs, CDs, Magazines/periodicals, Study guides,Teacher guides, Labs, Models, Movies, Televisions shows, Webcasts, Podcasts and Maps/atlases.

2.4.1 *Micas*

Under the scope of the CnE project it was developed in the University of Minho the *Micas web platform*, a platform designed to support teachers at school when it comes to teach Computational Thinking (Azevedo et al., 2019; Araújo et al., 2019b). In Micas the educators are able to find the Learning Resources needed for the classes of CT, categorized and divided by year/grade, subjacent concept, type of activity and school courses (Azevedo, 2019).

Micas is available online at `https://micas.epl.di.uminho.pt/` and is already populated with Learning Resources for several years and various types of activities such as games and videos. It also allows for the visualization of the ontology it uses for the internal classification of games (OntoCnE) and virtual interaction with it so as to better understand it. Lastly, it allows the insertion of Learning Resources, provided one specifies the information required such as grades it can be used on as well as other pertaining details, for instance, description of the item, instructions, type of activity and so on.

5 Retrieved from *What Are Learning Resources?* by Association of American Publishers. Accessed November 2019.

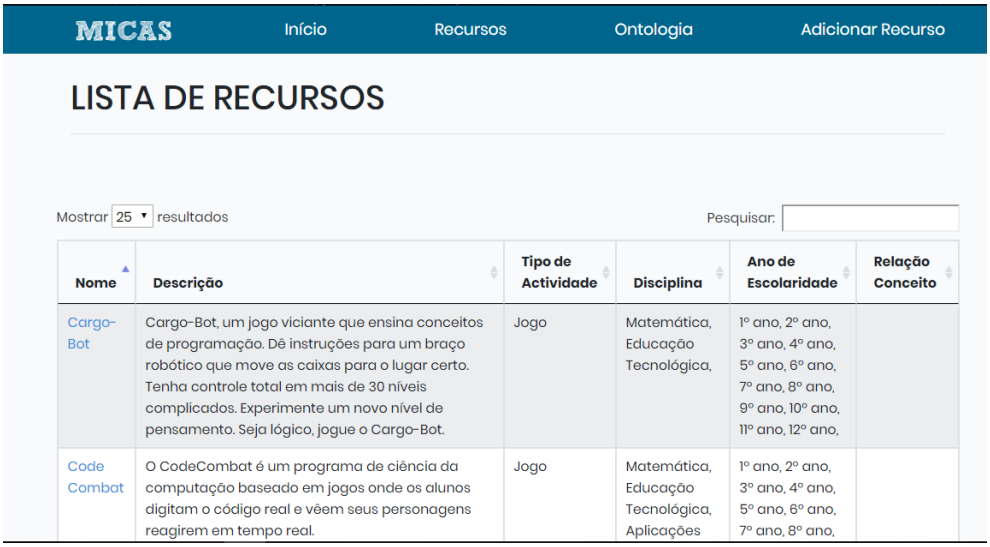

Figure 6: Micas web platform - List of available Resources.

The Figure 6 depicts the Resource List page on the Micas project web platform. It is possible to review the categorization of resources (by type of activity, discipline and school year) as well as their description, or even to access a particular resource.

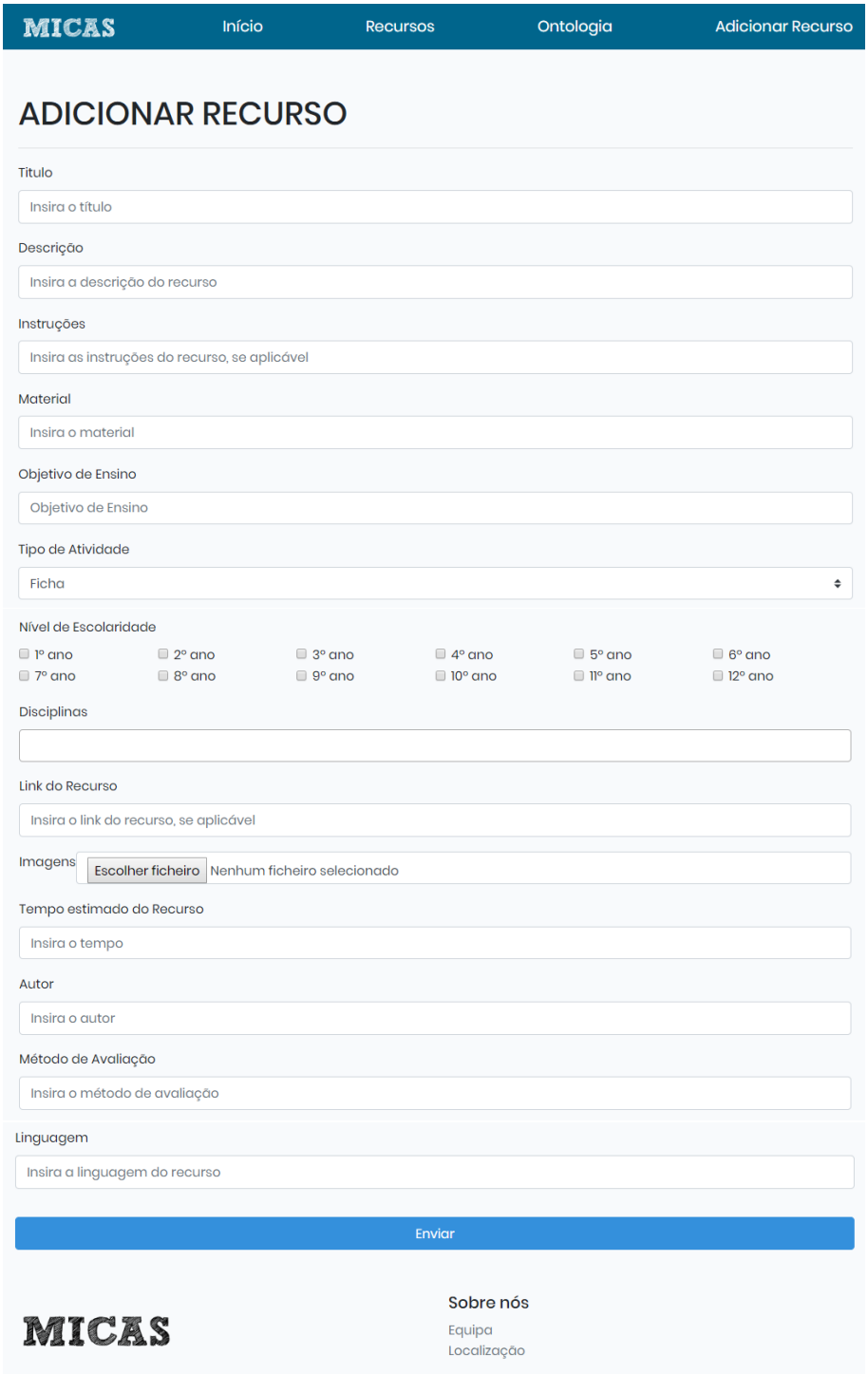

Figure 7: Micas web platform - Add Resource page.

In Figure 7 it is possible to analyze the insertion page of a Learning Resource in the Micas platform, as well as observe what the author considers essential elements of categorization of an educational resource, thereby making this image particularly relevant for this dissertation.

2.5 SUMMARY

In this chapter we presented the State of the Art concerning the areas of greater importance to the project, specifically, Computational Thinking, Adult Learning and Education, Ontologies and Learning Resources.

Specifically, we discussed the most important initiatives in the areas of Computational Thinking and Adult Learning and Education (both worldwide, and at a European and national levels). We also featured materials whose study was the starting point for the work we developed in terms of ontologies and programming, namely those developed under the scope of the CnE (Computação na Escola) project .

In short, all this extensive study and bibliographic research was extremely important to start the project with knowledge in these domains in order to be able to give the best, most appropriate and most useful contribution that was possible.

3

A PROPOSAL FOR LR ADEQUACY IN ADULT EDUCATION

Since the majority of the Computational Thinking Learning Resources (LR) and curricula have not been created for adult learners (Zapata-Rivera et al., 2019), a teacher may only have available Learning Resources intended for younger students. On the other hand, it is also possible that a Learning Resource was designed with an adult audience in mind that is very different from the one that the resource will be used to teach.

Therefore, it is of the utmost importance to understand if a certain LR is appropriate to a given adult. To that end, it is necessary to have an overview of both the LR and the adult. In some cases, it is intuitive (even if one can not put it into words) why a given LR is not appropriate for an adult in general, or even a specific one. However, some cases are more complex and therefore the task of identifying the different situations becomes more difficult.

To that end, we propose to develop after extensive bibliographical study, an approach and methodology to Learning Resource Adequacy in Adult Education, that comprises an ontology that facilitates this process.

The suggested ontology - **OntoAL** - will take into consideration the research done in Adult Learning and Education in order to accomplish its purpose: **describing the domain of Adult Learning**, including the adult learner and the other pertinent concepts to this thesis (e.g Computational Thinking). The goal is that within the knowledge it contains, it will hold the answers to the following questions:

- What are the main concepts that influence Adult Learning?
- What are the differences in the learning process of Adults over Children?
- What parameters are most relevant to characterize Adult Learners?
- What are the main factors of difference between adults (e.g. literacy) that most impact their learning process?
- What are the causes that may lead to an adult rejecting or, on the other hand, embracing a Learning Resource?

Additionally, from this ontology we will create a **list of parameters to properly describe a Learning Resource**. Said parameters will allow for the description of the LRs in concepts relevant to rate their suitability to an adult learner.

The correct cataloging of a Learning Resource is a very significant part of the process. The lack of pertinent information over a LR prevents a proper adequacy analysis since one cannot know if the resource is adequate to a certain adult without having an accurate summary to assess it.

It is worth noting once again that the Learning Resources must pertain to the teaching of Computational Thinking. Thus, all the resources that will be tested are in accordance with the OntoCnE ontology (explained in detail in Chapter 2.3.1) which describes the domain of Computational Thinking and its teaching.

In short, the Adult Learning ontology OntoAL and the Descriptive Parameters of Learning Resources will allow a better understanding of the Adult Learner and the Learning Resource at hand.

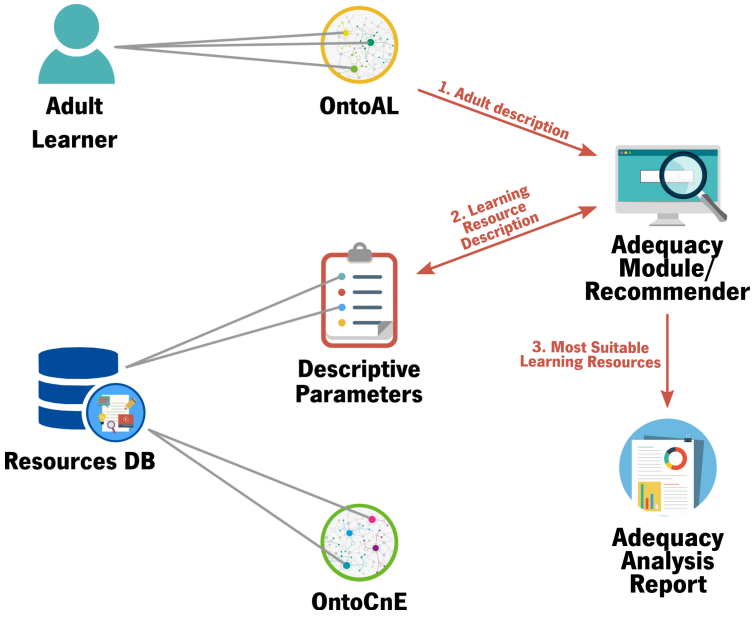

Figure 8: Architecture of the Adequacy Analysis processor.

Figure 8 illustrates the Master's Thesis proposal. The scheme flows from the left to the right side. Firstly, it starts with a student (the adult learner) and a database containing learning resources. The description of the adult will be written following the guidelines contained in OntoAL, that is, it is possible to describe the Adult Learner according to the OntoAL. Similarly, the LR will be described according to the Descriptive Parameters and in compliance with the OntoCnE ontology (to guarantee its suitability as a Computational Thinking Learning Resource). Finally, in the third column of the schema, we have the Adequacy Module/Recommender and the Adequacy Analysis Report.

Subsequently, we can analyze the process depicted in the architecture schema. First, given an Adult Learner, its description is drawn up according to OntoAL. This description is then sent to the Adequacy Analysis module which searches the list of descriptions of Learning Resources for the most suitable one for the learner. Lastly, a report is generated with the result.

3.1 SUMMARY

Let us recall that the scope of this project is the adequacy of Learning Resources for Adult Learners who decide to move into the field of Informatics and whose difficulties in their introduction to this area c an be solved by the use of suitable Computational Thinking LRs.

In this chapter we present the Masters Thesis proposal. Specifically, an approach to LR Adequacy in Adult Education, which makes use of an ontology to achieve the best adequacy of Learning Resources for Adult Learners.

4

ONTOAL, AN ONTOLOGY TO DESCRIBE ADULT LEARNING AND LEARNING RESOURCES

The purpose of the OntoAL ontology is to assist in teaching Computational Thinking to adult learners, by describing the domain of Adult Learning. Therefore, it was paramount for us that it should include theoretical knowledge about the domain (i.e. the theory on andragogy and adult learners), useful adult descriptors (such as gender, age range, qualifications, among others), and the parameters that may affect the learning experience should they occur (as is the case of impairments that the adult may have).

Figure 9 illustrates the ontology created under the scope of this project which we have named OntoAL.

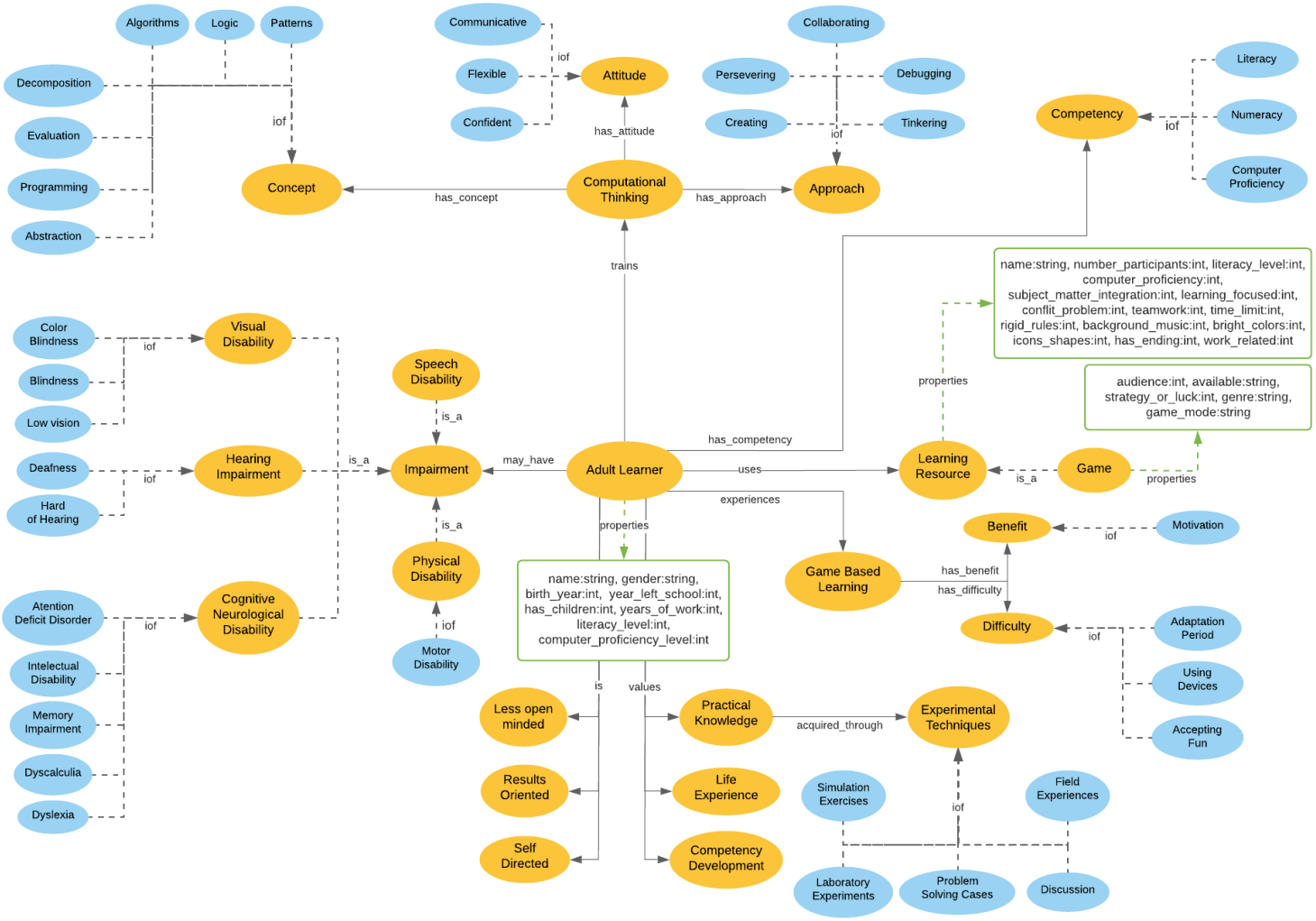

Figure 9: Illustrative image of the OntoAL ontology.

Therefore, to be able to create an ontology that matches those expectations we started from the extensive bibliographic research carried out during the first months, drawing from the knowledge we gathered regarding Computational Thinking and from the most relevant theoretical works pertaining to the field of Adult Learning and Education, Ontologies and Learning Resources.

Suitably, the concept at the center of OntoAL is the Adult Learner. This concept has a set of properties (e.g. name, literacy level, computer proficiency level,...) and has a first degree relation with seven other concepts. These are the pillars on which the ontology is based with regard to the points of the domain that we consider of particular relevance and chose to describe and highlight. Namely, Computational Thinking, Game-Based Learning, Learning Resources, Impairments, Competencies and lastly Adult Learning assumptions.

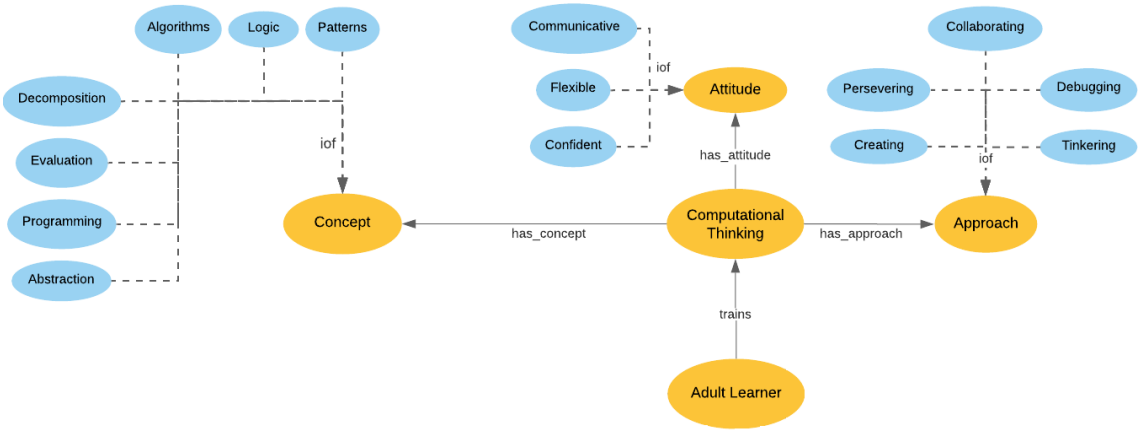

Figure 10: Excerpt of the OntoAL ontology - Computational Thinking.

Starting with the component of the OntoAL concerned with Computational Thinking we felt that it was an important inclusion to the ontology since to teach CT it is necessary to understand this method and what it entails. In 2.1 we present each one of these topics, namely, the appropriate Approaches to problem-solve using Computational Thinking, the Concepts that define this method, as well as the Attitudes that optimize and facilitate the process.

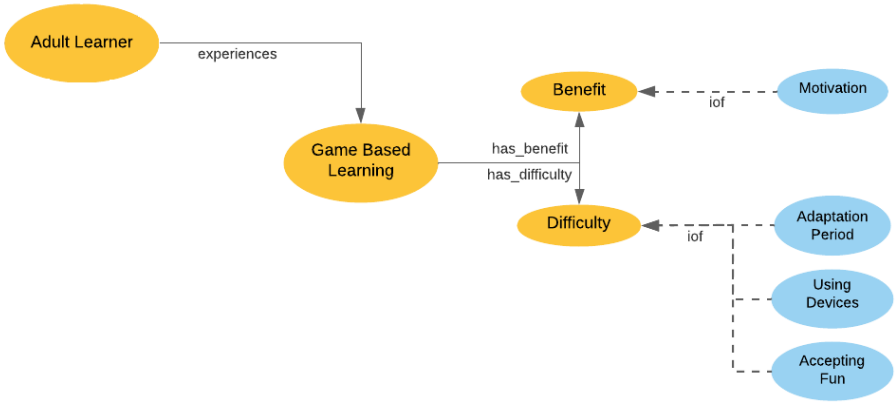

Figure 11: Excerpt of the OntoAL ontology - Game-Based Learning.

Secondly, we have the triple "Adult Learner experiences Game-Based Learning". This concepts are extremely relevant to this project since, as explained in 2.2.2, Game-Based Learning has enormous potential for teaching adults. However, with an adult audience comes a particular set of difficulties which need to be taken into consideration in both scientific work and practical classes.

Thus, on this ontology we highlight both the major benefit of employing GBL (a boost in student motivation) but also the potential difficulties: obtaining approval/acceptance of this method by adults who consider games inappropriate and not serious enough for the classroom, adults who are not used to technology adapting to it and overcoming any anxiety and lastly

helping the students who due to any impairment/old age have difficulties in using technological devices.

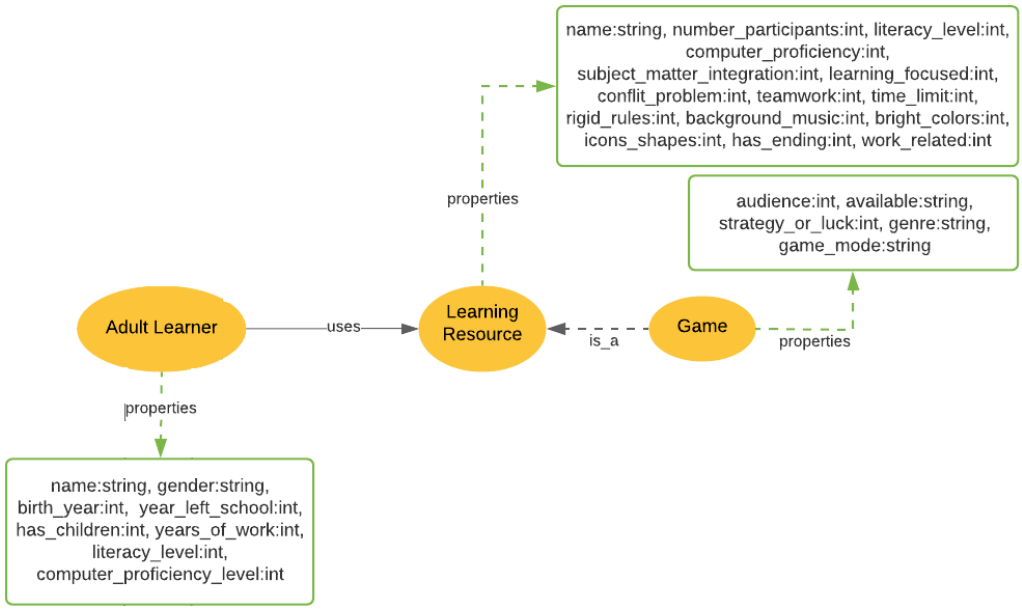

Figure 12: Excerpt of the OntoAL ontology - Learning Resources.

In Figure 12 we can see the two focal points of this work, the Adult Learners and the Learning Resources (including Games who are a type of LRs, as evidenced by the relation `is_a`).

These three concepts are the only ones from the OntoAL ontology who have a set of Properties, that is, a set of parameters that serves to characterize the Instances of these concepts (i.e. the adults, the LRs and the Games).

To characterize both the student and a given resource is of the utmost importance to achieve a good adequacy between Learner and Learning Resource. The parameters referring to the adult were selected based on the bibliographic analysis carried out (from several papers and projects). Regarding the resource parameters, we will analyze them in more detail in Section 4.2.1.

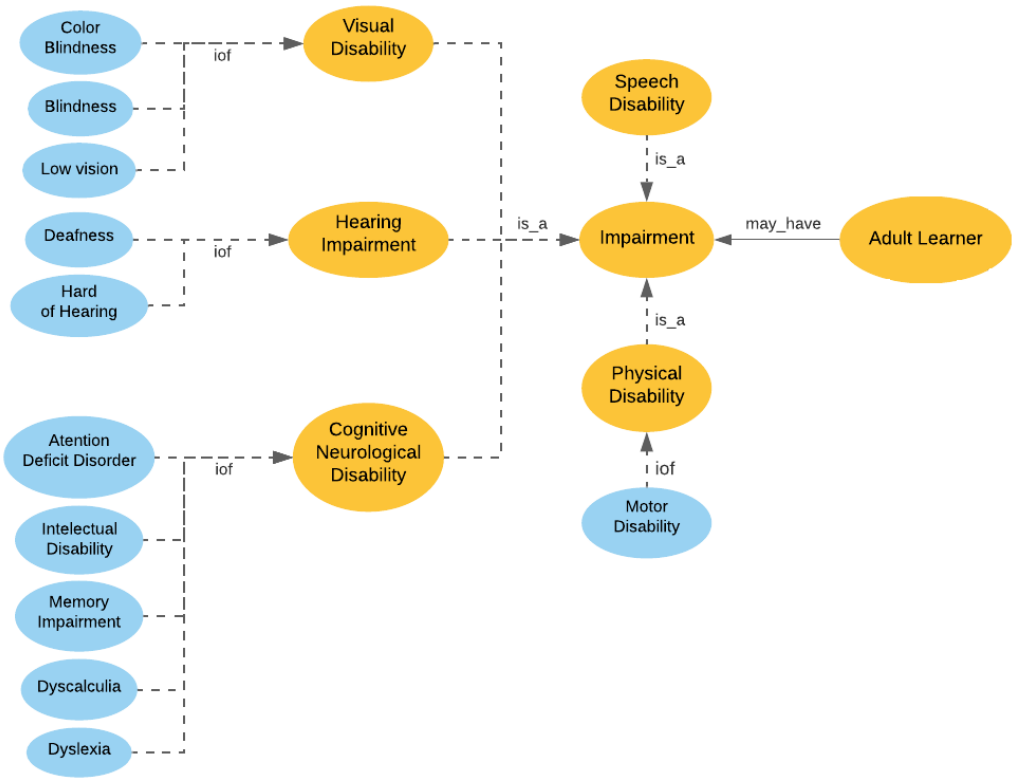

Figure 13: Excerpt of the OntoAL ontology - Impairments.

Next, in Figure 13 we have the relation between Adult Learner and (a possible) Impairment. This situation is very important and worthy of the inclusion on the ontology since, even if the Learning Resource is a perfect fit to the student, he or she may have an impairment that prevents them from taking advantage of it. Thus, it is a factor with a lot of influence and teachers and facilitators of Adult Learning must remember to take it into consideration and check for any disabilities that might difficult the students' Web Accessibility[1].

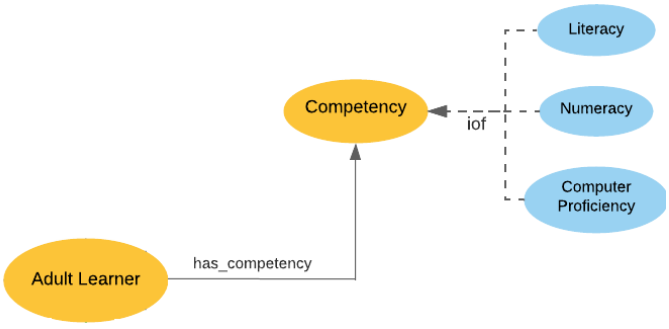

Figure 14: Excerpt of the OntoAL ontology - Competencies.

1 Detailed information about this subject can be consulted at *https://www.w3.org/WAI/EO/Drafts/PWD-Use-Web/#diff*

Regarding the concepts presented in Figure 14, we decided to group these three competencies in a category in order to give them due prominence. The level of literacy, numeracy and technological proficiency of a student have a huge impact on how the he or she perceives and approaches the educational resource. Thus, there are several studies that divide this parameters into different levels according to people's abilities, as described in the State of the Art chapter.

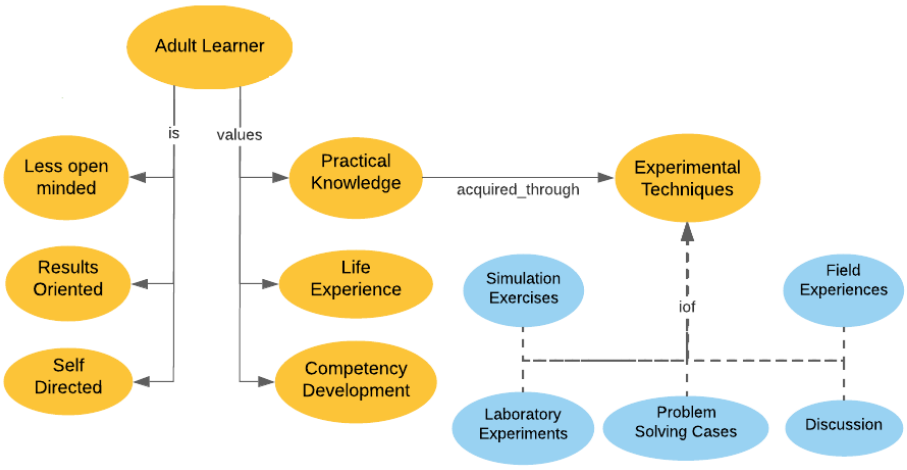

Figure 15: Excerpt of the OntoAL ontology - Adult Learning theory.

Lastly, the relations `is` and `values` of OntoAL (refer to Figure 15) pertain to the research of Adult Learning theory and were mostly derived from the works of Malcolm Knowles (the father of Andragogy) presented in Table 1. They provided valuable insights to the psychology behind Adult Learners, characteristics of theirs behavior and their motivation as well as successful teaching techniques.

4.1 OntoAL written in OntoDL

In order to represent the knowledge contained in the OntoAL ontology we opted for the **OntoDL** language, developed by the gEPL - Language Specification and Processing Group of the Departamento de Informática from Universidade do Minho.

OntoDL is a DSL (Domain Specific Language) that allows for a fast and easy specification of the structure of any given ontology (Martins et al., 2019) as well as its instantiation (Araújo et al., 2019b). Furthermore, OntoDL has the advantages of being much more user-friendly than other more complete and elaborated notations (Pereira et al., 2016).

In fact, this language allows to specify an ontology in quite a simple and efficient manner. To do so, we must create a document with the following structure: writing the title of the ontology on the first line and then write the sections concerning the concepts, individuals, relations and triples.

Let us consider the following excerpt of OntoAL as an example.

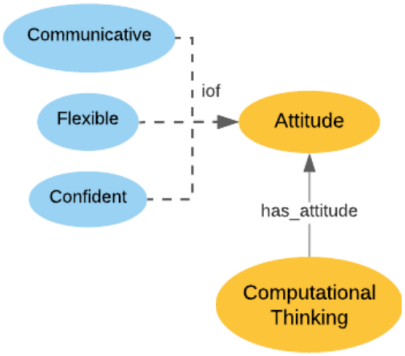

Figure 16: OntoAL excerpt - Computational Thinking attitudes.

Using the example of Figure 16, the specification of this mini ontology according in OntoDL would be as follows (it is never necessary to declare in the section *"relacoes"* neither "is_a" nor "iof"):

```
Ontologia OntoMini

conceitos{
    Computational_Thinking, Attitude
}

individuos{
    Flexible, Confident, Communicative
}

relacoes{
    has_attitude
}

triplos{
    Computational_Thinking=has_attitude=>Attitude;
    Flexible=iof=>Attitude;
    Confident=iof=>Attitude;
    Communicative=iof=>Attitude;
}.
```

In the case of OntoAL, the concepts section would be as shown in Listing 4.1. For improving readability the concepts were grouped with the most similar ones.

```
1 conceitos {

3     Adult_Learner[name:string, gender:string, birth_year:int, year_left_school:int, has_children:int,
       years_of_work:int, literacy_level:int, computer_proficiency_level:int],
```

```
    Learning_Resource[name:string, number_participants:int, literacy_level:int, computer_proficiency:int
     , subject_matter_integration:int, learning_focused:int, conflit_problem:int, teamwork:int,
     time_limit:int, rigid_rules:int, background_music:int, bright_colors:int, icons_shapes:int,
     has_ending:int, work_related:int],

    Game[audience:int, winners_loosers:int, strategy_or_luck:int, genre:string, game_mode:string],

    Competency,

    Computational_Thinking, Concept, Attitude, Approach,

    Impairment, Speech_Disability, Visual_Disability, Hearing_Impairment,
     Cognitive_Neurological_Disability, Physical_Disability,

    Self_Directed, Results_Oriented, Less_open_minded, Life_Experience, Competency_Development,
     Practical_Knowledge, Experimental_Techniques,

    Game_Based_Learning, Difficulty, Benefit

}
```

Listing 4.1: Section "conceitos" of the OntoAL ontology in OntoDL.

Secondly, the individuals of the ontology were listed, as dictated by the structure of the OntoDL language.

```
individuos {

    Literacy, Numeracy, Computer_Proficiency,

    Creating, Persevering, Debugging, Collaborating, Tinkering, Flexible, Communicative, Confident,
     Patterns, Programming, Logic, Algorithms, Abstraction, Decomposition, Evaluation,

    Blindness, Low_Vision, Color_Blindness, Deafness, Hard_of_Hearing, Motor_Disability, Dyslexia,
     Dyscalculia, Attention_Deficit_Disorder, Intellectual_Disability, Memory_Impairment,

    Laboratory_Experiments, Simulation_Exercises, Field_Experiences, Problem_Solving_Cases, Discussion,

    Motivation, Adaptation_Period, Using_Devices, Accepting_Fun

}
```

Listing 4.2: Section "individuos" of the OntoAL ontology in OntoDL.

Thirdly, we listed all the relations existing in the ontology, with the exception of the `is_a` and `iof`.

```
relacoes {
    has_competency,
    trains, has_concept, has_attitude, has_approach,
    may_have,
    is, values, acquired_through,
    experiences, has_difficulty, has_benefit,
```

```
    uses

}
```

Listing 4.3: Section "relacoes" of the OntoAL ontology in OntoDL.

Lastly, we have listed all the triples of the ontology, that is, we specified all the relationships between the various concepts and individuals of the OntoAL ontology.

```
triplos {
    Adult_Learner=has_competency=>Competency;
    Literacy=iof=>Competency;
    Numeracy=iof=>Competency;
    Computer_Proficiency=iof=>Competency;

    Adult_Learner=trains=>Computational_Thinking;
    Computational_Thinking=has_approach=>Approach;
    Creating=iof=>Approach;
    Persevering=iof=>Approach;
    Debugging=iof=>Approach;
    Collaborating=iof=>Approach;
    Tinkering=iof=>Approach;
    Computational_Thinking=has_attitude=>Attitude;
    Flexible=iof=>Attitude;
    Communicative=iof=>Attitude;
    Confident=iof=>Attitude;
    Computational_Thinking=has_concept=>Concept;
    Evaluation=iof=>Concept;
    Decomposition=iof=>Concept;
    Abstraction=iof=>Concept;
    Algorithms=iof=>Concept;
    Logic=iof=>Concept;
    Programming=iof=>Concept;
    Patterns=iof=>Concept;

    Adult_Learner=may_have=>Impairment;
    Visual_Disability=isa=>Impairment;
    Hearing_Impairment=isa=>Impairment;
    Physical_Disability=isa=>Impairment;
    Speech_Disability=isa=>Impairment;
    Cognitive_Neurological_Disability=isa=>Impairment;
    Blindness=iof=>Visual_Disability;
    Low_Vision=iof=>Visual_Disability;
    Color_Blindness=iof=>Visual_Disability;
    Deafness=iof=>Hearing_Impairment;
    Hard_of_Hearing=iof=>Hearing_Impairment;
    Motor_Disability=iof=>Physical_Disability;
    Dyslexia=iof=>Cognitive_Neurological_Disability;
    Dyscalculia=iof=>Cognitive_Neurological_Disability;
    Attention_Deficit_Disorder=iof=>Cognitive_Neurological_Disability;
    Intellectual_Disability=iof=>Cognitive_Neurological_Disability;
    Memory_Impairment=iof=>Cognitive_Neurological_Disability;

    Adult_Learner=is=>Less_open_minded;
```

```
    Adult_Learner=is=>Results_Oriented;
47  Adult_Learner=is=>Self_Directed;
    Adult_Learner=values=>Life_Experience;
49  Adult_Learner=values=>Competency_Development;
    Adult_Learner=values=>Practical_Knowledge;
51  Practical_Knowledge=acquired_through=>Experimental_Techniques;
    Laboratory_Experiments=iof=>Experimental_Techniques;
53  Simulation_Exercises=iof=>Experimental_Techniques;
    Field_Experiences=iof=>Experimental_Techniques;
55  Problem_Solving_Cases=iof=>Experimental_Techniques;
    Discussion=iof=>Experimental_Techniques;
57
    Adult_Learner=experiences=>Game_Based_Learning;
59  Game_Based_Learning=has_benefit=>Benefit;
    Motivation=iof=>Benefit;
61  Game_Based_Learning=has_difficulty=>Difficulty;
    Adaptation_Period=iof=>Difficulty;
63  Using_Devices=iof=>Difficulty;
    Accepting_Fun=iof=>Difficulty;
65
    Adult_Learner=uses=>Learning_Resource;
67  Game=isa=>Learning_Resource
}.
```

Listing 4.4: Section "triplos" of the OntoAL ontology in OntoDL.

It is also important to mention the existence of an OntoDL compiler that allows to compile this ontology, generating a DOT version of it. This new file can be used to visualize the ontology (on *websites* such as http://www.webgraphviz.com/) since it specifies all the elements needed for that task. Furthermore, to run the compiler it is only necessary to have the latest Java version installed, an ontology correctly specified in OntoDL, access to the jar file (the compiler), and finally to run the command `$ java -jar OntoDL.jar ontoExample.txt` given a hypothetic ontoExample.txt ontology.

An improved and updated version of this compiler (named `OntoDL+`) is being finalized and can be downloaded at `https://epl.di.uminho.pt/~gepl/GEPL_DS/OntoDL/`.

4.2 Exploring OntoAL in Prolog

As previously mentioned, one of the purposes of this research is to develop a **list of descriptive parameters of Learning Resources** that gathers the criteria of greater relevance within this field (the adequacy of educational resources to an adult learner). That is, we intend to improve the process of analysis of a given learning resource, uncovering which characteristics are more relevant both for its description and for its classification (in more or less adequate).

This knowledge is very important since there is an unlimited number of parameters by which we can analyze and evaluate an educational resource, so it is easy to get overloaded with information.

Thus, in this thesis, we have been able to establish a list with the most vital parameters which enables us to **improve the analysis of Learning Resources** (as it tells us what to focus

on), provides us with a **means of describing/classifying them** and **facilitates the reaching of conclusions** (being potentially useful in several other projects).

This was possible after an extensive bibliographic research of other projects, papers and websites which we analyzed critically (by gathering information and drawing conclusions). In addition, we applied the knowledge described in the **OntoAL** ontology. Throughout this process we also classified and analyzed games and in each iteration we improved the Descriptive Parameters List, until we reached the final version. Classifying games and other LRs was very important as it allowed us to form empirical knowledge and helped to predict the adequacy for other educational resources.

Furthermore, we understand the potential of this material we developed, which can be used in future projects across a wide range of areas. On the other hand, it is one of the vital points for adequacy analysis calculations and the systems that are developed for this purpose. Therefore, in order to leverage its use, we have chosen a suitable programming language to convert the ontology into a program from which such works can be developed. The language selected was Prolog.

Prolog stands for Programming in Logic and it is a programming language commonly used in Artificial Intelligence and non-numerical programming due to its ability to **express structured objects** and the **relations between them**, and also **infer from said relations** (Bratko, 2001). Thus, for these very same reasons, many projects focused on ontologies are developed using the Prolog language such as (Antoniou and Bikakis, 2006), (Papadakis et al., 2011) and (Seipel et al., 2018).

Furthermore, for this project, we used the SWI-Prolog editor available at *https://www.swi-prolog.org/IDE.html* . This environment is a very popular choice for developing Prolog projects of a smaller scale, conceivably due to it being free, scalable, portable, complete and open (Wielemaker, 2003).

4.2.1 *Descriptive Parameters, Development Process*

The process of developing the List of Descriptive Parameters of LRs was long and, as previously mentioned, consisted of extensive bibliographic research and consequent critical analysis of other projects, scientific papers and *websites* belonging to the area of Learning Resources, Games (including Educational Games, Game Classification and Game Based Learning, Game Interface and UX/UI[2]), Adult Learning (Game Based Learning in Adults, adult experience using adult learning resources including games) as well as the OntoAL ontology.

In fact, we analyzed these studies and materials, gathered information and developed the Parameter List from there, classifying games and learning resources at each step. With each iteration, we evaluated the results obtained and gradually improved the list, adding new parameters according to our findings. Thus, in addition to the detailed research in the State of the Art chapter, we highlight some of the sources that we examined in order to illustrate the development process of the list.

First of all, it is worth mentioning that among the various Learning Resources in existence, in this thesis we highlight games and Game-Based Learning. Thus, we conducted this research with the knowledge that in order to achieve the best results, the most appropriate classification

2 **UX** design stands for "User Experience design" and **UI** design stands for "User Interface design"

system for games may differ from the most appropriate classification system for the other types of educational resources. Thus, the list contains parameters that apply to any learning resource and also contains some specific ones that apply only to games.

Regarding the sources that we consider most relevant, we can begin by naming the repositories of Exploring Computational Thinking and Micas, as well as the OntoCnE Ontology (which are explained in detail in the State of the Art chapter). These are particularly relevant since, under the scope of this project, the List will be used to classify Computational Thinking resources previously validated according to OntoCnE.

Since both mentioned repositories contain only CT educational resources, we can establish a link between OntoCnE and the repositories, as well as classify all their resources according to this ontology. Furthermore, both Exploring Computational Thinking and Micas feature a characterization of their resources, which is displayed on the pages of each of them as well as in the system of filters (e.g. filtering the resources by subject or school year), which we can then analyze.

Secondly, we highlight the role of the game MetaVals. In the research we conducted regarding games, namely game classification, game based learning (which resulted in the publication of a scientific paper(Teixeira et al., 2020a)) and educational games we found several studies involving the use of the educational game MetaVals. MetaVals is a serious and educational game initially developed for the area of Finance, but today can be adapted to various domains (Padrós et al., 2012). It offers both individual and collaborative learning processes based on decision making, classification and knowledge demonstration (Romero et al., 2012) and has already been the target of several studies of implementation in real classrooms(Popescu et al., 2012).

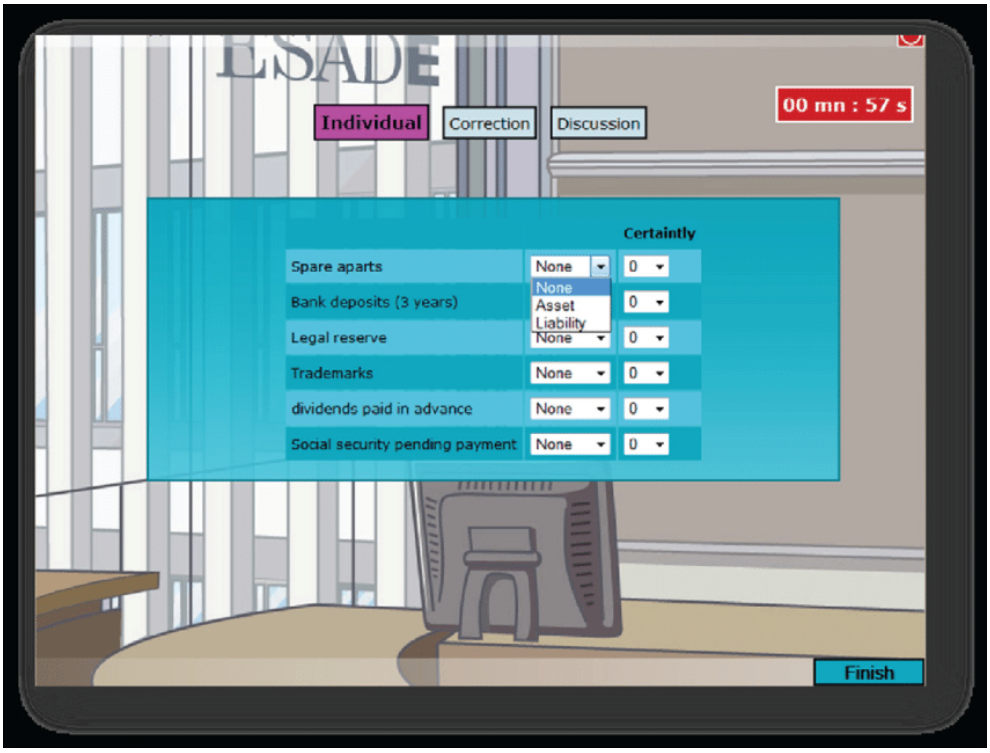

Figure 17: Interface of the MetaVals serious game.

Due to the success of MetaVals as an educational game and the various scientific publications published we considered that this would be a good example to study and that an examination of these papers would be of great relevance in acquiring knowledge about good educational games and the characteristics they possess.

Also within the MetaVals game research, we deem it relevant to mention the Serious Game Classification website which proposes a game classification system based on multiple criteria: gameplay, purpose, market, target audience and user-contributed keywords. In addition to the classification it provides for each game 3 sections: Informations, Analyses and Discussion. Based on the analysis of this project we extracted the Audience parameter corresponding to the age range for which the game is suitable.

Thirdly we would like to mention the role of OntoJogo, in detail in the Section 2. Similarly to the Serious Game Classification website, it also proposes a game classification system, and its review was very useful in terms of acquiring knowledge and broadening perspectives.

One of the steps we did at this point in the process was to classify the MetaVals game from the ontology in order to potentially draw additional conclusions. The classification we reached is the following.

```
MetaVals =iof=> Game[name='MetaVals', description='MetaVals is a sorting game
    where students play in dyads with a virtual peer, against the
    rest of the class, to practice basic finance concepts.',
    age_rating =Adults];
```

```
MetaVals =is_available=>Digital_Online;
MetaVals =belongs_to_platform=> PC;
MetaVals =belongs_to_genre=> Educational;
MetaVals =with_input=> Mouse;
MetaVals =has_player_number=> Multiplayer ;
MetaVals =has_mode=> Competitive;
MetaVals =with_ending=> Singular;
```

Still regarding OntoJogo, we ultimately decided to extract three of its concepts for the list of parameters, namely:

- **Game Genre:** Table, Paper and Pen, Cards, Dice, Board, Music, Rhythm, Saloon, Puzzle, Simulation, Arcade, Racing, Survival, Role-Playing, Sportos, Shooter, Platform, Fighting, Educational, Adventure, Strategy, Action.
- **Game Mode:** Casual, Competitive, Cooperative.
- **Available:** Non Digital, Digital Online, Digital Offline.

As part of this research we interviewed several adult educators in order to take advantage of the knowledge that results from their vast professional experience in the area of Adult Education. From this exchange of knowledge and by unanimous opinion of all interviewees, resulted the parameter Related To Work.

According to these teachers, an adult student feels more comfortable in a classroom context when a learning resource arises related to his/her area of knowledge, namely, his/her work. More specifically, this results in a visible increase in their commitment and self-worth since the student feels they have something to contribute to the others. In short, we highlight the Related to Work parameter.

In fourth place we focus on the parameters obtained from the OntoAL ontology, namely the Level of Computer Proficiency and Literacy. In addition to those whose extraction from OntoAL was direct, we also obtained after an in-depth analysis of themes present in the ontology (Impairments, Game-Based Learning, UX/UI) the parameters Background music, Bright Colors and Icons/Shapes.

The remaining parameters resulted from conclusions and knowledge acquired during the elaboration of this thesis, namely, all the research on the State of the Art, the development of all the materials and the research on classification systems and analysis of games and other studies, as previously mentioned.

We finish by defining some of the parameters whose meaning may not be so clear at first glance, and then we will present the final and complete version of the list.

LEARNING FOCUSED Evaluates whether the resource is very focused on learning or whether you spend more time in the game pushing buttons, going back and forth (among other actions) than learning.

STRATEGY OR LUCK Evaluates whether the game rewards the student's ability more than luck. To be a good educational game the player has to feel that if he tries hard, he can win the game.

SUBJECT MATTER INTEGRATION Evaluates whether it is necessary to master the learning process and the knowledge to be successful in the game.

The following is the final and complete version of the Learning Resource Parameter Descriptive List. It is possible to observe them in the OntoAL ontology since they have already been placed there as attributes of the concepts Learning Resource and Game.

Learning Resource:

1. Name
2. Number Participants
3. Literacy Level
4. Computer Proficiency
5. Subject Matter Integration
6. Learning Focused
7. Conflict Problem
8. Teamwork
9. Time Limit
10. Rigid Rules
11. Background Music
12. Bright Colors
13. Icons/Shapes
14. Has Ending
15. Work Related

Game (please bear in mind that Game inherits all the attributes of Learning Resource)**:**

1. Audience
2. Strategy/Luck
3. Game Genre
4. Game Mode
5. Available

4.2.2 *Conversion of OntoAL from OntoDL to Prolog*

Let us now focus on the conversion of the OntoAL ontology to a program in the logic programming language Prolog. Namely, we converted concepts, relations and triples. Next, we will illustrate the results through excerpts of the program which is available for consultation in full in Appendix A.

In addition to convert the ontology, Prolog allows us to document the program (which facilitates its reading, interpretation, and use by researchers of many fields) as well as to write functions and develop a full system using the Prolog features and both the users' and the infered knowledge.

In fact, we have already started this process (creating formulas to predict the adequacy of a LR to a given adult based on their characteristics) through the concept Influence. The Influence concept is essentially a weight that we attribute to all parameters that indicates whether it influences the result of the adequacy calculations, in a qualitative scale of influences "a lot", "a little", "nothing" or "variable" (e.g. parameter time limit which for some learners results in added motivation and for others only disturbs and worries them).

```
conceito(learning_Resource).
atributos(learning_Resource,[name:string, number_participants:int, literacy_level:int,
computer_proficiency:int, subject_matter_integration:int, learning_focused:int,
conflit_problem:int, teamwork:int, time_limit:int, rigid_rules:int, background_music:int,
bright_colors:int, icons_shapes:int, has_ending:int, work_related:int]).

% audience  (17-25, 25-35, 35-60,60+,all)
%  " levels:  1       2      3    4  5
isa(game,learning_Resource).
atributos(game,[audience:int, strategy_or_luck:int, available:string, genre:string, game_mode:string])
   .

iof(game_scratch,learning_Resource).
propriedades(lr_scratch,['Scratch',1,2,2,2,2,0,0,0,1,2,0,0,0,0]).

iof(game_chess,game).
propriedades(game_chess,['Xadrez',2,2,1,0,2,1,0,0,2,2,2,2,1,0,2,2,'digital online','strategy','
   competitive']).

%What is the name of the LR?
influence(name,0).

%What is the number of participants?
influence(number_of_participants,0).

%Does the LR require a medium (1) or a high (2) level of literacy?
influence(required_level_of_literacy,2).
```

Listing 4.5: Excerpt from the OntoAL ontology program in Prolog.

4.3 SUMMARY

This chapter is dedicated to OntoAL, an ontology to describe Adult Learning and Learning Resources.

Thus, we begin by analyzing and substantiating each of its components by explaining their development process and how the knowledge we want to represent is reflected in the ontology.

Next we examine how the ontology is described in OntoDL as well as its conversion to Prolog, exploring the potential and accomplishments of these two versions.

Finally, we thoroughly examine the list of Descriptive Parameters of Learning Resources, focusing on and explaining each of the parameters we have selected to be part of this list, as well as its development process.

All in all, this is a very important chapter in content and is most relevant for grasping the fundamentals of the work that has been conducted.

5

ADEQUACY ANALYSIS WITH ONTOAL, AN EXPERIMENT

In order to validate the Adequacy Analysis approach and methodology proposed in this dissertation, we decided to create a questionnaire to characterize Adult Learners. The questionnaire is intended for adults and all questions apart from demographic information were created based on the knowledge represented in OntoAL.

To assist in filling out the questionnaire, a website was created with a game catalog and access to the form. Both the questionnaire and the website are entirely in Portuguese to facilitate the participation of the respondents.

5.1 1ST STAGE WITH ADULTS

In this section we present the first questionnaire that was carried out in this experiment. Specifically, we explain each of the experiment's stages and components, namely the Catalog of Games (Learning Resources) that were evaluated; the website on which we made available both the questionnaire and the catalog; we also explain the questionnaire itself, followed by an evaluation and analysis of the Results and Lessons Learned in this first phase.

5.1.1 *Catalog of games*

For the Catalog of Games we selected 6 different games: **Chess**, **Cargo Bot**, **Code Monsters**, **Sudoku**, **Debugger** and **Four in a Line**. All games were analyzed according to the **OntoCnE** ontology (mentioned in section 2.3.1). As a result of this analysis we have found all games to be viable options for teaching Computational Thinking.

As for the criteria defined to assist in making the selection, besides the game's viability for teaching CT, we opted for a mixture of well-known games (such as chess), low difficulty games (such as 4 in line), programming games (such as Cargo Bot), similar games with a more or less childish look (Code Monsters and Debugger).

It was also very crucial that for each game in the catalog there was a link to an online version for the participant to play. For this purpose we were able to find 6 options with good image and sound quality, which do not force the participant to create an account or to pay to play.

The following is a brief description of each game complemented with the respective image.

Figure 18: Illustrative image of the game Chess.

CHESS Chess (see Figure 18) is a board game of strategic and competitive nature. Each piece has a set of associated moves. The objective of the game is to capture the opponent's king.

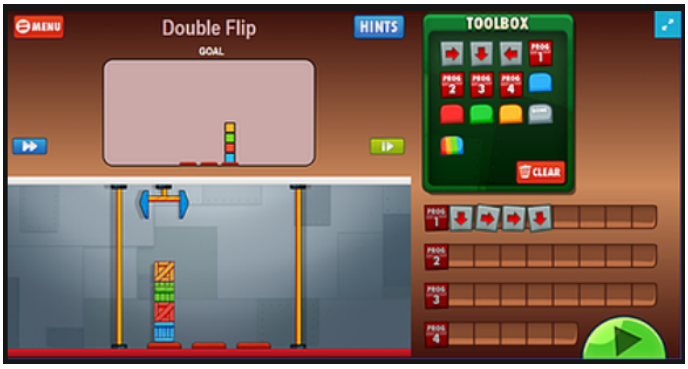

Figure 19: Illustrative image of the game Cargo Bot.

CARGO BOT Cargo Bot (see Figure 19) is a game that teaches programming concepts. The goal is to program a robotic crane that moves boxes, in order to recreate the pattern of the provided image.

Figure 20: Illustrative image of the game Code Monsters.

CODE MONSTERS Code Monsters (see Figure 20) is a game that teaches programming concepts. At each level, we program our monster's battle strategy using blocks with instructions. The set of selected blocks forms a program.

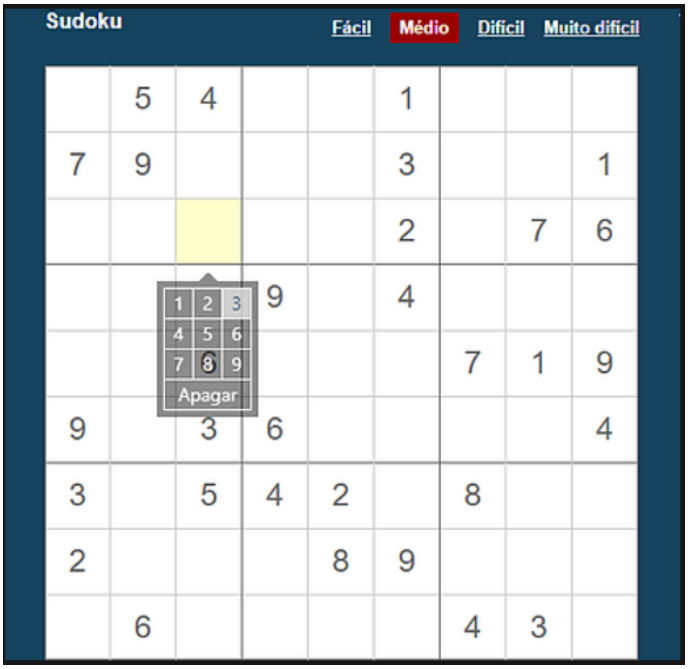

Figure 21: Illustrative image of the game Sudoku.

SUDOKU Sudoku (see Figure 21) is a numbers game with a 9x9 structure, that is, a grid that is divided into 9 squares, each with 9 cells. The goal of the game is to fill all the cells with

numbers from 1 to 9, so that there are no repeated numbers in any row or in any square of the grid.

Figure 22: Illustrative image of the game Debugger.

DEBUGGER Debugger (see Figure 22) is a game that teaches programming concepts. Design your own hero and at each level fight like this character, solving several programming challenges with progressively more resources and defeating the Bugs.

Figure 23: Illustrative image of the game Four in A Line.

FOUR IN A LINE For in a Line is a game (see Figure 23) where each player can insert one of his pieces (a "coin") through one of the slots. The first player to get 4 of his pieces to form a straight line wins.

5.1.2 *OntoAL Website*

Once the process of selecting the games was finished, the next step was to decide on how to make the questionnaire and the catalog of games available to the participants in the way that facilitates the most collecting the responses.

The criteria defined to evaluate the various options were the following:

- Must have an understandable, easy-to-remember link.
- Must provide both the questionnaire and the catalog of games.
- Must allow to describe the games with images and text, as well as to give access to them.
- Must allow providing relevant and necessary information regarding the experiment.
- Must have an intuitive and appealing interface.

Taking into consideration the criteria defined above, we opted to create a *website* for this effect. The *website* was built using *Wix.com*. Wix is a free website builder that allowed us to quickly put together a page that met all the requirements.

Starting with the link, it was set to *https://ontoal.wixsite.com/ontoal*. However, to further simplify the access to the page, the link shared with the participants was a shorter version: `ontoal.wixsite.com/ontoal` . With a more understandable and brief access address, we intended to simplify the process of accessing the website as well as to minimize possible errors that could arise from a larger and more complicated link.

Additionally, this approach has allowed us to place at disposal the questionnaire alongside the catalog of games, as intended. The top of the *website* comprises a bar that provides access to the form page (*"Questionário"*) as well as the list of games (*"Catálogo de Jogos"*) page.

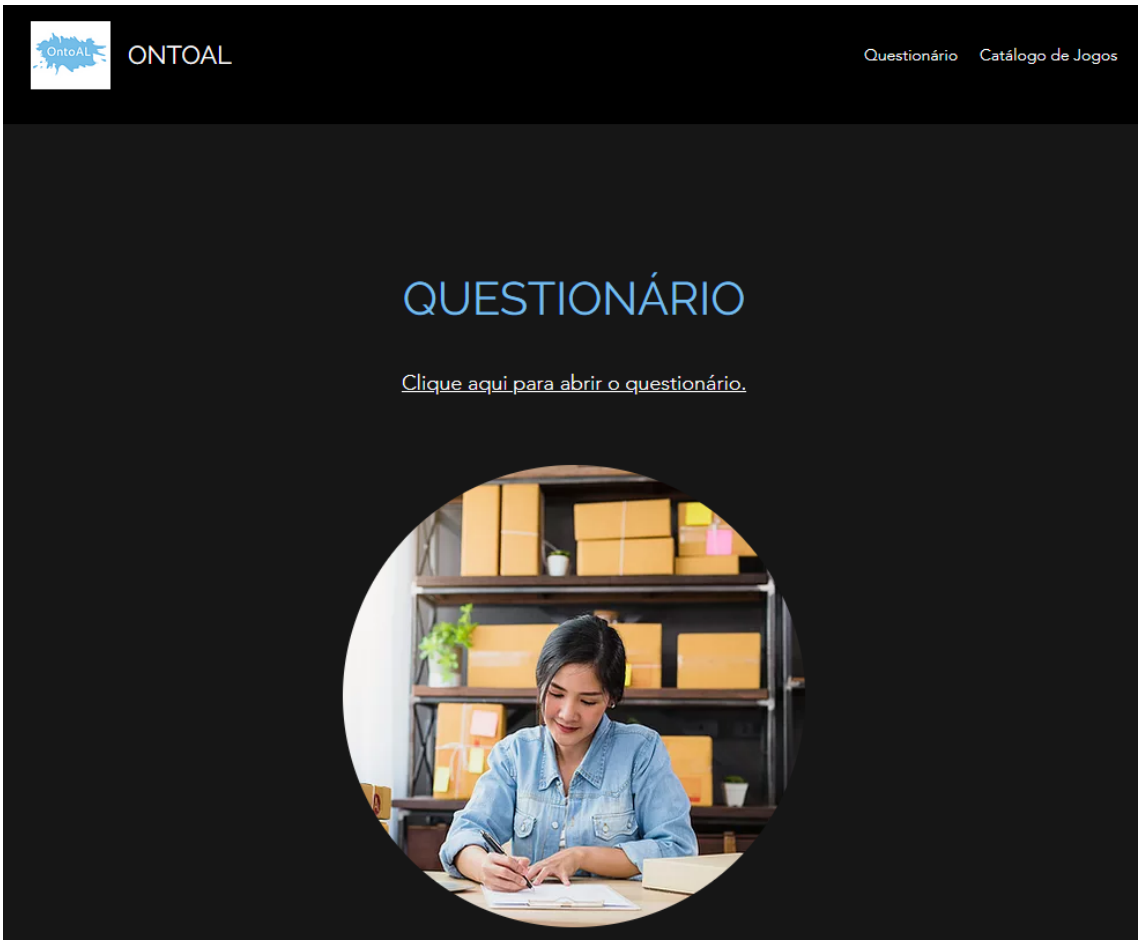

Figure 24: Main page of the *website*. Accessible at *ontoal.wixsite.com/ontoal* .

Figure 24 illustrates the main page of the *website*, which can be accessed at *ontoal.wixsite.com/ontoal*, as said above. The web page displays the title *"QUESTIONÁRIO"* (translation of "*Questionnaire*" in Portuguese). Below the title, there is a link to open the form that reads "*Clique aqui para abrir o questionário*" (i.e. "Click here to open the questionnaire"). In short, this page presents a simple, intuitive and appealing interface along with a means of easy access to the survey.

Figure 25 shows the web page of the Catalog of Games. This web page is accessible either through the top bar by clicking on *"Catálogo de Jogos"*, as well as through the link `ontoal.wixsite.com/ontoal/catálogo` (i.e. by adding *"/catálogo"* to the main page's link). Furthermore, as previously mentioned, like the rest of the website, this page is also fully written in Portuguese.

Starting with the top of web the page, we have the title (*"Jogos"*, in English "Games"). Below, it is provided relevant information regarding the games and the catalog. Namely, the text explains that for each of the games we provide a link that can be opened to access to the game. Furthermore, it clarifies that all games are free and there is no need to register an account to play them.

Additionally, Figure 25 also allows to see the first game of the catalog, namely, chess. For each game, the structure of the presentation is as follows. Firstly, on the left side we have an

image which accurately depicts the game (corresponding to the interface of the game version we provide). Secondly, on the right side the structure is divided in three sections. The top section corresponds to the name of the game. The middle section contains a link that redirects to the game, and reads the same in every item of the list: Click here to play (*"Clique aqui para jogar"*). Lastly, the bottom section contains a brief description of the game and its purpose. In this case, the translation of said text in English would be *"Chess is a strategic and competitive board game. Each piece has a set of associated movements. The objective of the game is to capture the opponent's king."*

Figure 25: *Website* page of the Catalog of Games.

Figure 26 presents an excerpt of the catalog of games, specifically the second and third games (Cargo Bot and Code Monsters, respectively) which confirms the characterization of the list above-mentioned. The rest of the catalog is available for consultation in Appendix B.1.

Figure 26: Excerpt of the Catalog of Games.

5.1.3 *OntoAL and the Adult Student*

Regarding the questionnaire it is entitled *"OntoAL e o Estudante Adulto"*, that is, OntoAL and the Adult Student. And like the website, it was written entirely in Portuguese. The full questionnaire is available for consultation in Appendix B.2.

As for the tools used for its elaboration, we opted to use Google Forms. Google Forms is a web-based app used to create forms for data collection purposes. The app is free and allows to ask questions with 11 different types of methods to answer: Short answer, Paragraph, Multiple Choice, Checkboxes, Dropdown, File Upload, Linear Scale, Multiple choice grid, Checkbox grid, Date and Time. It also offers several different methods of data validation, that is, rules to restrict the answers so that they are valid. A few examples are the option to set a question to required, to restrict entries to a certain set of/number of options, shuffling the answers and so on.

Figure 27: Introduction to the "OntoAL e o Estudante Adulto" questionnaire.

The questionnaire is divided into 3 sections. Figure 27 illustrates the header of the first section, which serves as an introduction to the form. This text provides a contextualization of the project, explaining the purpose of the form, as well as providing relevant information about filling it out.

The first section of the questionnaire is dedicated to the collection of information about the participant, particularly, demographic and regarding computer proficiency/ownership. It also concerns the validation of the ontology, namely, the segment of the ontology pertaining to the theory of Adult Learning.

The questions devised to collect demographic information were the following:

1. **What is your gender?** Available options: Female and Male.
2. **What is your age?** Available options: 18 to 25 years; 26 to 35 years; 36 to 45 years; 46 to 55 years; 56 to 65 years; Over 65 years.
3. **What are your qualifications?** Available options: 4th grade; 6th grade; 9th grade; 12th grade; Bachelor's degree; Master's degree; Doctorate; Other.
4. **How many years ago did your school education end? (If you have more than one degree please consider the most recent one.)** Available options: Up to 2 years; 3 to 5 years; 6 to 10 years; More than 10 years.

5. **Did you do other complementary training?** Available options: Yes; No.
6. **If you answered "Yes" to the previous question, please indicate when the most recent one ended.** Available options: Up to 2 years; 3 to 5 years; 6 to 10 years; More than 10 years.
7. **For how many years have you been working?** Available options: Up to 2 years; 3 to 5 years; 6 to 10 years; More than 10 years.
8. **What age group is your oldest child in?** Available options: I don't have kids; 0-10 years; 11-20 years; More than 20 years.
9. **If you have more than one child, your youngest child is in what age range?** Available options: 0-10 years; 11-20 years; More than 20 years.

All 9 questions were required, except for number 9 (*"If you have more than one child, your youngest child is in what age range?"*). Furthermore, it was chosen for all these questions the Multiple Choice type (i.e. multiple choice question with the selection of only 1 answer). This choice was intended to standardize the data. In this way we were able to simplify its interpretation as well as to facilitate the subsequent processing of the data. This is due to the fact that the answers are divided into categories previously thought and defined according to what we want to evaluate. That is, for these questions it is more important to analyze the answers by categories than each entry, one by one.

With these demographic questions, we aimed at understanding the context of each participant, particularly as a student. In this way, we asked not only what the qualifications of each participant were, but also how long ago that education ended (or if he or she had done a more recent complementary training, how long ago that training ended). This allows us to know how long it has been since the adult was exposed to a teaching experience as a student (i.e. formal education, in a classroom), to later analyze the impact of this factor on the answers collected.

Still within the same topic, we also asked if the participant has children and if so, what is the age of the youngest and the oldest. This question aims to understand what impact school-age children have on their parents as Adult Students. This doubt arose from the fact that parents with young children are exposed second-hand to teaching experiences through their children. Parents often help their children with their homework, have meetings with teachers, and ultimately end up learning through this proximity and exposure to the regular teaching method. In addition, they are constantly exposed to new ideas and challenges through their children. In short, we want to understand the impact that close interaction with regular school students has on the Adult Learner.

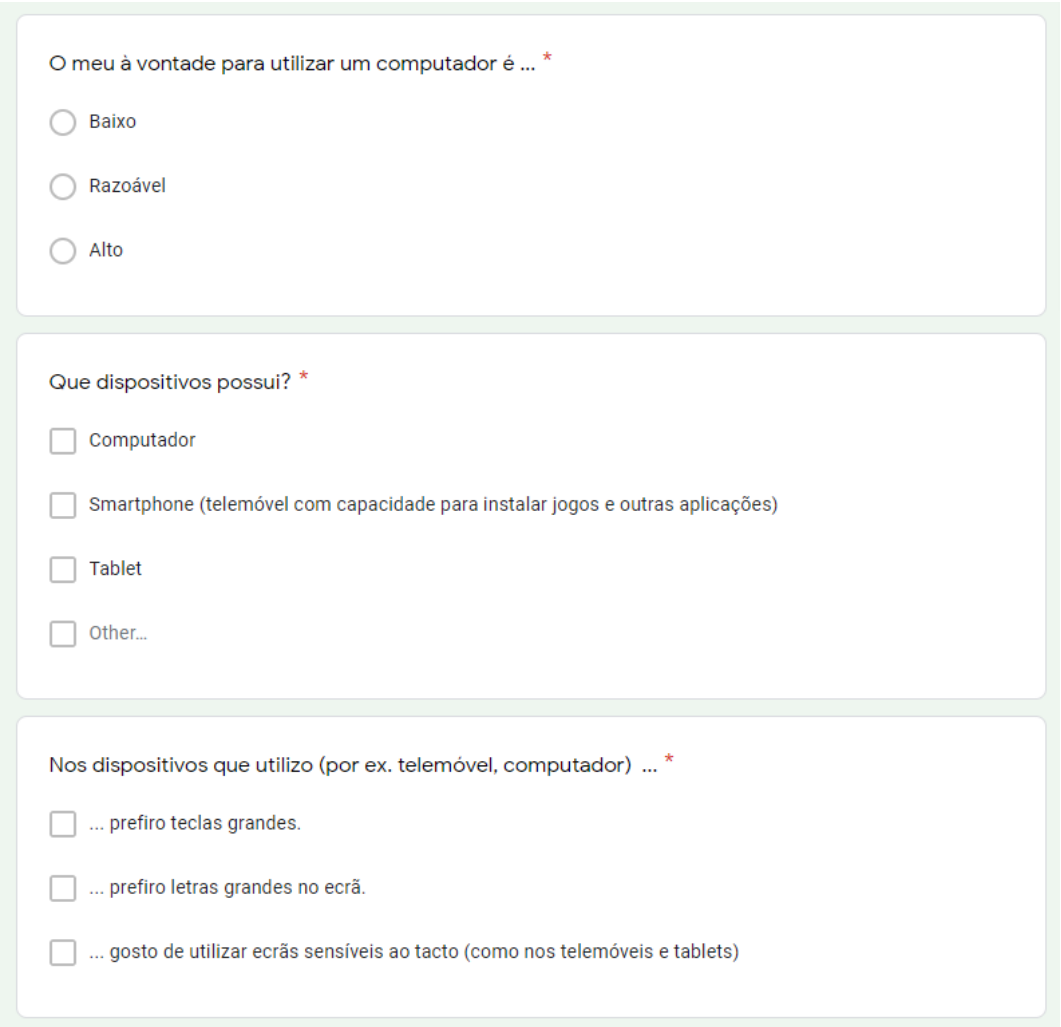

Figure 28: Excerpt from the first section of the "OntoAL e o Estudante Adulto" questionnaire.

Figure 28 serves as an illustrative example of the questionnaire, and depicts the three questions of the first section that relate to technology. Specifically, we inquired about computer proficiency, which technological devices the respondent owns (e.g. computer, smartphone) and preferences regarding the use of those same devices (e.g. prefer large keys, touch screens).This information is relevant to contextualize the answers in the following sections and to make the connection between the at ease with technology and the motivation to engage in virtual learning resources.

Finally, the last five questions of the first section were derived from the OntoAL ontology part concerning Adult Learning theory. The first question requests to choose between two types of knowledge. In each of the remaining four we present a statement and the participant selects the *"Disagree"* option or the *"Agree"* option, as he or she sees fit.

The questions are the following:

1. **Which knowledge do you value the most?** Available options: Practical; Theoretical.

2. **I like to have control in my learning experiences. That is, I value a relationship of peers with my teachers, as well as assisting in making decisions about what and how I will learn.** Available options: I Agree; I Disagree.

3. **I value learning information related to my professional needs, that improves my skills and facilitates my work, rather than theoretical information, more general, or about other areas.** Available options: I Agree; I Disagree.

4. **I prefer my learning experiences to be conducted in the way that I consider more appropriate, rather than a new way, which the teacher considers more appropriate.** Available options: I Agree; I Disagree.

5. **In a classroom context, the knowledge/experience I have acquired over the years is relevant and useful to help me learn.** Available options: I Agree; I Disagree.

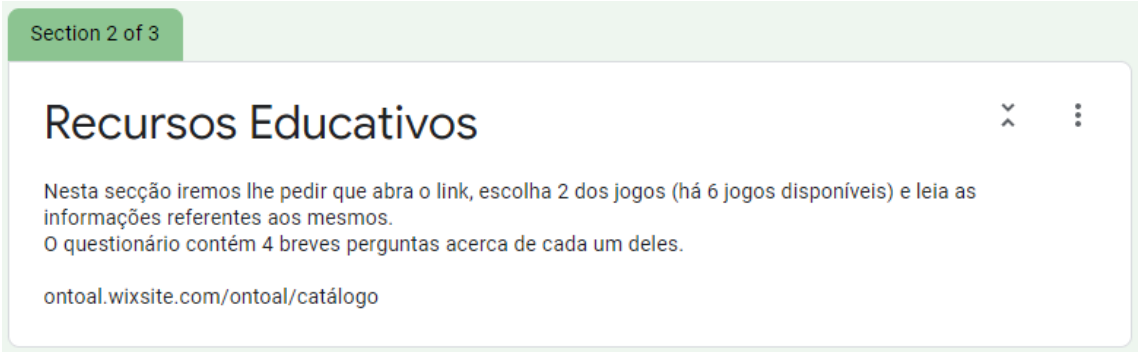

Figure 29: Header of the 2nd section of the "OntoAL e o Estudante Adulto" questionnaire.

Section 2 entitled "Educational Resources" is about the games available in the catalog. First, in the header (see in Figure 29), we start with an introduction by sharing the link to the Games Catalog and requesting the respondent to analyze it and choose two games to answer the questions below.

For each game, firstly it is requested to specify which one was chosen. This is followed by four brief questions regarding the game:

1. **Please select the options that represent what you did NOT like in the game. (If you liked everything please leave it blank).** Available options: Background music; game colors; icons/designs.

2. **Please indicate if this game would motivate you as a learning tool.** Available options: A lot; A little; Not at all.

3. **Please indicate what you least liked about the game.** Long answer text.

4. **Please indicate what you liked the most in the game.** Long answer text.

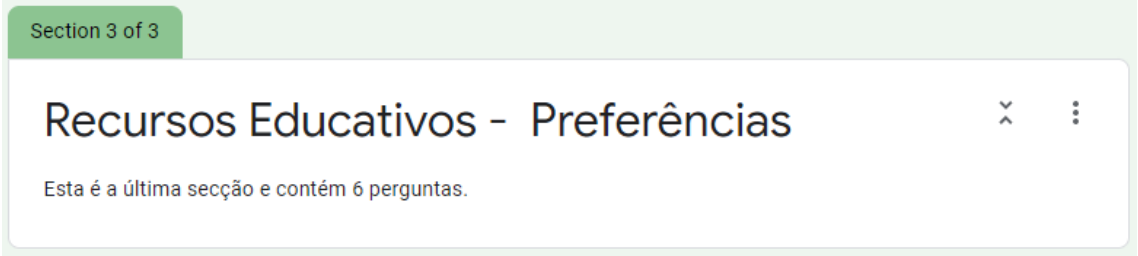

Figure 30: Header of the 3rd section of the "OntoAL e o Estudante Adulto" questionnaire.

Figure 30 illustrates the header of Section 3 ("Educational Resources - Preferences"), which contains only the number of questions in this section.

We considered it unnecessary to add more information to the header taking into consideration the questions in this section, and found it important to disclose the number of questions left (just as had given similar indications in the other headers) to improve the user experience. Questionnaires are usually tiring for the respondent and we believe that disclosing the number of questions that are missing can give a motivation boost and improve the participant's focus and as a consequence the accuracy of their answers.

The questions in this section are the following:

1. **Please select the types of games you like the most. "I prefer ..."** Available options: individual games; group games; games with winners/losers; easy-to-play games; difficult to learn how to play games; digital games (to play on a computer, smartphone,...); games with a time limit; games related to my profession; games whose success depends on luck.
2. **I prefer background music more...** Available options: Lively; Calm; No background music.
3. **In games, I prefer colors more...** Available options: Lively; Sober.
4. **The icons/designs in the most appropriate/appealing games are ...** Available options:Large; Small; Round; Straight lines. [Select all that apply]
5. **I feel comfortable/interested/open to play games for children.** Available options: Yes; No.
6. **Please select the types of games you LIKE the most.** Available options: Paper and Pen; Cards; Dice; Board Games; Puzzles; Educational Games; Adventure Games; Action Games; Strategy Games.

5.1.4 *Results*

In this questionnaire we approached several classes of adult students since they are the public of interest of this project, and we obtained answers from both students and adult educators. However, we did not restrict ourselves to these, since we opened the questionnaire to all adults. In short, for this questionnaire we have obtained **40 answers**.

Since we use the Google Forms tool we have 4 possible ways to review the results. Namely, we can see a summary of the answers, view the answers grouped by questions or by respondent and finally we can view them in an Excel format file (as illustrated in Figure 31).

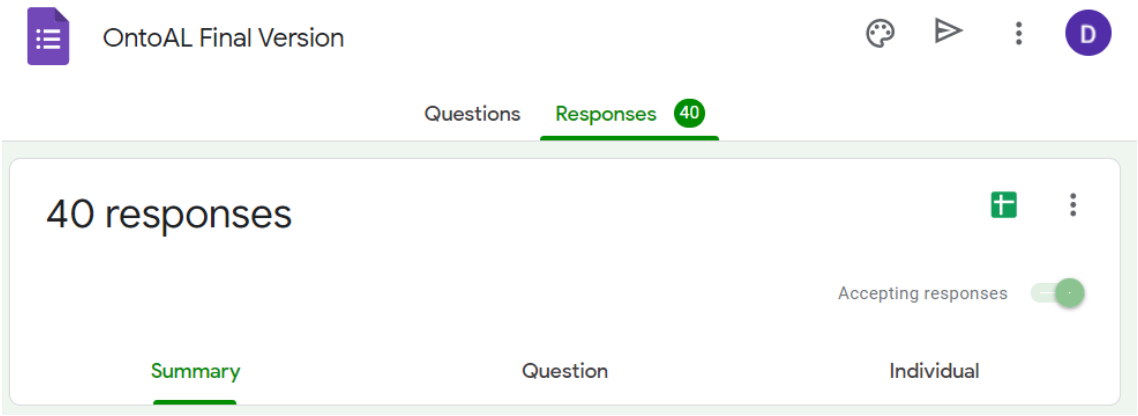

Figure 31: Header of the "OntoAL e o Estudante Adulto" questionnaire Responses page.

Let us now focus on the achieved results. Regarding the demographic data we obtained a rather heterogeneous sample with adults with several different levels of education, age ranges, family and professional backgrounds and computer proficiency levels. This is very advantageous to validate the results since they take into consideration a wide spectrum of diverse contexts (of the respondants).

Additionally, it also allows us to group users by categories and analyze the responses of the various groups. That is, we can for example analyze the answers to a given question by comparing the answers of adults with children with the answers of adults without children. The fact that we have a large heterogeneity of adults allows us to make more and better comparisons.

Figure 32 shows the results of some of the questions we mentioned that demonstrate the variety of respondents. The complete list of the results is available in Appendix B.2.1.

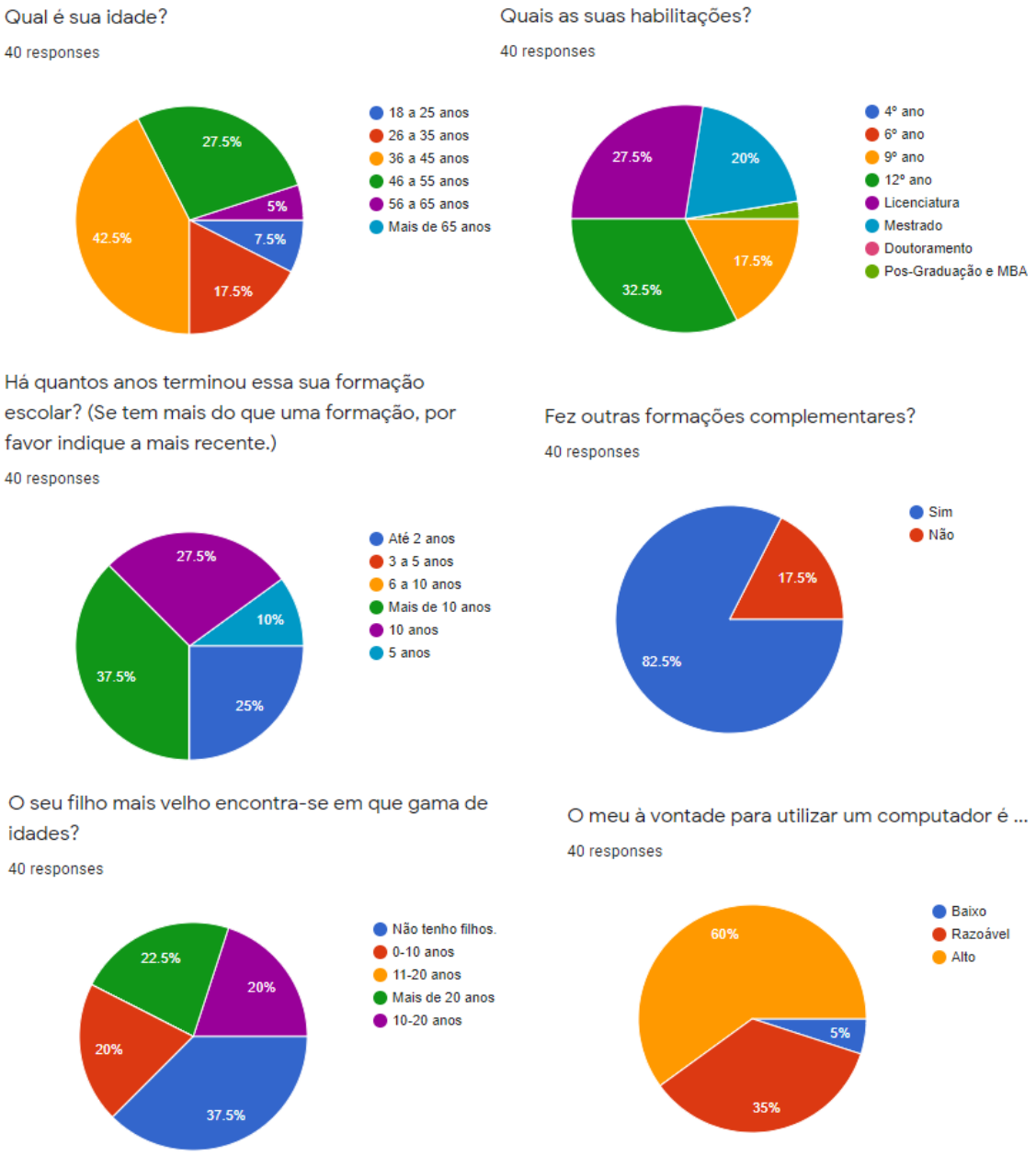

Figure 32: Summary of the answers to six demographic questions of the "OntoAL e o Estudante Adulto" questionnaire.

Regarding the questions elaborated from the theoretical knowledge of Adult Learning presented on OntoAL, the results that we obtained allow us to validate 4 of the 5 statements (see Figure 33). In fact, for the 4 favorable answers we obtained results above 80% (two of them around 90% and one 100%).

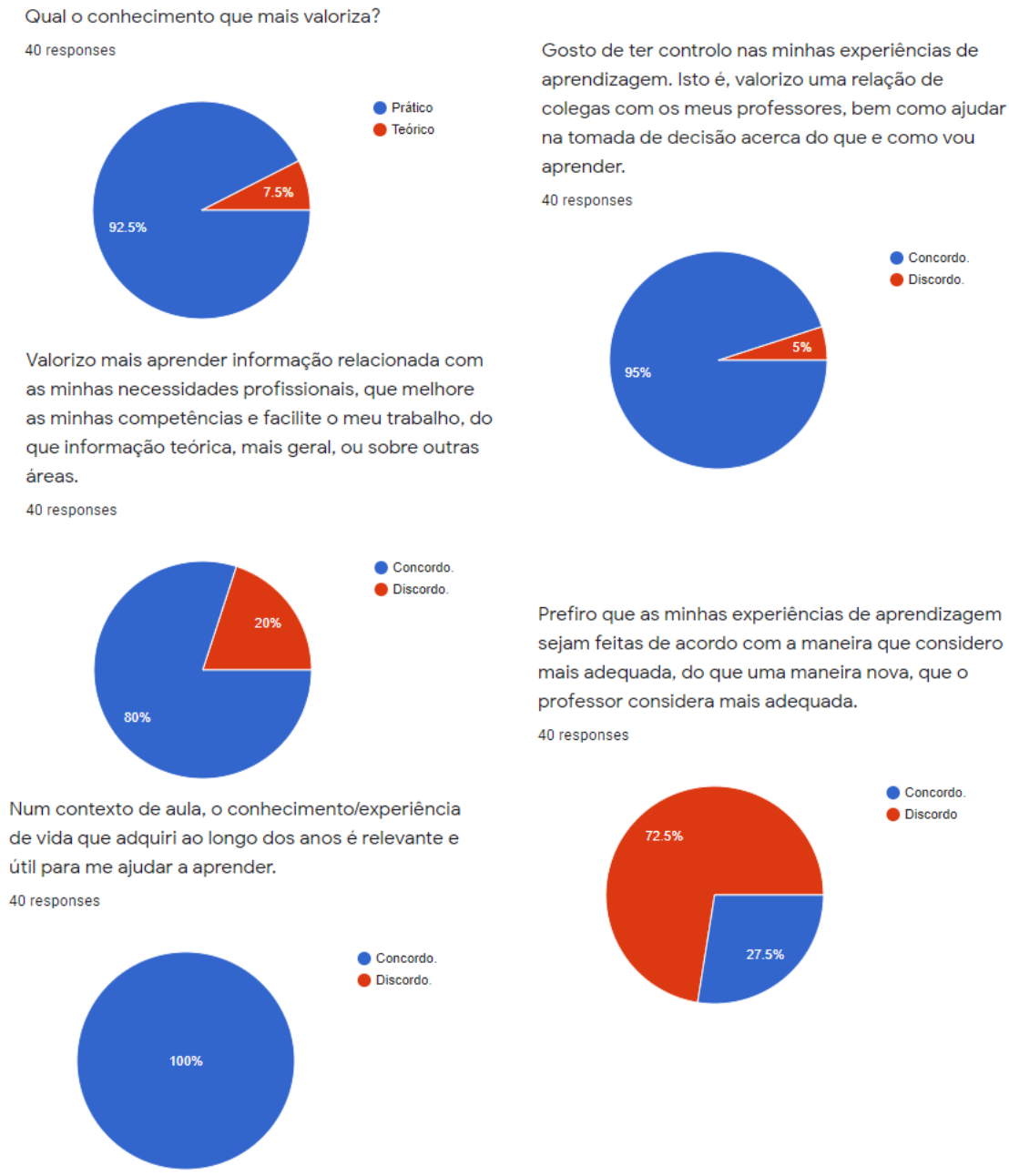

Figure 33: Summary of the answers pertaining to the OntoAL theory questions of the "OntoAL e o Estudante Adulto" questionnaire.

As for the questions in section two (opinion about games) we obtained many different answers. We can emphasize that the answers concerning what the adult liked better on the game was the pleasure derived from the game being challenging and stimulating; and the most disliked characteristic was the graphics of the game (perceived as a childish appearance).

It is also important to mention that the most chosen games were 4 in a Line (chosen 22 times), followed by Sudoku (selected 14 times) and, in third place we have a tie with 11 votes Chess and Code Monsters.

Whats most interesting about these results is that on the first selection the top 3 games were Sudoku, Chess and 4 in Line which are the most well known games to the audience. However, on the second selection, the second and third most selected games were Code Monsters and Cargo Bot. We can therefore infer that the first instinct of most adult learners is to choose the games that they already know and that once they feel comfortable they are more open to new experiences and resources.

On the other hand, on both rounds the most selected game was 4 in Line, which was also the game that received the most negative reviews for its presentation (perceived to have a childish game interface).

Lastly, in section 3 (see Figure 34) of the questionnaire that concerns the adult preferences regarding learning resources we were able to identify the preferred Game Genres; to conclude that most adults (more that 80%) feel comfortable/interest/open playing games initially intended for children; and that the opinions are very divided when it comes to preferences on background music and colors of the games.

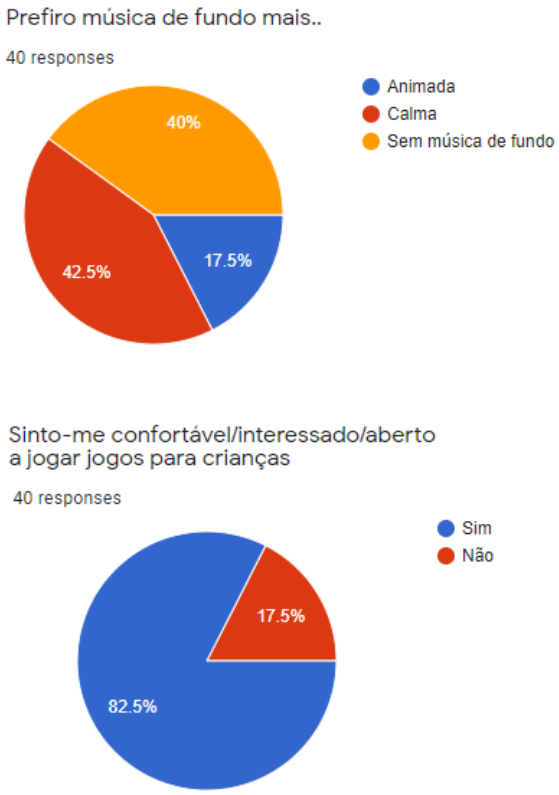

Figure 34: Summary of the answers of two questions from the 3rd section of the "OntoAL e o Estudante Adulto" questionnaire.

5.1.5 *Lessons Learned from the 1st Stage*

During the process of analyzing the results and after thoroughly reassessing the questionnaire, we came to the conclusion that there is room for improvement on a few aspects.

The first improvement is the first question of Section 3. In this question we ask the respondent to select the types of games he likes the most given a list with several categories. It is therefore a question of the type Select All That Apply, in this case to the statement *"I prefer..."*.

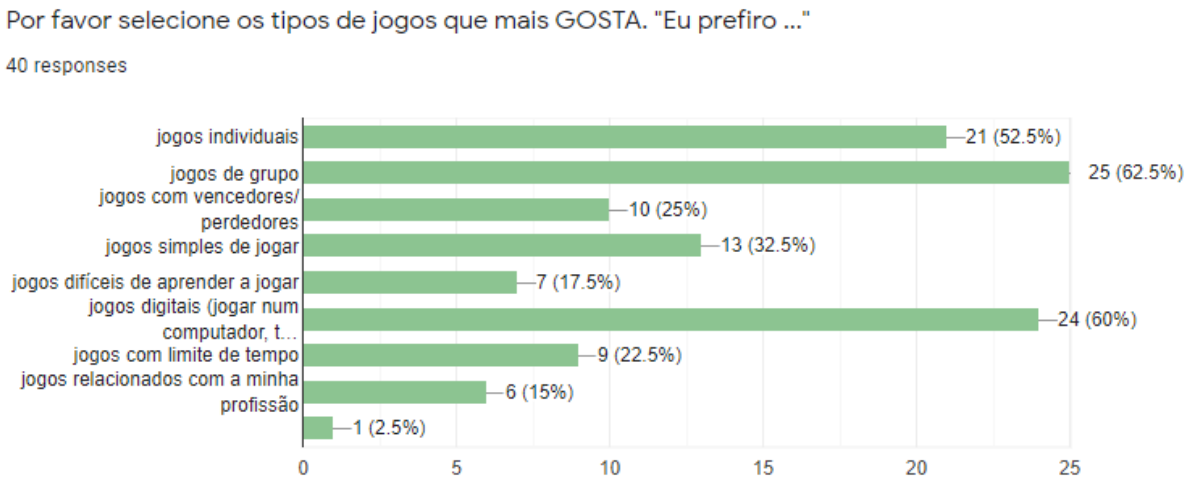

Figure 35: Summary of the *I prefer...* question from section 3 of the questionnaire.

The 9 options in the list are the following:

I PREFER... individual games; group games; games with winners/losers; easy-to-play games; difficult to learn how to play games; digital games (to play on a computer, smartphone,...); games with a time limit; games related to my profession; games whose success depends on luck.

What led us to suspect that this question might not have been interpreted in the intended way was the fact that some participants selected only one option out of the 9, as well as several who selected only two or three.

Thus, after re-analyzing the question we realize that it can become ambiguous for the following reason: a participant can interpret that the question asks to select only the types of games he or she likes the most in the sense of referring to the two or three that stand out the most from the list. On the other hand, not selecting an answer (e.g. time-limited games) may mean either that the participant likes games with or without that feature, being indifferent to it, or it may mean that the participant has not selected it because he or she doesn't like them.

The second question that we think deserves to be rewritten, also belongs to the third section, and refers to the adult's opinion about playing children's games.

The following is the transcript of the question:

I FEEL COMFORTABLE/INTERESTED/OPEN TO PLAY GAMES FOR CHILDREN. yes; no.

As can be verified there are three adjectives in the sentence, namely, comfortable, interested and open. One point of improvement in this case would be to divide this sentence into three, one for each adjective, and gather the adult's opinion for each of the three resulting statements.

Finally, the third improvement concerns the following question (Figure 36 shows the answers collected):

THE ICONS/DESIGNS IN THE MOST APPROPRIATE/APPEALING GAMES ARE... Large; Small; Round; Straight lines. [Select all that apply]

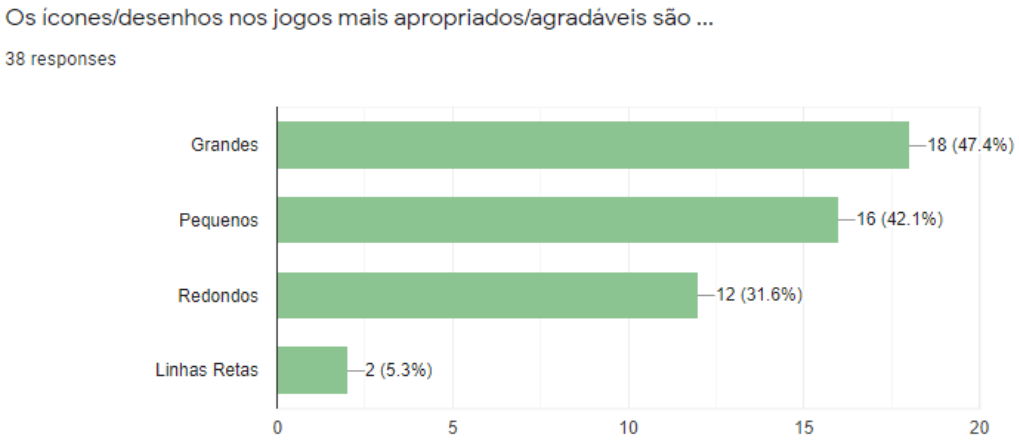

Figure 36: Summary of the icons and shapes question from section 3 of the questionnaire.

As for this question we consider that providing in the questionnaire a support image to help contextualize the question would be extremely advantageous and would improve the validity of the answers.

5.2 2nd Stage with Adults

This second questionnaire was intended for adult participants and aims to fill in some gaps that resulted from the original questionnaire.

As we detailed in Section 5.1.5, after analyzing the results we realized that certain questions could be improved. Thus, after a thorough examination of the original questionnaire, the results obtained and the possible improvements, we developed a new version.

The questionnaire is available for consultation in the Appendix B.3.

5.2.1 *Questionnaire*

We will now proceed to the analysis of the questionnaire from the second stage of the experiment (see Figure 37).

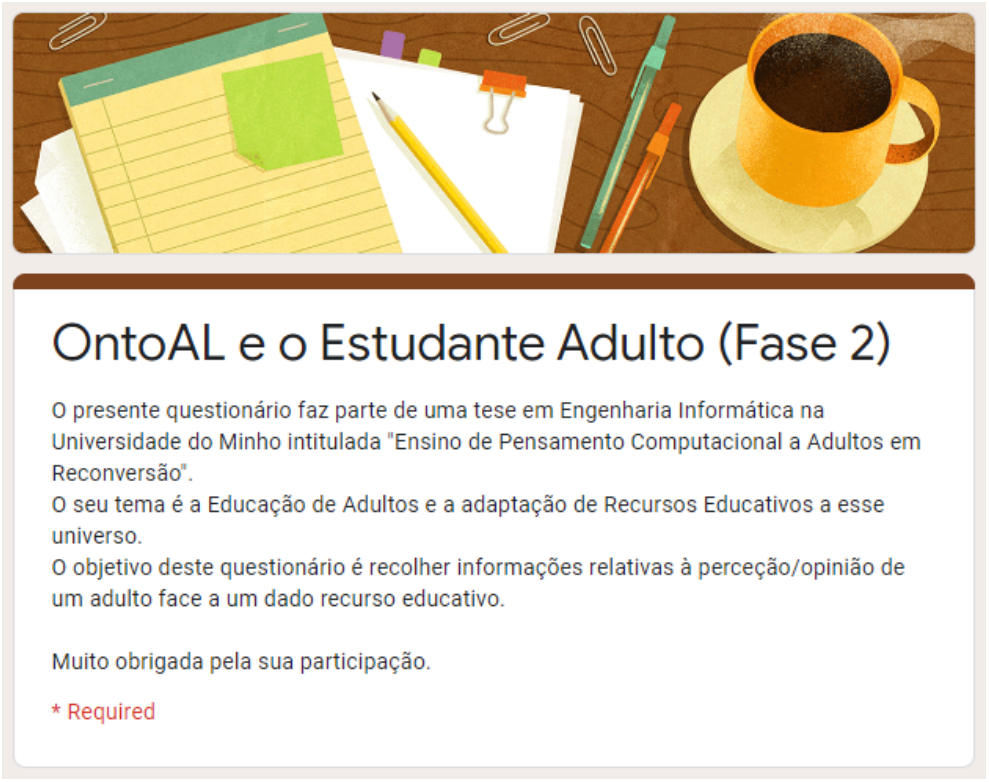

Figure 37: Header of the 1st section of the "OntoAL e o Estudante Adulto (Fase 2)" questionnaire.

This enhanced version is divided into two sections. The first section contains 12 questions, with the first 9 being of a demographic nature and the next 2 being related to the use of technology. The last question in this section is duplicated from the original questionnaire and we have chosen to include it in this one due to the unexpected results obtained (in order to get more answers and confer more validity to the result).

The questions in this first section are the following:

1. **What is your gender?** Available options: Female and Male.
2. **What is your age?** Available options: 18 to 25 years; 26 to 35 years; 36 to 45 years; 46 to 55 years; 56 to 65 years; Over 65 years.
3. **What are your qualifications?** Available options: 4th grade; 6th grade; 9th grade; 12th grade; Bachelor's degree; Master's degree; Doctorate; Other.
4. **How many years ago did your school education end? (If you have more than one degree please consider the most recent one.)** Available options: Up to 2 years; 3 to 5 years; 6 to 10 years; More than 10 years.
5. **Did you do other complementary training?** Available options: Yes; No.
6. **If you answered "Yes" to the previous question, please indicate when the most recent one ended.** Available options: Up to 2 years; 3 to 5 years; 6 to 10 years; More than 10 years.

7. **For how many years have you been working?** Available options: Up to 2 years; 3 to 5 years; 6 to 10 years; More than 10 years.
8. **What age group is your oldest child in?** Available options: I don't have kids; 0-10 years; 11-20 years; More than 20 years.
9. **If you have more than one child, your youngest child is in what age range?** Available options: 0-10 years; 11-20 years; More than 20 years.
10. **My ease in using a computer is ...** Available options: Low; High; Reasonable.
11. **What devices do you own?** Available options: Computer; Smartphone; Table; Other:___ .
12. **I prefer my learning experiences to be conducted in the way that I consider more appropriate, rather than a new way, which the teacher considers more appropriate.** Available options: I Agree; I Disagree.

The second (and last) section of this questionnaire, entitled "Learning Resources - Preferences" contains 10 questions. The first seven were derived from question 1 of the third section of the original questionnaire. On that question, the respondent was asked to select the types of games he likes the most given several options (e.g. individual games, group games, games with winners/losers, easy-to-play games, ...).

Let us recall the question:

PLEASE SELECT THE TYPES OF GAMES YOU LIKE THE MOST. "I PREFER ..." Available options: individual games; group games; games with winners/losers; easy-to-play games; difficult to learn how to play games; digital games (to play on a computer, smartphone,...); games with a time limit; games related to my profession; games whose success depends on luck.

As explained in Section 5.1.5 this question could be ambiguous. Did the participants select only two or three options that stood out to them because they liked these much more than the other options on the list? Could it be that, for example, a participant who did not select the option "games with a time limit" it was because he does not like this type of games, because he is indifferent to the presence/absence of this limitation, or because there are other game options in the list that he preferred more?

To solve this problem, we have broken the question into several so that we can make a direct comparison for each case. The questions that were derived from question 1 were the following:

1. **I prefer...** Available options: Individual Games; Group Games; I have no preference.
2. **I prefer...** Available options: Games with winners/losers; Games without winners/losers; I have no preference.
3. **I prefer...** Available options: Easy-to-play games; Difficult-to-play games; I have no preference.
4. **I prefer...** Available options: Easy to learn how to lay games; Difficult to learn how to play games; I have no preference.

5. **I prefer...** Available options: Digital games (to play on a computer, smartphone,...); Games that are not digital; I have no preference.
6. **I prefer...** Available options: Games with a time limit; Games without a time limit; I have no preference.
7. **What is your opinion about games related to your profession? (A game in which you can apply/demonstrate knowledge you have acquired through your profession).** Available options: I like them; I don't like them; I neither like nor dislike them.

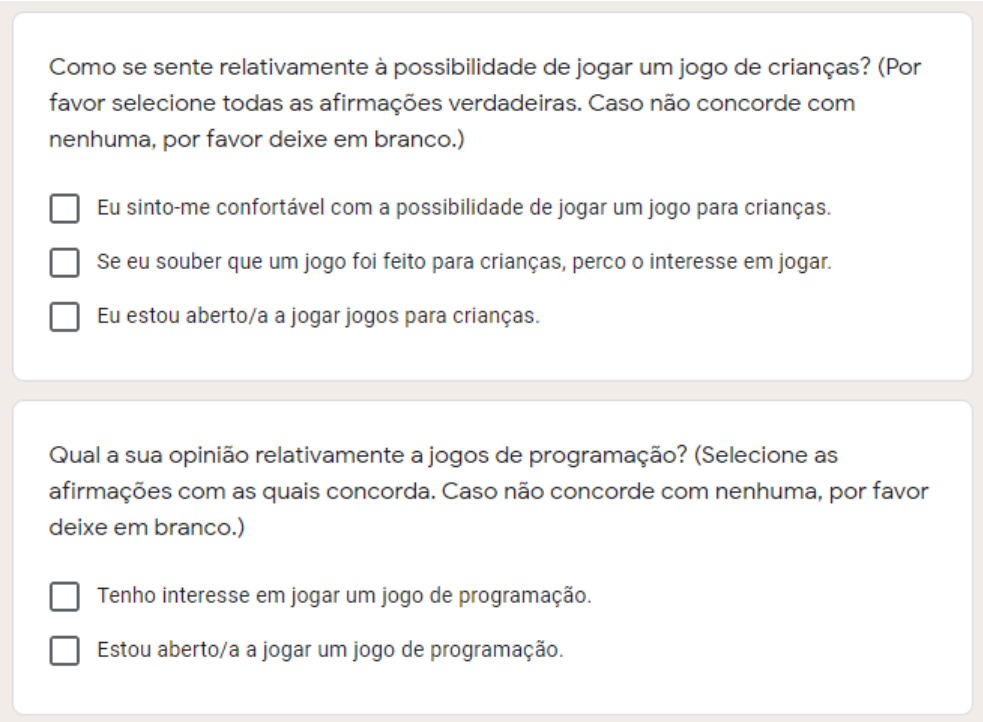

Figure 38: Excerpt of the "OntoAL e o Estudante Adulto (Fase 2)" questionnaire.

The following two questions have a different format than the previous ones. Specifically, they allow the selection of any number of answers (e.g. one answer, all, none, ...), so that the participant can select all that he agrees with.

Their goal is to understand in a more concrete way the participant's opinion with each answer containing a different adjective and intention. For example, for the previously ambiguous question regarding the participant's opinion on playing children's games (that asked if the participant was interested/comfortable/open to play) we split the answers into 3 options, one for each of these adjectives. The three resulting statements were:
I feel comfortable with the possibility of playing a game for children.
If I discover that a game was made for children, I lose interest in playing.
I am open to playing games for children.

The second question in the image 38 is about programming games. In it we ask if the participant is open and/or interested in playing programming games, in two separate statements.

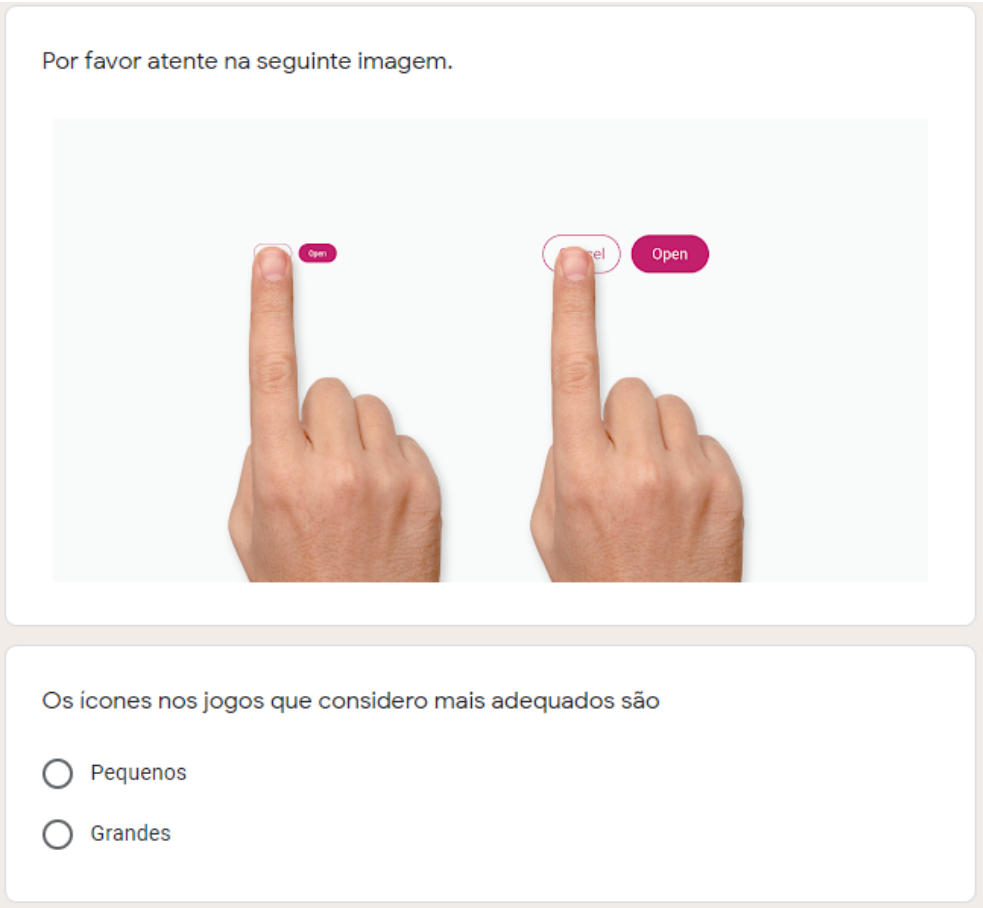

Figure 39: Excerpt of the "OntoAL e o Estudante Adulto (Fase 2)" questionnaire (questions 8 and 9).

Finally, the last question in the questionnaire, illustrated in Figure 39 allowed us to give context to a question that had already been asked and that made us understand (through the analysis of the responses) that it might not have been interpreted in the way we intended through. Thus, we added an illustrative image to provide support to the question.

5.2.2 *Results*

For this improved questionnaire we were able to gather 9 participants and to maintain the heterogeneity among them, as we did before on the original questionnaire.

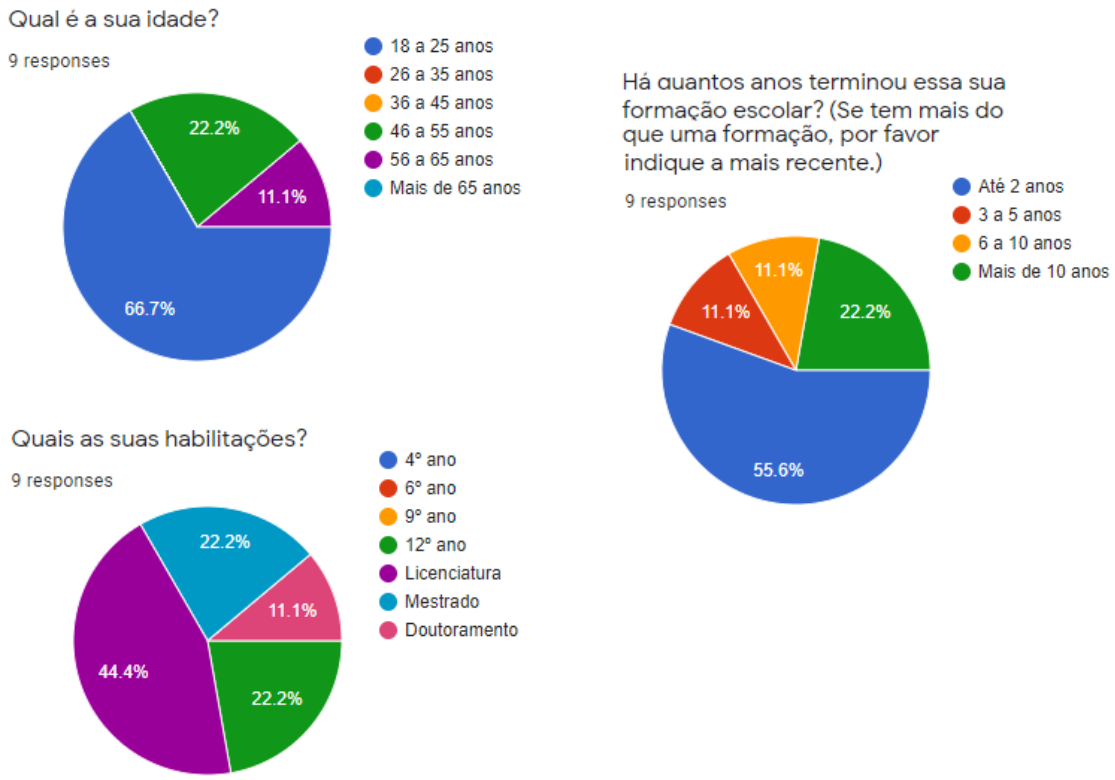

Figure 40: Summary of two answers from the "OntoAL e o Estudante Adulto (Fase 2)" questionnaire.

Furthermore, we managed to capture very significant information to address the concerns set out in Section 5.1.5, as shown in the graphics of Figure 40.

First of all, we corroborated the answer (majority "I Disagree") in the question *"I prefer my learning experiences to be done in the way I consider most appropriate, rather than in a new way, which the teacher considers most appropriate"*. However, although the results remain (majority of I Disagree), the figures have dropped from 72.5 percent to 55.6 percent. It would be interesting to carry out a study in order to discover the cause of this variation. It should be kept in mind, however, that the population of this study is much smaller than that of the original study and the values of 55.6 percent translate only to a difference in a unit of participants (i.e. it corresponds to 5 participants and the opposing option I Agree corresponds to 4 participants). Thus, for a better understanding of the results, the best course of action would be to add the results of this question from both questionnaires (i.e. add the Disagree/Agree votes in each questionnaire and analyze the values as a whole).

Secondly, due to the restructuring of the first question of section 3 of the original questionnaire (*"I prefer..."*) we were able to obtain much more elucidative results for these topics, i.e. for each parameter to understand what the adults' preference is or whether they are indifferent to the choice. We would like to highlight the answer to the question *"What is your opinion about games related to your profession? (A game in which you can apply/demonstrate knowledge you have acquired through your profession)."* which obtained an impressive result of 100 percent of Gosto,

thus validating in a solid way this parameter of the Descriptive List of Parameters of Learning Resources.

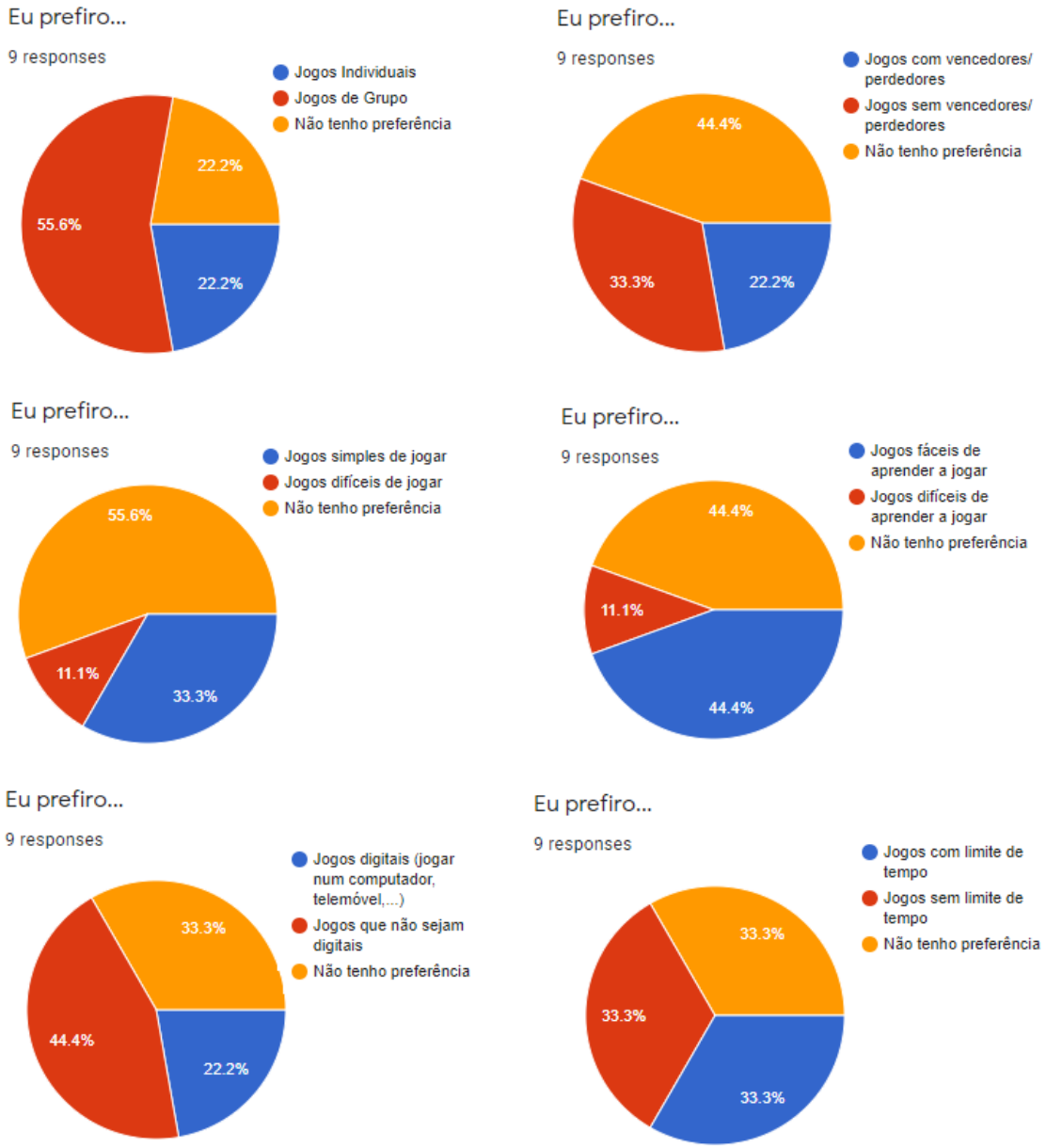

Figure 41: Summary of six answers from the "OntoAL e o Estudante Adulto (Fase 2)" questionnaire.

On the other hand, we also managed to obtain unambiguous results on the issue of adult opinion regarding games for children; and we obtained information regarding the adult opinion regarding programming games (pertinent to computer thought learning resources). The results obtained were very positive and no participant said they lose interest in games if they know they

were made for children; as well as all users said they were open to playing programming games. These results are apparent in the charts in Figure 41.

5.3 2ND STAGE WITH CHILDREN

Lastly, we thought it would be advantageous to create a questionnaire aimed at children to inquire about their preferences regarding the selection of games in the catalog. That is, to compare their opinions about the games available in the Catalog of Games with the answers obtained in Section 2 of the questionnaire "OntoAL and the Adult Student" (directed to adults), and to do an analysis of the results obtained.

This questionnaire is aimed at children up to the age of 14 and can be filled, when necessary, with the help of parents or other adults.

5.3.1 *Questionnaire*

This questionnaire is the shortest of the three surveys (see Figure 42).

Figure 42: Header of the 1st section of the "OntoAL e o Estudante Jovem" questionnaire.

It comprises two sections, the first of which contains only three questions: what is the child's gender, what is his or her age range, and what devices he or she has.

1. **What is the child's gender?** Available options: Male; Female.
2. **What is their age range?** Available options: 0-5 years; 6-10 years; 11- 14 years.
3. **Devices they usually use:** Available options: Computer; Tablet; Smartphone; Smart TV; Other: ___.

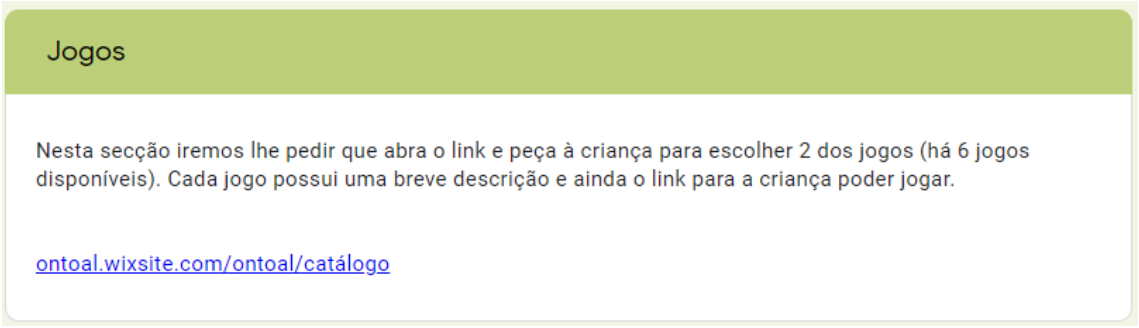

Figure 43: Header of the 2nd section of the "OntoAL e o Estudante Jovem" questionnaire.

The second section of this form is quite similar to the second section of the original questionnaire. The child is asked to choose two games, and for each one there are two questions (see Figure 43):

1. **Please select the options of what you did NOT like in the game. (If you liked everything, leave it blank)** Available options: Background Music; Colors of the game; Icons/drawings.
2. **Why did you choose this game? What is your opinion about the game?** Long answer text.

5.3.2 *Results*

In this last questionnaire we interviewed 4 children, aged between 6 and 14 years old. This was undoubtedly the most difficult process to obtain answers due to the fact that it is more difficult to get children to stay focused on the questionnaire for as long as necessary to complete it. Due to this reason we have five game evaluations, since only one of the children evaluated two games. Still, this questionnaire has allowed us to make a comparison about the choice of educational resources of the children with that of the adults. Now proceeding to the analysis of the results, we have a tie in the most chosen games: 4 in Line and Cargo Bot; in second place we have the game Code Monsters. The selection of the game 4 in Line was justified by the fact that they already know the game and know that they like it. On the other hand, the reason for choosing Cargo Bot was mostly due to its visual appeal, both in terms of colors as well as looking interesting and fun.

It is important to mention that the game selected more often in first place was the 4 in Line, either by adults or children, although it is at the bottom of the list of the Games Catalog. The difference between the two was that the children found the game visual eye-catching while the adults found it childish.

For further information, we provide the graphs with the results in Appendix B.4.

5.4 SUMMARY

In this chapter we analyzed the whole process of the Adequacy Analysis with OntoAL experiment. Specifically, the catalog of games suitable for teaching Computational Thinking, the 3 questionnaires that were developed as well as their results and conclusions we drawn, and the methods of obtaining responses and making the materials readily available to the participants.

Through this experiment it was possible to both validate this approach to Adequacy Analysis in adults as well as validate the OntoAL ontology and the knowledge it encompasses.

6

CONCLUSION

In this Master's thesis in Computer Engineering entitled "Adequacy Analysis of Learning Resources in Adult Education" we intend to contribute to providing an answer to the question "How can we ensure that the Learning Resources used to teach Computational Thinking to adults are as suitable to the learner as they can possibly be?".

For this purpose we studied the Adult Learning domain, namely the adult learning process and how it compares with that of children (very important since most of the learning resources of Computational Thinking are developed for young learners); we also studied Game-Based Learning and its classification systems; and, equally important, we analyzed several materials developed under the scope of the CnE project (Portuguese branch of Computing at School) in which this project is inserted, concretely, the ontology describing the Computational Thinking domain and how it relates with the Teaching of CT: OntoCnE.

The main outcomes of this Master's work are:

- An approach to Learning Resource Adequacy in Adult Education that comprises the OntoAL ontology that describes the domain of Adult Learning, including the pillars of this project (Computational Thinking and Learning Resources); this ontology is detailed using OntoDL.
- Secondly, a Descriptive Parameter List of Learning Resources has also resulted, which allows describing and classifying games and other LRs in the most appropriate way to do the Adequacy Analysis between LR and Adult.
- We also converted the whole ontology to Prolog as we consider it to be the best format to develop formulas and an Adequacy Analysis (AA) system in the future. In fact, we have already started the process by creating the Influence concept, which classifies each parameter of the list regarding its weight/importance in AA formulas.

Finally, we validated the materials that were produced through a survey involving about 50 adult participants (several of whom are currently students in formal education), 4 children participants, 3 versions of the Questionnaires developed for the gathering and writing of data, and a *website* to make the forms available and to provide a Catalog of Games to support the questionnaires.

Additionally, two scientific papers resulted from this thesis:

- *Improving Game Based Learning Through Game Appropriation* (Teixeira et al., 2020a) presented at ICPEC2020 - 1st International Computer Programming Education Conference;

- *Using Ontologies to plan Computer Programming courses for different levels* (Araújo et al., 2020) presented at MOVE2020 - Measuring Ontologies in Value Seeking Environments.

These scientific papers contribute to validate the work developed, both at the level of the construction of the OntoAL ontology and at the level of knowledge described therein (Adult Learning, Game-Based Learning in Adults, Computational Thinking and Learning Resources).

Still regarding the dissemination and sharing of knowledge related to this Master's Thesis, we gave several seminar classes at different stages of the project. In these, we presented the work developed so far as well as a more general perspective of the dissertation including the Proposal and the next steps. In addition to this we also conducted activities with the students. These seminar classes were given to students of the Master's in Computer Science Education, which includes Adult Learners and several Adult Educators as well. This was very beneficial in that we were able to gain perspectives and information relevant to the project through the exercises and talks with the students, whose experience and demographics make their input even more valuable.

Finally, in terms of future work, it is important to build on the application in Prolog, creating a complete system that analyzes a specific Learner and a Learning Resource and automatically returns a prediction of the Adequacy level based on inference formulas. To this end, it is essential to apply and evaluate this proposal in the field and to make further evaluations. That is, to do more experiments with more Adult Learners, in different contexts and with more educational resources, so that we can finalize the system with the most solid knowledge base possible.

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A

ONTOAL IN PROLOG

This chapter contains the full Prolog program version of the OntoAL ontology.

```
% ---------------- ONTOLOGIA OntoAL ------------------

:- discontiguous conceito/1.
:- discontiguous isa/2.
:- discontiguous individuo/1.
:- discontiguous atributos/2.
:- discontiguous propriedades/2.
:- discontiguous iof/2.
:- discontiguous is/2.
:- discontiguous values/2.


conceito(adult_Learner).
atributos(adult_Learner,[name:string, gender:string, birth_year:int, year_left_school:int, has_children:
     int, years_of_work:int, literacy_level:int, computer_proficiency_level:int]).

relacao(uses).
conceito(learning_Resource).
atributos(learning_Resource,[name:string, number_participants:int, literacy_level:int,
computer_proficiency:int, subject_matter_integration:int, learning_focused:int,
conflit_problem:int, teamwork:int, time_limit:int, rigid_rules:int, background_music:int,
bright_colors:int, icons_shapes:int, has_ending:int, work_related:int]).


% audience  (17-25, 25-35, 35-60,60+,all)
%  " levels:  1       2      3    4  5
isa(game,learning_Resource).
atributos(game,[audience:int, winners_loosers:int, strategy_or_luck:int, genre:string, game_mode:string
     ]).


%What is the name of the LR?
influence(name,0).
%What is the number of participants?
influence(number_of_participants,0).
%Does the LR require a medium (1) or a high (2) level of literacy?
influence(required_level_of_literacy,2).
%Does the LR require a medium (1) or a high (2) level of computer proficiency?
influence(required_level_of_computer_proficiency,2).
%Is it necessary to master the subject to succeed in the LR/game?
```

```
%(0)no (1)a little (2)a lot
influence(subject_matter_integration,1).
% Is the majority of the time spent on learning or other activities
%(e.g pushing buttons, walking)?
% (0)not learning focused (1)a little l.f (2)very l.f.
influence(learning_focused,1).
%Is there a conflict/problem to overcome (e.g solving a puzzle)?
influence(conflit_problem,variable).
% Does it require team work?
influence(teamwork,variable).
%Does it have a limit of time to complete tasks or levels?
influence(time_limit,variable).
%Does it have rigid rules to follow?
influence(rigid_rules,2).
%Is the background music adult appropriate?
% (0)childish,annoying
influence(background_music,2).
%Are the collors adult appropriate?
% (0)bright and collorful (2)sober
influence(bright_colors,2).
%Are the icons adult appropriate?
%(0)round and big
influence(icons_shapes,2).
%Does it have an ending?
influence(has_ending,variable).
%is it related to any job?
influence(work_related,1).
%What is the audience?
influence(audience,2).
%Does it end with winners/Loosers?
influence(winners_loosers,0).
%Does success depend on strategy or luck'
influence(strategy_or_luck,2).
%What is the game genre?
influence(genre,0).
%What is the game mode?
influence(game_mode,0).


relacao(iof).

conceito(computational_thinking).
relacao(trains).
trains(adult_Learner,computational_thinking).

relacao(has_attitude).
conceito(attitude).
has_attitude(computational_thinking,attitude).
iof(communicative,attitude).
iof(flexible,attitude).
iof(confident,attitude).

relacao(has_concept).
conceito(concept).
```

```
has_concept(computational_thinking,concept).
iof(patterns,concept).
iof(logic,concept).
iof(algorithms,concept).
iof(decomposition,concept).
iof(evaluation,concept).
iof(programming,concept).
iof(abstraction,concept).

relacao(has_approach).
conceito(approach).
has_approach(computational_thinking,approach).
iof(creating,approach).
iof(persevering,approach).
iof(collaborating,approach).
iof(debugging,approach).
iof(tinkering,approach).

relacao(has_competency)
conceito(competency).
has_competency(adult_Learner,competency).
iof(literacy,competency).
iof(numeracy,competency).
iof(computer_proficiency,competency).

relacao(isa).

relacao(may_have).
conceito(impairment).
conceito(speech_disability).
conceito(visual_disability).
conceito(hearing_impairment).
conceito(cognitive_neurological_disability).
conceito(physical_disability).

isa(speech_disability,impairment).
isa(visual_disability,impairment).
isa(hearing_impairment,impairment).
isa(cognitive_neurological_disability,impairment).
isa(physical_disability,impairment).

iof(motor_disability,physical_disability).
iof(color_blindness,visual_disability).
iof(blindness,visual_disability).
iof(low_vision,visual_disability).
iof(deafness,hearing_impairment).
iof(hard_of_hearing,hearing_impairment).
iof(atention_deficit_disorder,cognitive_neurological_disability).
iof(intelectual_disability,cognitive_neurological_disability).
iof(memory_impairment,cognitive_neurological_disability).
iof(dyscalculia,cognitive_neurological_disability).
iof(dyslexia,cognitive_neurological_disability).

relacao(is).
```

```
conceito(less_open_minded).
conceito(results_oriented).
conceito(self_directed).
is(adult_Learner,less_open_minded).
is(adult_Learner,results_oriented).
is(adult_Learner,self_directed).


relacao(values).
conceito(competency_development).
conceito(life_experience).
conceito(practical_knowledge).
values(adult_Learner,competency_development).
values(adult_Learner,life_experience).
values(adult_Learner,practical_knowledge).
relacao(acquired_through).

conceito(experimental_techniques)
acquired_through(practical_knowledge,experimental_techniques).
iof(simulation_exercises,experimental_techniques).
iof(field_experiences,experimental_techniques).
iof(laboratory_experiments,experimental_techniques).
iof(problem_solving_cases,experimental_techniques).
iof(discussion,experimental_techniques).

relacao(experiences).
conceito(game_based_learning).
experiences(adult_Learner,game_based_learning).

relacao(has_benefit).
conceito(benefit).
has_benefit(game_based_learning,benefit).
iof(motivation,benefit).

relacao(has_difficulty).
conceito(difficulty).
has_difficulty(game_based_learning,difficulty).
iof(adaptation_period,difficulty).
iof(using_devices,difficulty).
iof(accepting_fun,difficulty).
```

Listing A.1: Full Prolog program corresponding to OntoAL ontology.

B

QUESTIONNAIRES

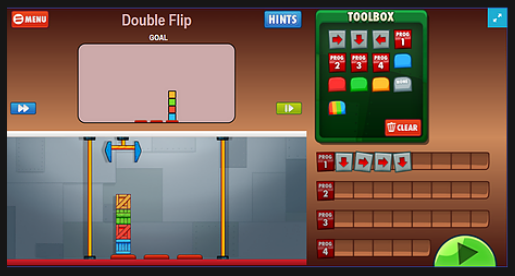
This chapter contains the full versions of the materials used in the experiments, namely the Catalog of Games and the three questionnaires (including their respective results).

B.1 CATALOG OF GAMES

CARGO BOT

Clique aqui para jogar

O Cargo Bot é um jogo que ensina conceitos de programação. O objetivo é programar um guindaste robótico que movimenta caixas, de modo a conseguir recriar o padrão da imagem fornecida.



CODE MONSTERS

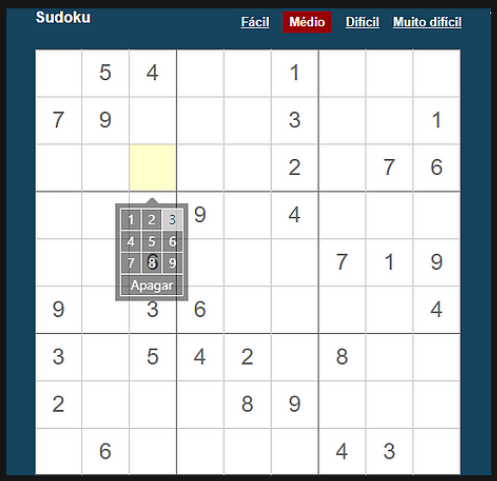
Clique aqui para jogar

O Code Monsters é um jogo que ensina conceitos de programação. Em cada nível, programamos a estratégia de batalha do nosso monstro usando blocos com instruções. O conjunto dos blocos selecionados, forma um programa.

SUDOKU

Clique aqui para jogar

O Sudoku é um jogo de números com uma estrutura de 9x9, isto é, uma grelha que se divide em 9 quadrados, cada um com 9 células. O objetivo do jogo é preencher todas as células com algarismos de 1 a 9, de modo a que não haja algarismos repetidos em nenhuma linha nem em nenhum quadrado da grelha.



DEBUGGER

Clique aqui para jogar

O Debugger é um jogo que ensina conceitos de programação. Desenha o teu próprio herói e em cada nível luta como essa personagem, resolvendo diversos desafios de programação com progressivamente mais recursos e derrotando os Bugs.

4 EM LINHA

Clique aqui para jogar

Cada jogador pode inserir uma das suas peças (uma "moeda") através de uma das ranhuras. O primeiro jogador a conseguir que 4 das suas peças formem uma linha reta, ganha.

B.2 1ST STAGE WITH ADULTS

OntoAL e o Estudante Adulto

O presente questionário faz parte de uma tese em Engenharia Informática na Universidade do Minho intitulada "Ensino de Pensamento Computacional a Adultos em Reconversão".
O seu tema é a Educação de Adultos e a adaptação de Recursos Educativos a esse universo.
O objetivo deste questionário é recolher informações relativas à perceção/opinião de um adulto face a um dado recurso educativo.

Muito obrigada pela sua participação.
O questionário contém 3 secções e demora cerca de 10 minutos a responder.

* Required

Qual é o seu género? *

- ◯ Feminino
- ◯ Masculino

Qual é sua idade? *

- ◯ 18 a 25 anos
- ◯ 26 a 35 anos
- ◯ 36 a 45 anos
- ◯ 46 a 55 anos
- ◯ 56 a 65 anos
- ◯ Mais de 65 anos

Quais as suas habilitações? *

- ◯ 4º ano
- ◯ 6º ano
- ◯ 9º ano
- ◯ 12º ano
- ◯ Licenciatura
- ◯ Mestrado
- ◯ Doutoramento
- ◯ Other: _____

Há quantos anos terminou essa sua formação escolar? (Se tem mais do que uma formação, por favor indique a mais recente.) *

- ◯ Até 2 anos
- ◯ 3 a 5 anos
- ◯ 6 a 10 anos
- ◯ Mais de 10 anos

Fez outras formações complementares? *

- ◯ Sim
- ◯ Não

Caso tenha respondido "Sim" na pergunta anterior, por favor indique quando terminou a mais recente.

- ◯ Até 2 anos
- ◯ 3 a 5 anos
- ◯ 6 a 10 anos
- ◯ Mais de 10 anos

Há quantos anos se encontra a trabalhar? *

- ◯ Até 2 anos
- ◯ 3 a 5 anos
- ◯ 6 a 10 anos
- ◯ Mais de 10 anos

O seu filho mais velho encontra-se em que gama de idades? *

- ◯ Não tenho filhos.
- ◯ 0-10 anos
- ◯ 11-20 anos
- ◯ Mais de 20 anos

Caso tenha mais de um filho, o seu filho mais novo encontra-se em que gama de idades?

- ◯ 0-10 anos
- ◯ 11-20 anos
- ◯ Mais de 20 anos

O meu à vontade para utilizar um computador é ... *

- ◯ Baixo
- ◯ Razoável
- ◯ Alto

Que dispositivos possui? *

- ☐ Computador
- ☐ Smartphone (telemóvel com capacidade para instalar jogos e outras aplicações)
- ☐ Tablet
- ☐ Other: _____

Nos dispositivos que utilizo (por ex. telemóvel, computador) ... *

- ☐ ... prefiro teclas grandes.
- ☐ ... prefiro letras grandes no ecrã.
- ☐ ... gosto de utilizar ecrãs sensíveis ao tacto (como nos telemóveis e tablets)

Qual o conhecimento que mais valoriza? *

- ◯ Prático
- ◯ Teórico

Gosto de ter controlo nas minhas experiências de aprendizagem. Isto é, valorizo uma relação de colegas com os meus professores, bem como ajudar na tomada de decisão acerca do que e como vou aprender. *

- ◯ Concordo.
- ◯ Discordo.

Valorizo mais aprender informação relacionada com as minhas necessidades profissionais, que melhore as minhas competências e facilite o meu trabalho, do que informação teórica, mais geral, ou sobre outras áreas. *

- ◯ Concordo.
- ◯ Discordo.

Prefiro que as minhas experiências de aprendizagem sejam feitas de acordo com a maneira que considero mais adequada, do que uma maneira nova, que o professor considera mais adequada. *

- ◯ Concordo.
- ◯ Discordo

Num contexto de aula, o conhecimento/experiência de vida que adquiri ao longo dos anos é relevante e útil para me ajudar a aprender. *

- ◯ Concordo.
- ◯ Discordo.

Next

Recursos Educativos

Nesta secção iremos lhe pedir que abra o link, escolha 2 dos jogos (há 6 jogos disponíveis) e leia as informações referentes aos mesmos.
O questionário contém 4 breves perguntas acerca de cada um deles.

ontoal.wixsite.com/ontoal/catálogo

Qual o nome do primeiro jogo que escolheu? *

Choose

Por favor selecione as opções do que NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

- [ ] Música de fundo
- [ ] Cores do jogo
- [ ] Ícones/Desenhos

Por favor indique se este jogo o ia motivar enquanto ferramenta de aprendizagem. *

- ( ) Muito
- ( ) Pouco
- ( ) Nada

Por favor indique se este jogo o ia motivar enquanto ferramenta de aprendizagem. *

- ◯ Muito
- ◯ Pouco
- ◯ Nada

Por favor indique o que menos gostou no jogo. *

Your answer

Por favor indique o que mais gostou no jogo. *

Your answer

Qual o nome do segundo jogo que escolheu? *

Choose

Por favor selecione as opções do que NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

- [ ] Música de fundo
- [ ] Cores do jogo
- [ ] Ícones/Desenhos

Por favor indique se este jogo o ia motivar enquanto ferramenta de aprendizagem. *

- ◯ Muito
- ◯ Pouco
- ◯ Nada

Por favor indique o que menos gostou no jogo *

Your answer

Por favor indique o que mais gostou no jogo *

Your answer

Back Next

Recursos Educativos - Preferências

Esta é a última secção e contém 6 perguntas.

Por favor selecione os tipos de jogos que mais GOSTA. "Eu prefiro ..." *

- [ ] jogos individuais
- [ ] jogos de grupo
- [ ] jogos com vencedores/perdedores
- [ ] jogos simples de jogar
- [ ] jogos difíceis de aprender a jogar
- [ ] jogos digitais (jogar num computador, telemóvel,...)
- [ ] jogos com limite de tempo
- [ ] jogos relacionados com a minha profissão
- [ ] jogos cujo sucesso depende de sorte

Prefiro música de fundo mais.. *

- ( ) Animada
- ( ) Calma
- ( ) Sem música de fundo

Nos jogos, prefiro cores mais *

- ◯ Vivas
- ◯ Sóbrias

Os ícones/desenhos nos jogos mais apropriados/agradáveis são ... *

- ☐ Grandes
- ☐ Pequenos
- ☐ Redondos
- ☐ Linhas Retas

Sinto-me confortável/interessado/aberto a jogar jogos para crianças *

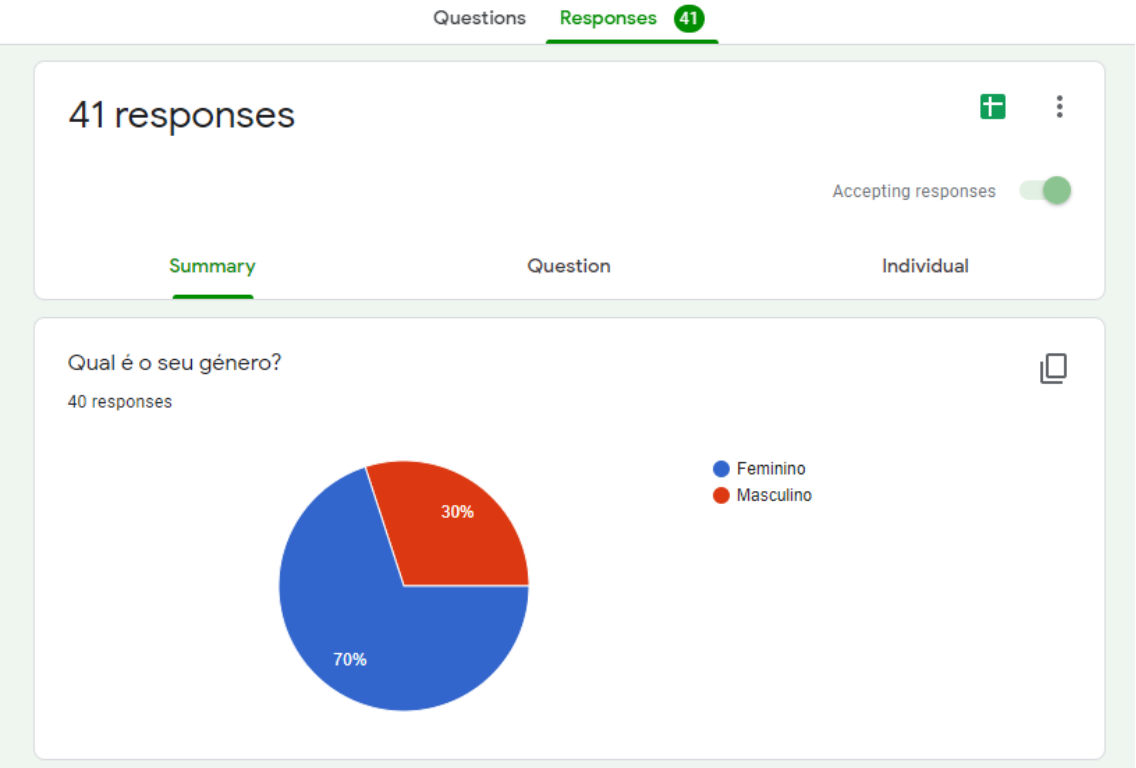
- ◯ Sim
- ◯ Não

Por favor selecione os tipos de jogos que mais GOSTA *

- [ ] Papel e Caneta
- [ ] Cartas
- [ ] Dados
- [ ] Jogo de Tabuleiro
- [ ] Puzzle
- [ ] Jogo Educativo
- [ ] Jogo de Aventura
- [ ] Jogo de Ação
- [ ] Jogo de Estratégia

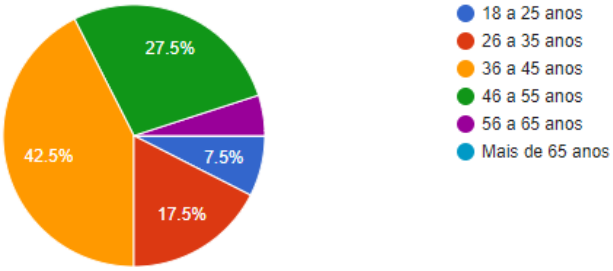
Back Submit

B.2.1 *Summary of Results*



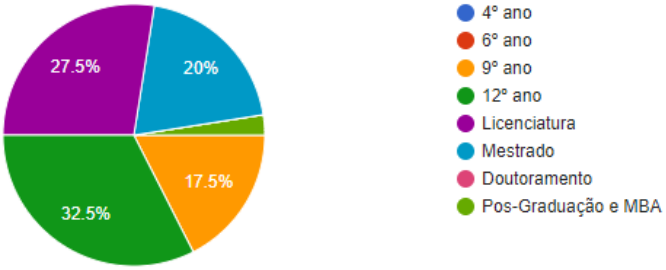
Qual é sua idade?

40 responses



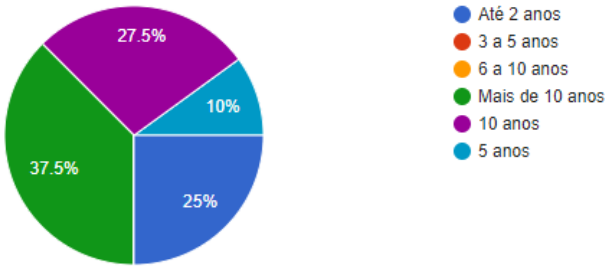
Quais as suas habilitações?

40 responses



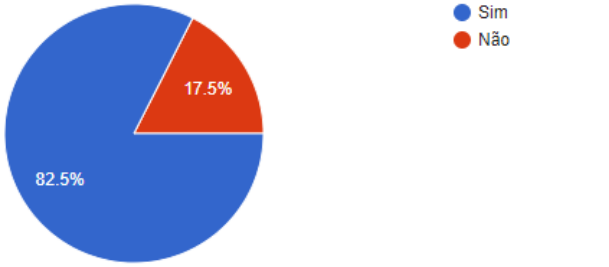
Há quantos anos terminou essa sua formação escolar? (Se tem mais do que uma formação, por favor indique a mais recente.)

40 responses



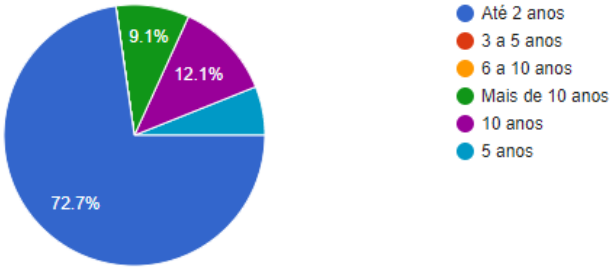
Fez outras formações complementares?

40 responses



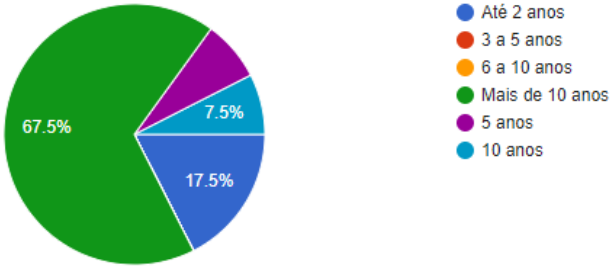
Caso tenha respondido "Sim" na pergunta anterior, por favor indique quando terminou a mais recente.

33 responses



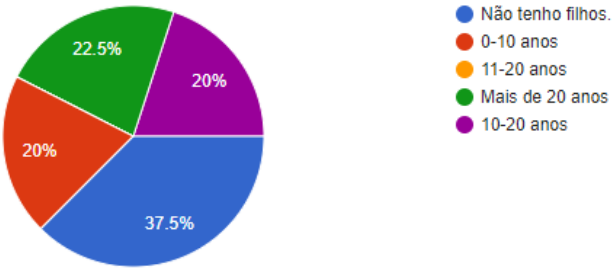
Há quantos anos se encontra a trabalhar?

40 responses



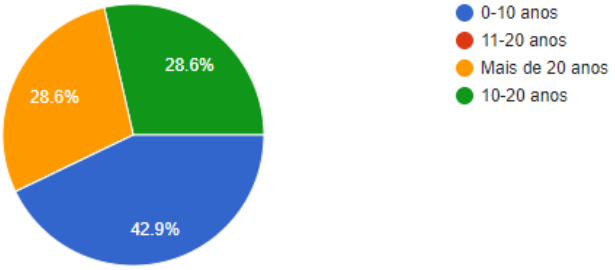
O seu filho mais velho encontra-se em que gama de idades?

40 responses



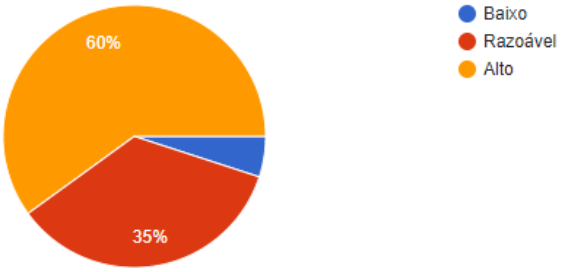
Caso tenha mais de um filho, o seu filho mais novo encontra-se em que gama de idades?

14 responses



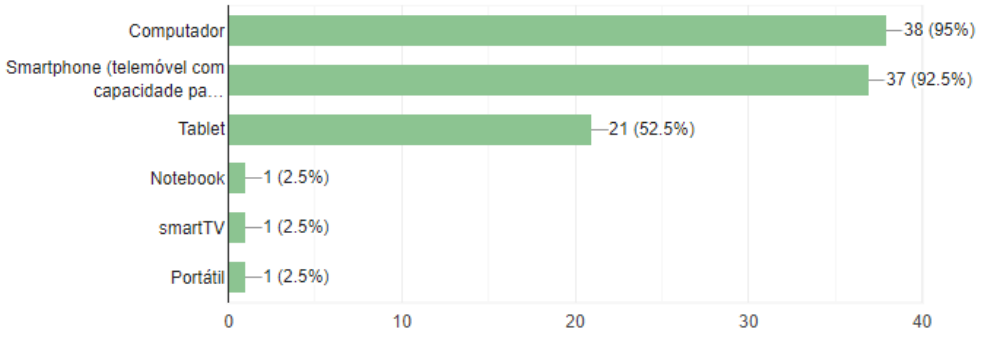
O meu à vontade para utilizar um computador é ...

40 responses



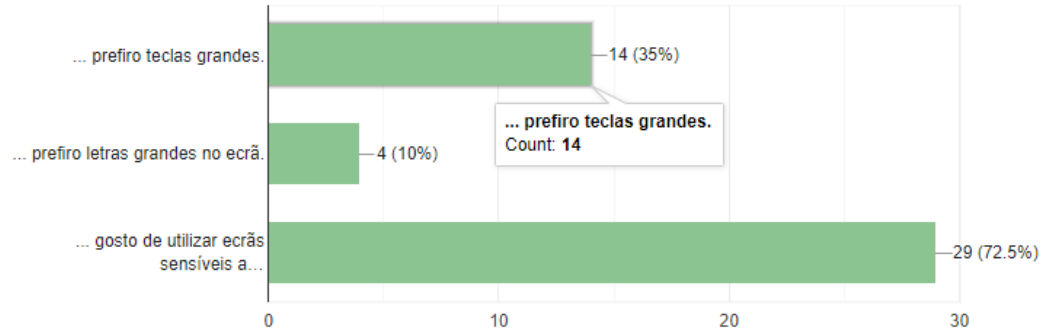
Que dispositivos possui?

40 responses



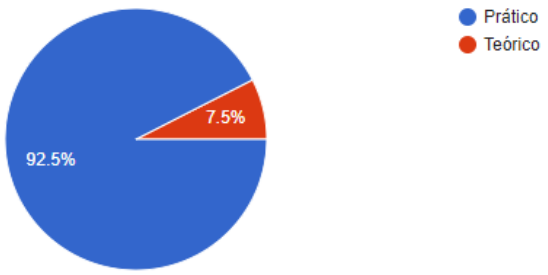
Nos dispositivos que utilizo (por ex. telemóvel, computador) ...

40 responses



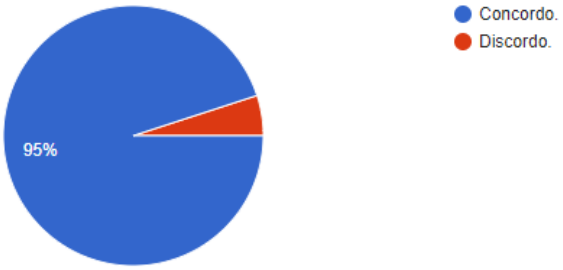
Qual o conhecimento que mais valoriza?

40 responses



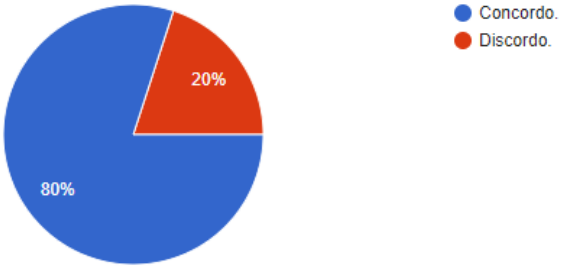
Gosto de ter controlo nas minhas experiências de aprendizagem. Isto é, valorizo uma relação de colegas com os meus professores, bem como ajudar na tomada de decisão acerca do que e como vou aprender.

40 responses



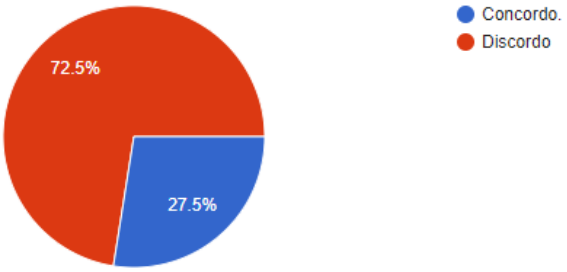
Valorizo mais aprender informação relacionada com as minhas necessidades profissionais, que melhore as minhas competências e facilite o meu trabalho, do que informação teórica, mais geral, ou sobre outras áreas.

40 responses



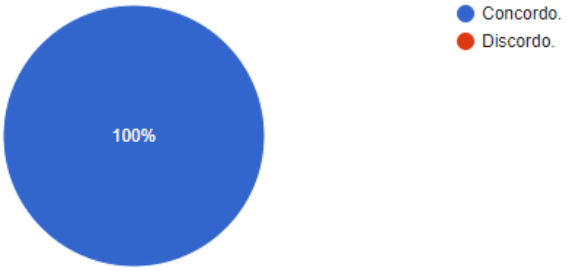
Prefiro que as minhas experiências de aprendizagem sejam feitas de acordo com a maneira que considero mais adequada, do que uma maneira nova, que o professor considera mais adequada.

40 responses



Num contexto de aula, o conhecimento/experiência de vida que adquiri ao longo dos anos é relevante e útil para me ajudar a aprender.

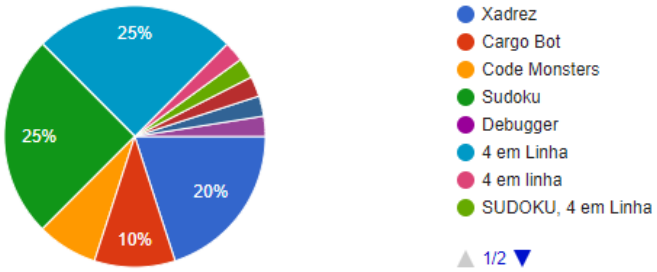
40 responses



Recursos Educativos

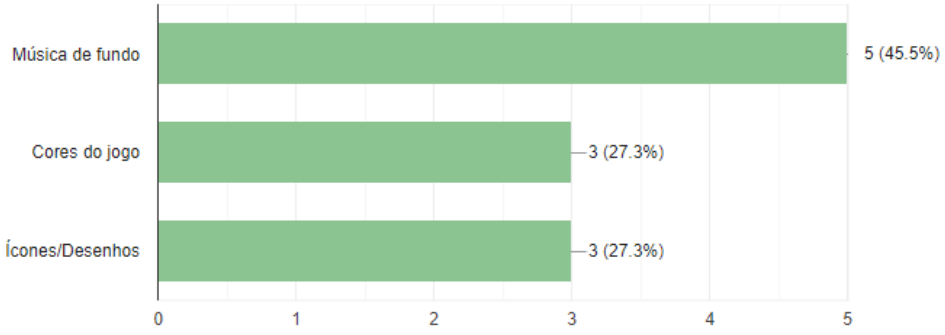
Qual o nome do primeiro jogo que escolheu?

40 responses



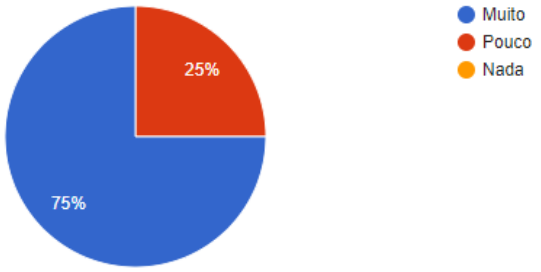
Por favor selecione as opções do que NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

11 responses



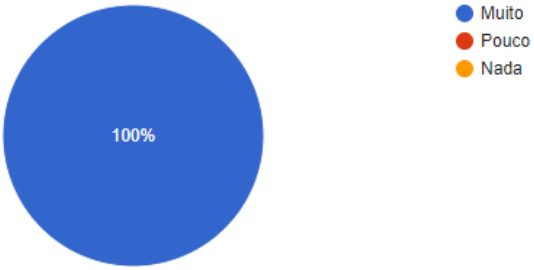
Por favor indique se este jogo o ia motivar enquanto ferramenta de aprendizagem.

40 responses



Por favor indique se este jogo o ia motivar enquanto ferramenta de aprendizagem.

1 response



Por favor indique o que menos gostou no jogo.

37 responses

Nada

nada

Publicidade na página

Demorado para completar.

Xadrez

Não está em português

Falta de anotações

Demora para passar as instruções

Complexidade perceber o jogo

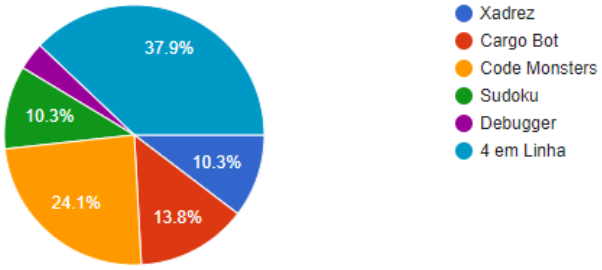
Por favor indique o que mais gostou no jogo.

39 responses

- Gostei de tudo
- Gostei de tudo.
- Tamanho do jogo adequado
- Simplicidade do jogo
- Tudo
- O facto de ser desafiante mas simples de aprender.
- Sudoku
- Gosto muito deste jogo em tudo o que ele pressupõe e estimula
- Aprender a jogar é muito fácil

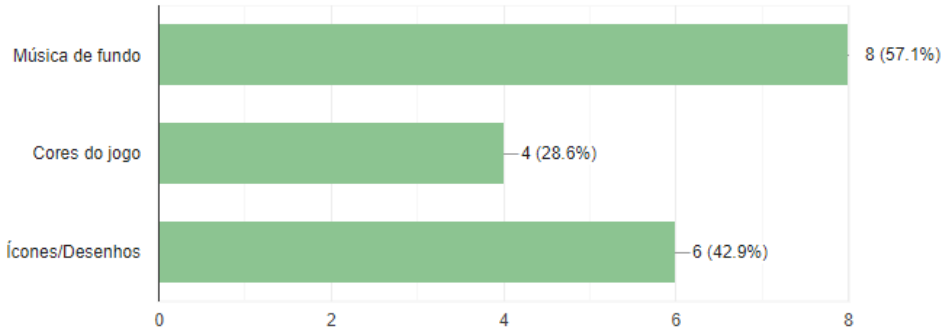
Qual o nome do segundo jogo que escolheu?

29 responses



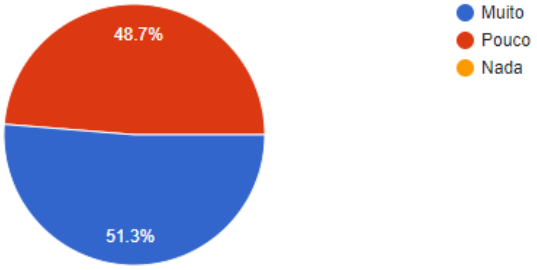
Por favor selecione as opções do que NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

14 responses



Por favor indique se este jogo o ia motivar enquanto ferramenta de aprendizagem.

39 responses



Por favor indique o que menos gostou no jogo

35 responses

Nada

Gostei de tudo.

nada

Publicidade

Ar infantil e demasiado simples. Pouco desafiante.

Xadrez

Difícil de começar

Dificuldade de compreender os processos

Não tem apresentação simples.

Por favor indique o que mais gostou no jogo

35 responses

gostei de tudo

Nada a destacar

Jogos rápidos. Não obrigam a ter muita disponibilidade em termos de tempo de jogo como um jogo de xadrez por exemplo.

Sudoku

Gosto muito deste jogo em tudo o que ele pressupõe e estimula

Não gostei

o modo de jogar.

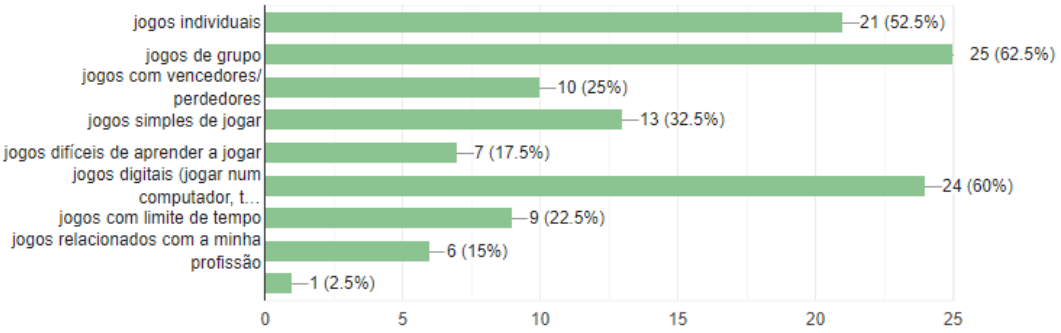
Raciocínio Lógico

Desafio

Recursos Educativos - Preferências

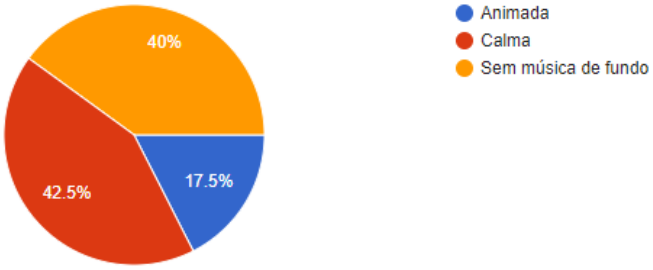
Por favor selecione os tipos de jogos que mais GOSTA. "Eu prefiro ..."

40 responses



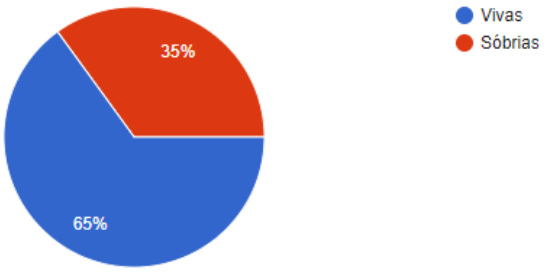
Prefiro música de fundo mais..

40 responses



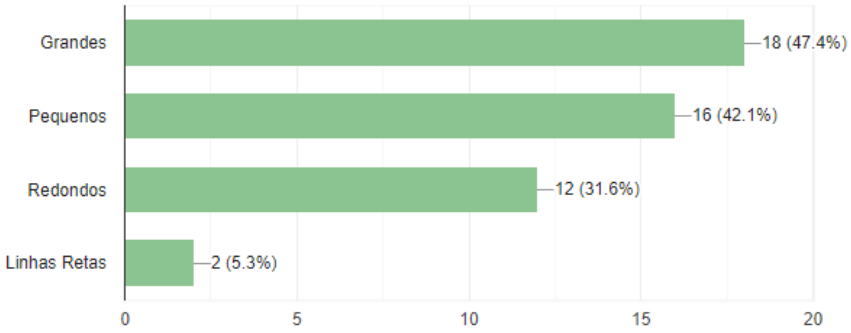
Nos jogos, prefiro cores mais

40 responses



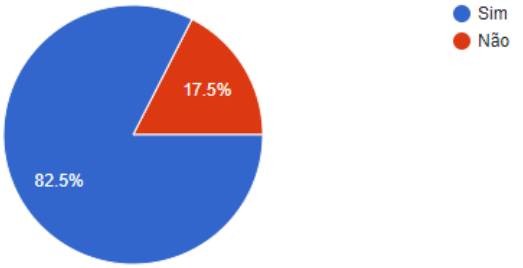
Os ícones/desenhos nos jogos mais apropriados/agradáveis são ...

38 responses



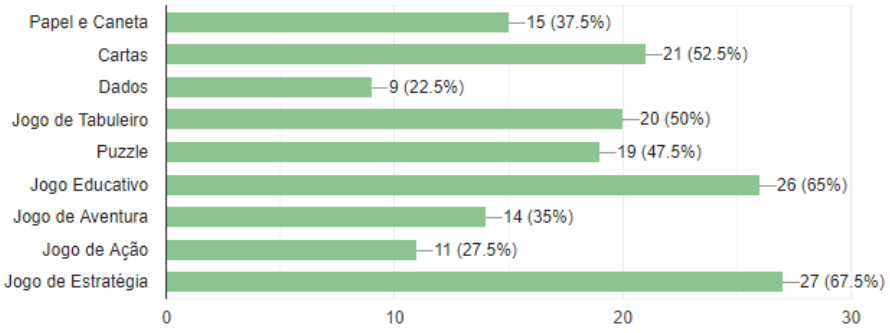
Sinto-me confortável/interessado/aberto a jogar jogos para crianças

40 responses



Por favor selecione os tipos de jogos que mais GOSTA

40 responses



B.3 2ND STAGE WITH ADULTS

OntoAL e o Estudante Adulto (Fase 2)

O presente questionário faz parte de uma tese em Engenharia Informática na Universidade do Minho intitulada "Ensino de Pensamento Computacional a Adultos em Reconversão".
O seu tema é a Educação de Adultos e a adaptação de Recursos Educativos a esse universo.
O objetivo deste questionário é recolher informações relativas à perceção/opinião de um adulto face a um dado recurso educativo.

Muito obrigada pela sua participação.

* Required

Qual é o seu género? *

Choose

Qual é a sua idade? *

Choose

Quais as suas habilitações? *

Choose

Há quantos anos terminou essa sua formação escolar? (Se tem mais do que uma formação, por favor indique a mais recente.) *

Choose

Fez outras formações complementares? *

Choose

Caso tenha respondido "Sim" na pergunta anterior, por favor indique quando terminou a mais recente.

Choose

Há quantos anos se encontra a trabalhar? *

Choose

O seu filho mais velho encontra-se em que gama de idades? *

Choose

Caso tenha mais de um filho, o seu filho mais novo encontra-se em que gama de idades?

Choose

O meu à vontade para utilizar um computador é ... *

- ◯ Baixo
- ◯ Alto
- ◯ Razoável

Que dispositivos possui? *

- ☐ Computador
- ☐ Smartphone (telemóvel com capacidade para instalar jogos e outras aplicações)
- ☐ Tablet
- ☐ Other:

Prefiro que as minhas experiências de aprendizagem sejam feitas de acordo com a maneira que considero mais adequada, do que uma maneira nova, que o professor considera mais adequada. *

- ◯ Concordo
- ◯ Discordo

Next

Recursos Educativos - Preferências

Eu prefiro... *

- ◯ Jogos Individuais
- ◯ Jogos de Grupo
- ◯ Não tenho preferência

Eu prefiro... *

- ◯ Jogos com vencedores/perdedores
- ◯ Jogos sem vencedores/perdedores
- ◯ Não tenho preferência

Eu prefiro... *

- ◯ Jogos simples de jogar
- ◯ Jogos difíceis de jogar
- ◯ Não tenho preferência

Eu prefiro... *

- ◯ Jogos fáceis de aprender a jogar
- ◯ Jogos difíceis de aprender a jogar
- ◯ Não tenho preferência

Eu prefiro... *

- ◯ Jogos digitais (jogar num computador, telemóvel,...)
- ◯ Jogos que não sejam digitais
- ◯ Não tenho preferência

Eu prefiro... *

- ◯ Jogos com limite de tempo
- ◯ Jogos sem limite de tempo
- ◯ Não tenho preferência

Qual a sua opinião relativamente a jogos relacionados com a sua profissão? (Um jogo no qual pode aplicar/demonstrar conhecimentos que adquiriu através da sua profissão.) *

- ◯ Não gosto
- ◯ Gosto
- ◯ Não gosto nem desgosto

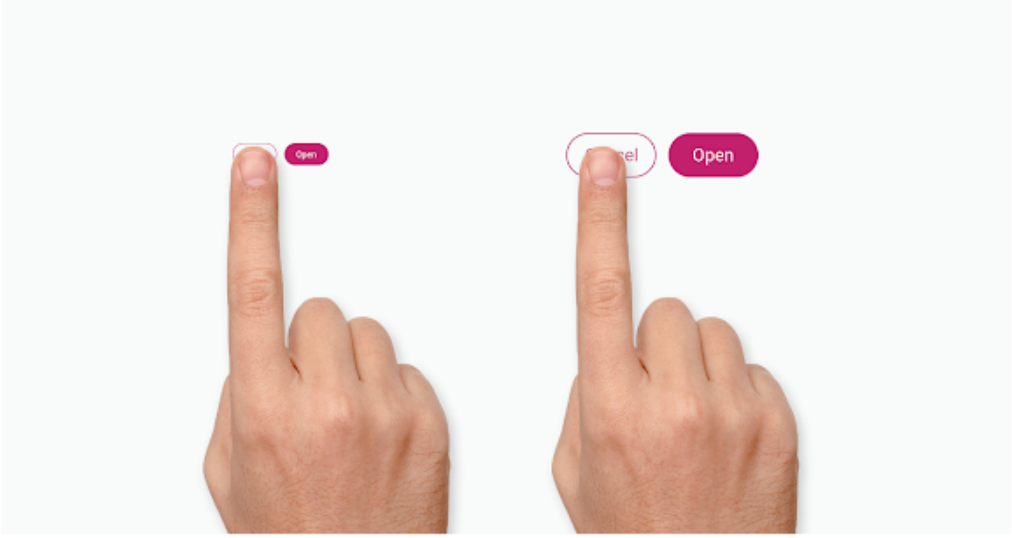
Como se sente relativamente à possibilidade de jogar um jogo de crianças? (Por favor selecione todas as afirmações verdadeiras. Caso não concorde com nenhuma, por favor deixe em branco.)

- ☐ Eu sinto-me confortável com a possibilidade de jogar um jogo para crianças.
- ☐ Se eu souber que um jogo foi feito para crianças, perco o interesse em jogar.
- ☐ Eu estou aberto/a a jogar jogos para crianças.

Qual a sua opinião relativamente a jogos de programação? (Selecione as afirmações com as quais concorda. Caso não concorde com nenhuma, por favor deixe em branco.)

- ☐ Tenho interesse em jogar um jogo de programação.
- ☐ Estou aberto/a a jogar um jogo de programação.

Por favor atente na seguinte imagem.

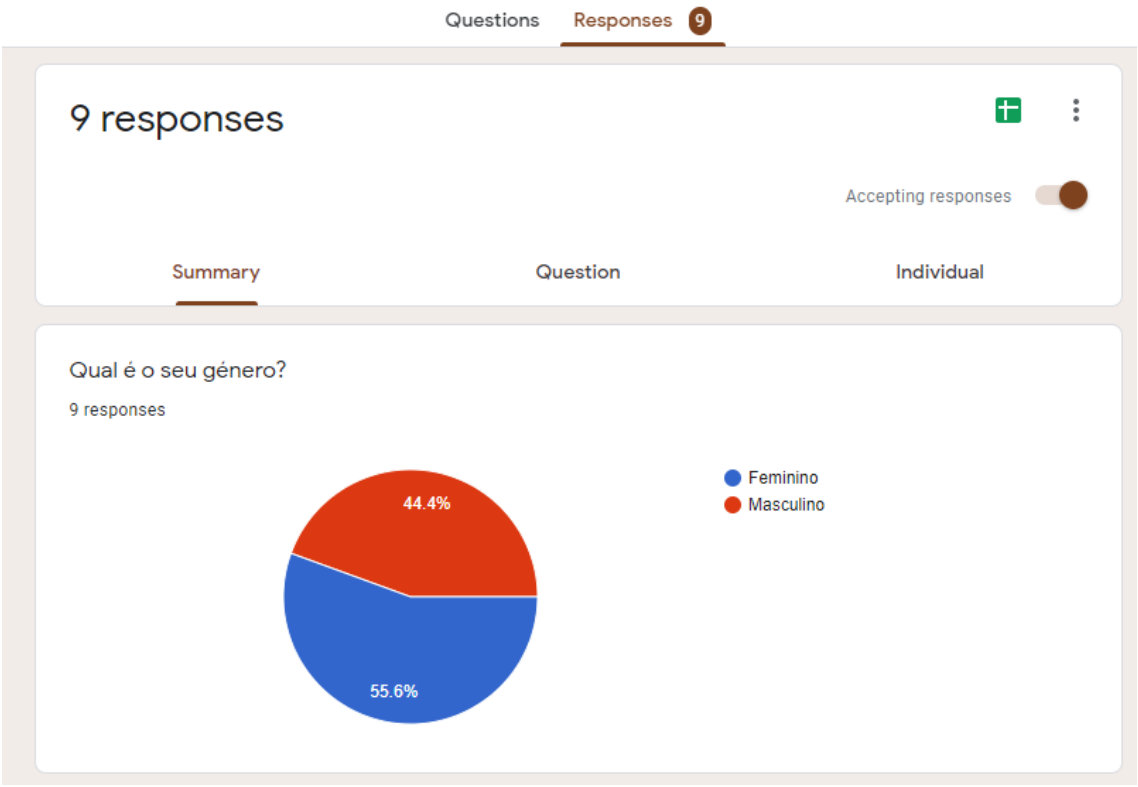


Os ícones nos jogos que considero mais adequados são

- ◯ Pequenos
- ◯ Grandes

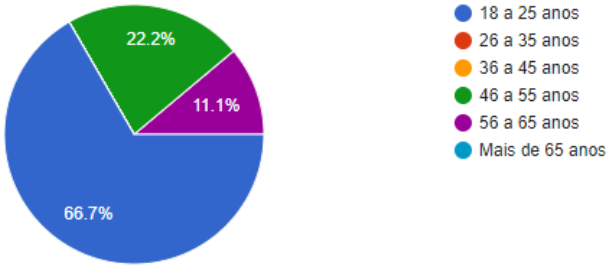
Back Submit

B.3.1 *Summary of Results*



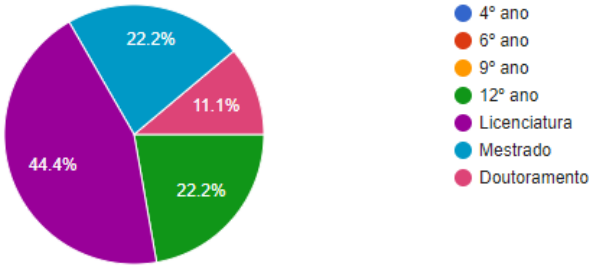
Qual é a sua idade?

9 responses



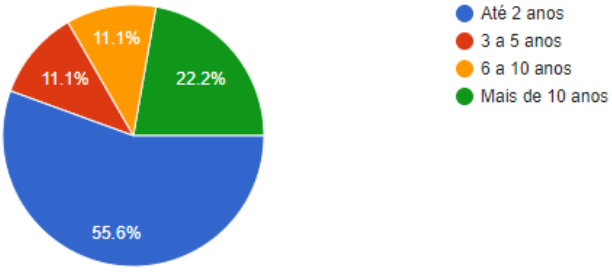
Quais as suas habilitações?

9 responses



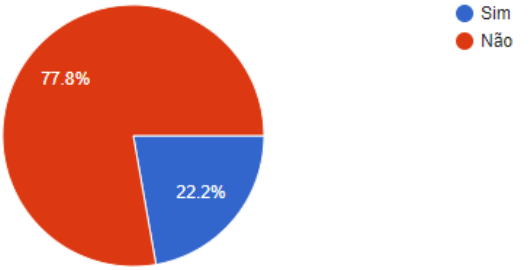
Há quantos anos terminou essa sua formação escolar? (Se tem mais do que uma formação, por favor indique a mais recente.)

9 responses



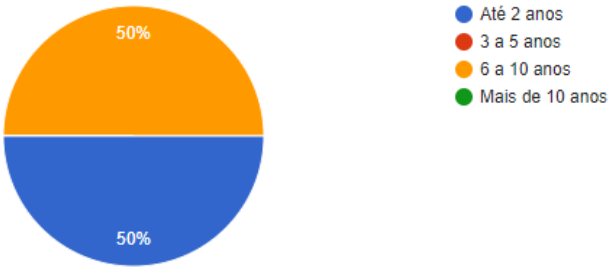
Fez outras formações complementares?

9 responses



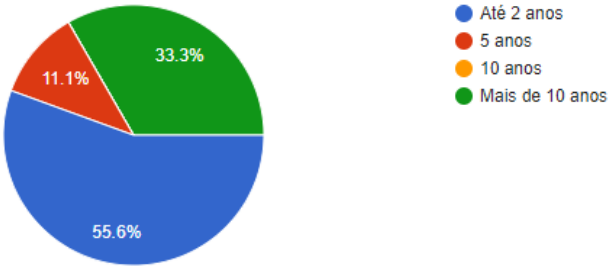
Caso tenha respondido "Sim" na pergunta anterior, por favor indique quando terminou a mais recente.

2 responses



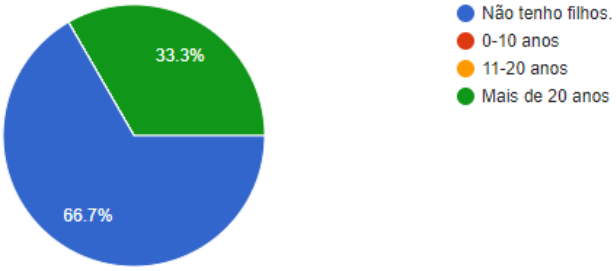
Há quantos anos se encontra a trabalhar?

9 responses



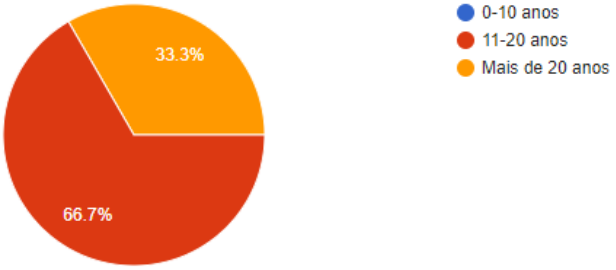
O seu filho mais velho encontra-se em que gama de idades?

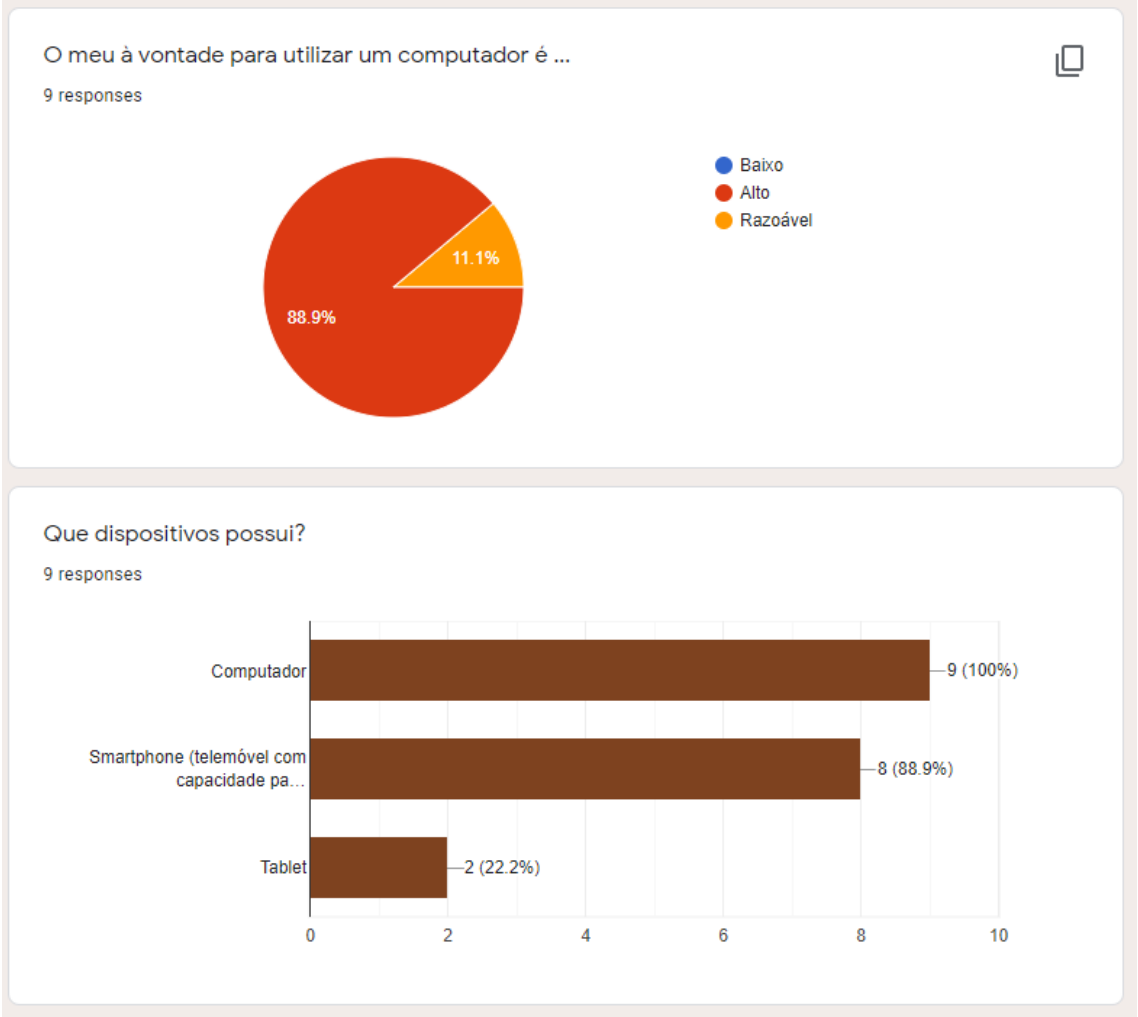
9 responses



Caso tenha mais de um filho, o seu filho mais novo encontra-se em que gama de idades?

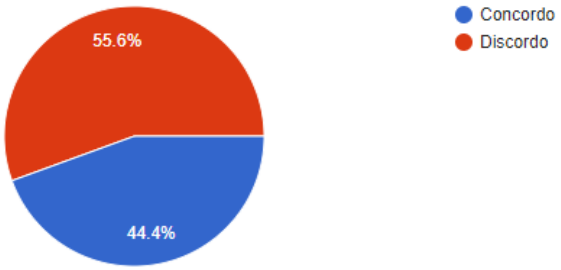
3 responses




O meu à vontade para utilizar um computador é ...
9 responses
Baixo
Alto
Razoável
11.1%
88.9%
Que dispositivos possui?
9 responses
Computador
9 (100%)
Smartphone (telemóvel com capacidade pa...
8 (88.9%)
Tablet
2 (22.2%)
0
2
4
6
8
10

Prefiro que as minhas experiências de aprendizagem sejam feitas de acordo com a maneira que considero mais adequada, do que uma maneira nova, que o professor considera mais adequada.

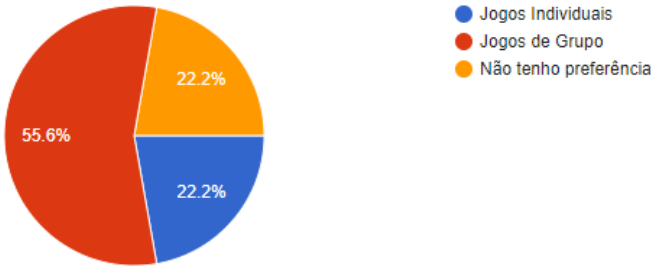
9 responses

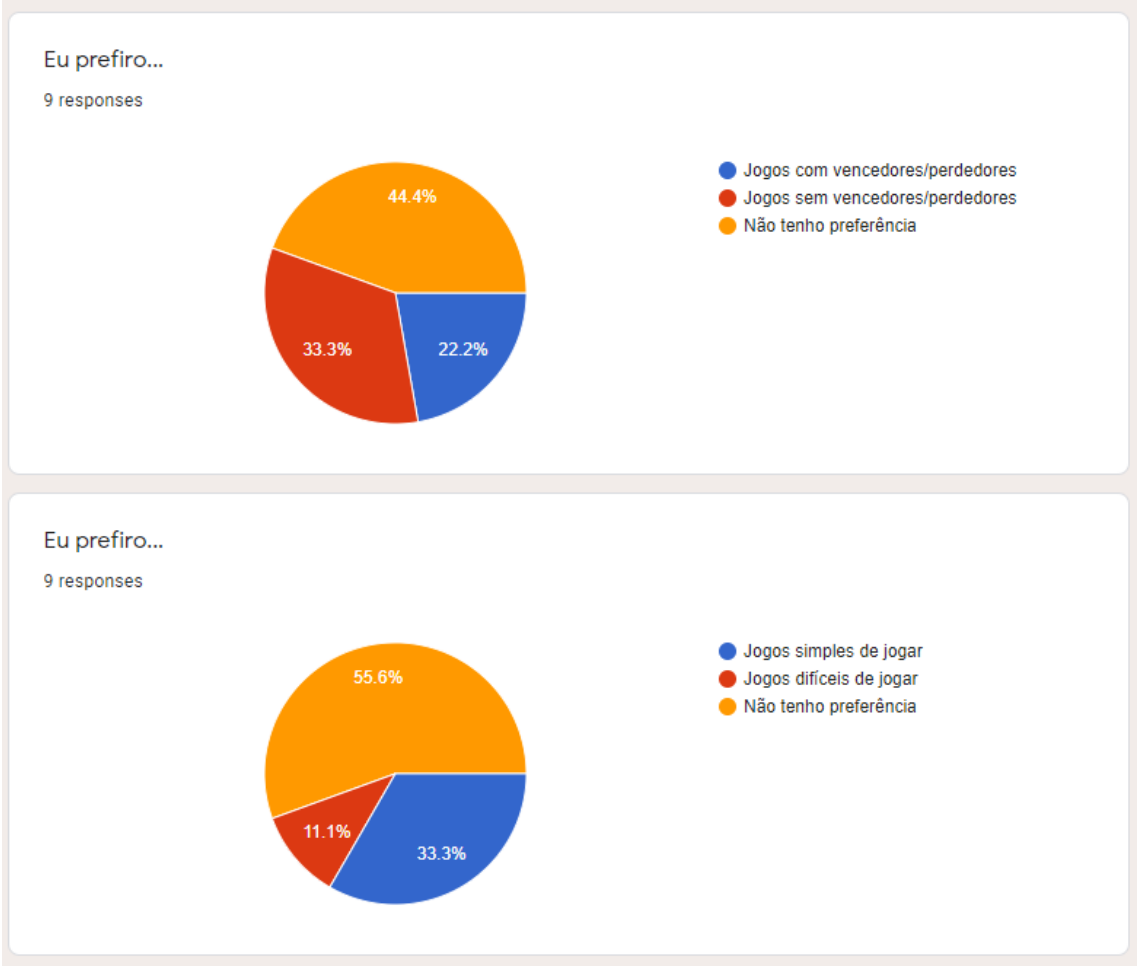


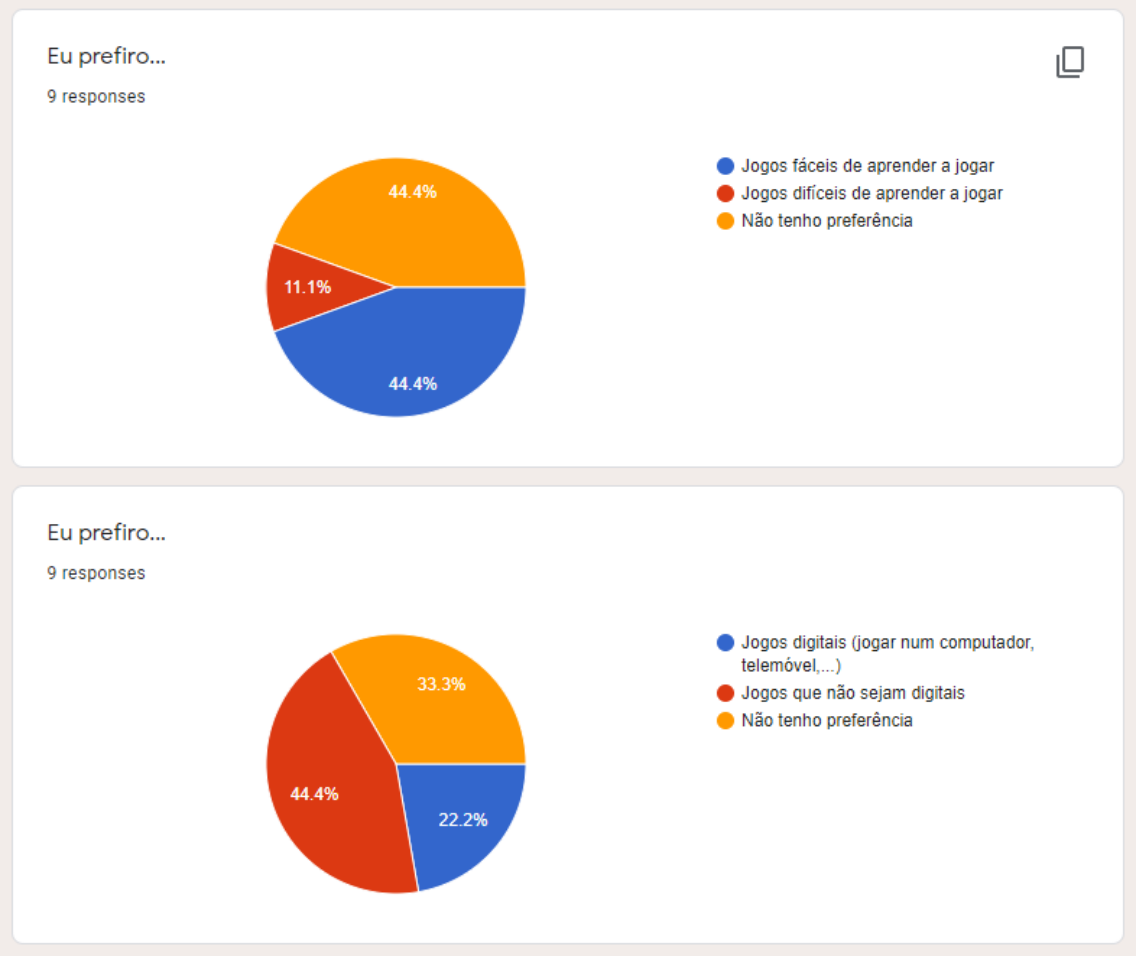
Recursos Educativos - Preferências

Eu prefiro...

9 responses

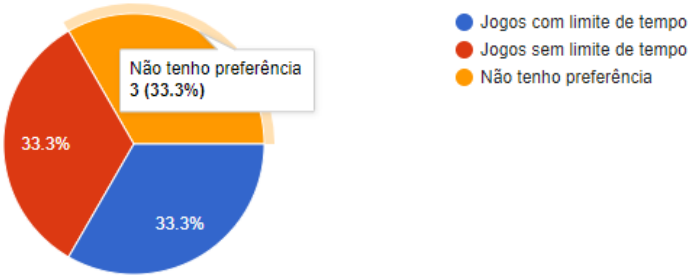



Eu prefiro...
9 responses
44.4%
33.3%
22.2%
Jogos com vencedores/perdedores
Jogos sem vencedores/perdedores
Não tenho preferência
Eu prefiro...
9 responses
55.6%
11.1%
33.3%
Jogos simples de jogar
Jogos difíceis de jogar
Não tenho preferência


Eu prefiro...
9 responses
44.4%
11.1%
44.4%
Jogos fáceis de aprender a jogar
Jogos difíceis de aprender a jogar
Não tenho preferência
Eu prefiro...
9 responses
33.3%
44.4%
22.2%
Jogos digitais (jogar num computador, telemóvel,...)
Jogos que não sejam digitais
Não tenho preferência

Eu prefiro...

9 responses

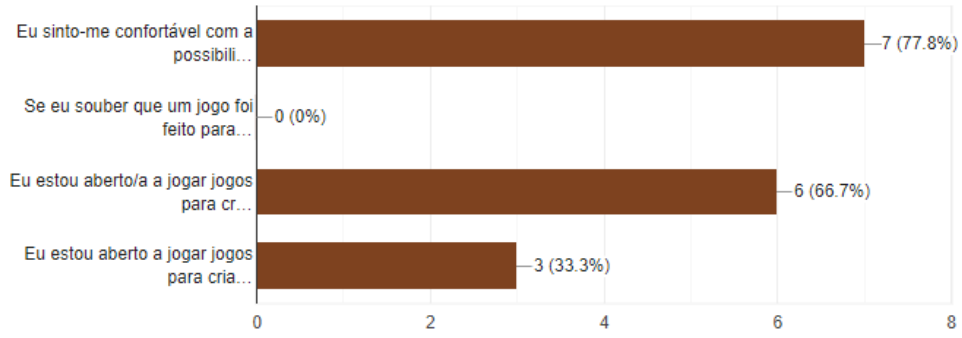


Qual a sua opinião relativamente a jogos relacionados com a sua profissão? (Um jogo no qual pode aplicar/demonstrar conhecimentos que adquiriu através da sua profissão.)

9 responses

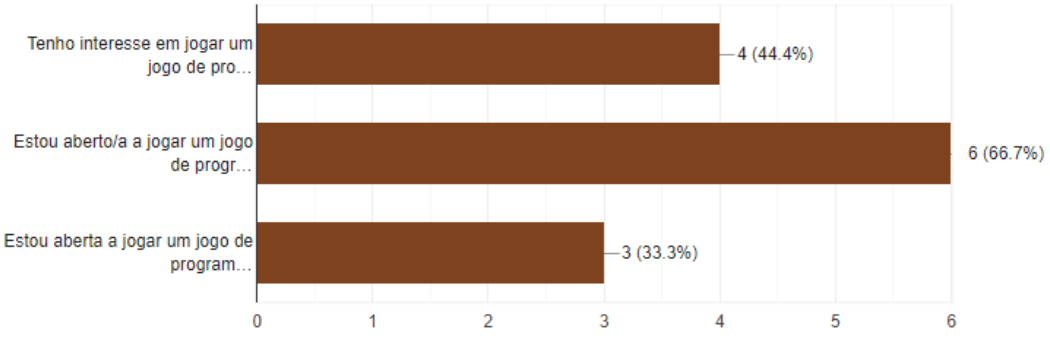
Como se sente relativamente à possibilidade de jogar um jogo de crianças? (Por favor selecione todas as afirmações verdadeiras. Caso não concorde com nenhuma, por favor deixe em branco.)

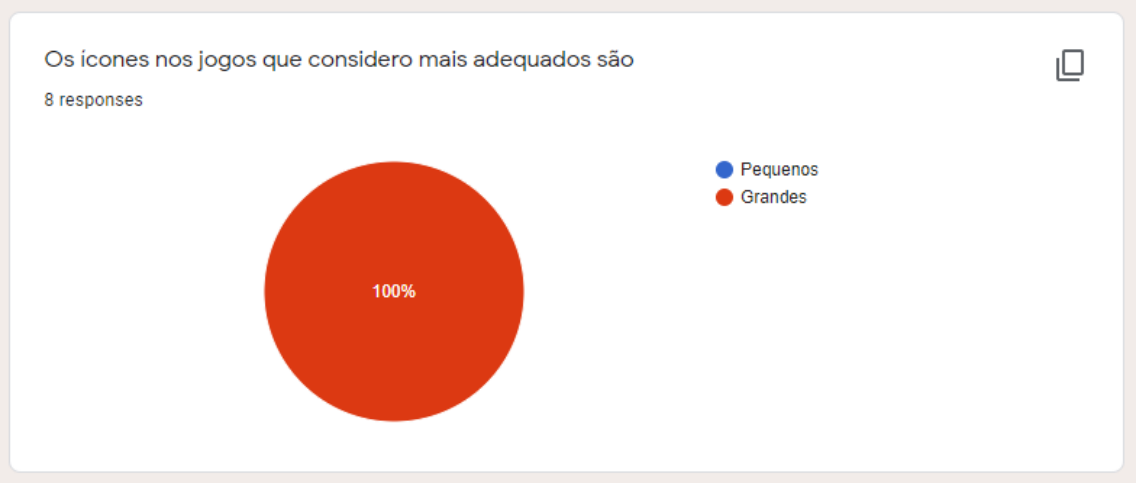
9 responses



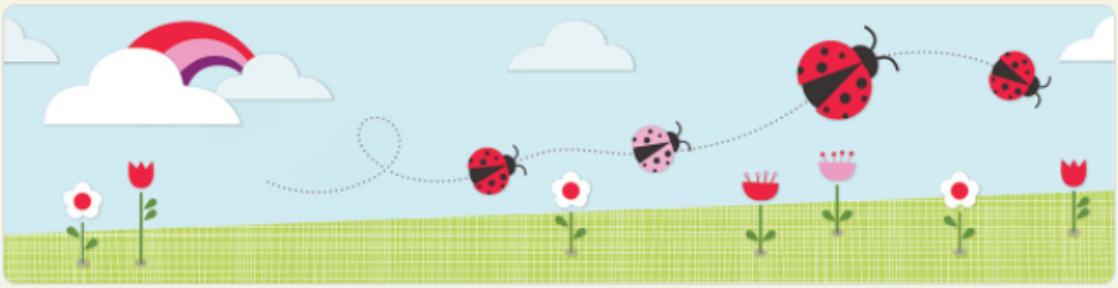
Qual a sua opinião relativamente a jogos de programação? (Selecione as afirmações com as quais concorda. Caso não concorde com nenhuma, por favor deixe em branco.)

9 responses




Os ícones nos jogos que considero mais adequados são
8 responses
Pequenos
Grandes
100%

B.4 2ND STAGE WITH CHILDREN



OntoAL e o Estudante Jovem

O presente questionário faz parte de uma tese em Engenharia Informática na Universidade do Minho intitulada "Ensino de Pensamento Computacional a Adultos em Reconversão". O seu tema é a Educação de Adultos e a adaptação de Recursos Educativos a esse universo.

O objetivo deste questionário é recolher informações relativas à perceção/opinião de uma criança face a um dado recurso educativo.

Muito obrigada pela sua participação.

* Required

Qual é o género da criança? *

- ◯ Masculino
- ◯ Feminino

Qual o seu intervalo de idades? *

- ◯ 0-5 anos
- ◯ 6-10 anos
- ◯ 11- 14 anos

Dispositivos que costuma utilizar: *

- [ ] Computador
- [ ] Tablet
- [ ] Smartphone (telemóvel com capacidade para instalar jogos e outras aplicações)
- [ ] Smart TV
- [ ] Other: _____

Next

Jogos

Nesta secção iremos lhe pedir que abra o link e peça à criança para escolher 2 dos jogos (há 6 jogos disponíveis). Cada jogo possui uma breve descrição e ainda o link para a criança poder jogar.

ontoal.wixsite.com/ontoal/catálogo

Qual o primeiro jogo que escolheu? *

Choose

Por favor selecione as opções do que a criança NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

- [ ] Música de Fundo
- [ ] Cores do jogo
- [ ] Ícones/desenhos

Porque escolheu este jogo? Qual a sua opinião relativamente ao jogo? *

Your answer

Qual o segundo jogo que escolheu?

Choose

Por favor selecione as opções do que NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

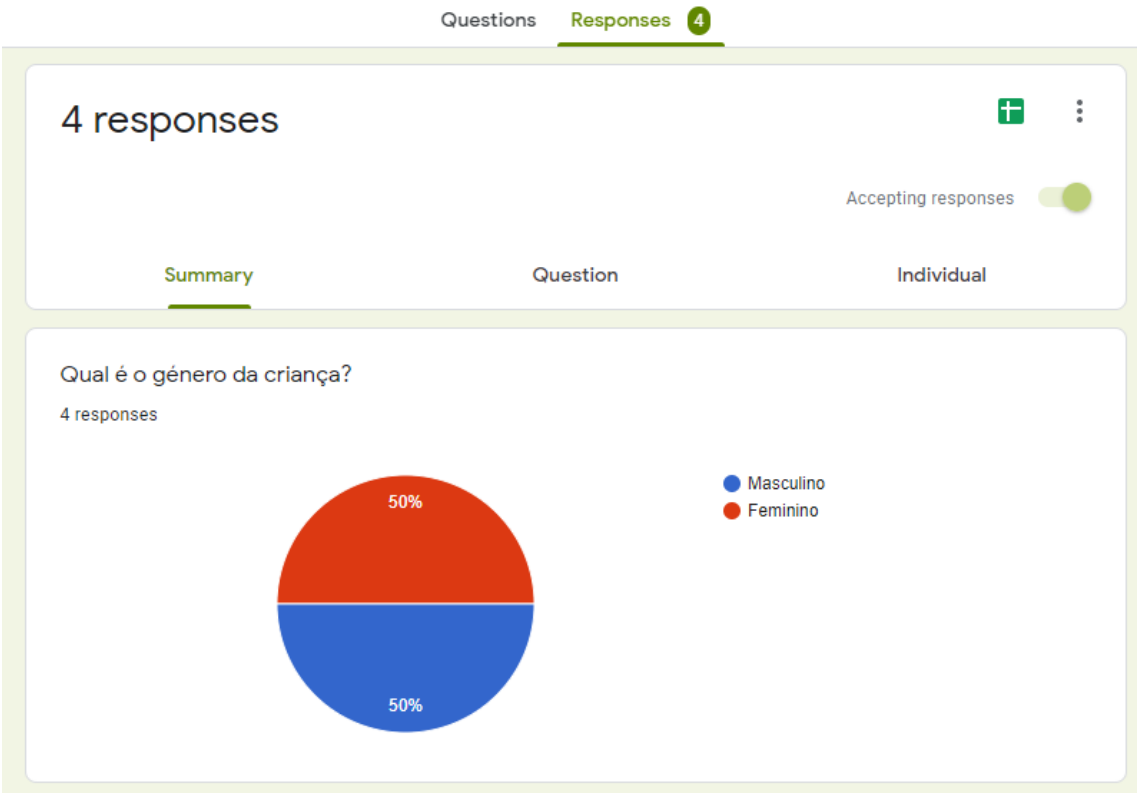
- [ ] Música de Fundo
- [ ] Cores do jogo
- [ ] Ícones/desenhos

Porque escolheu este jogo? Qual a sua opinião relativamente ao jogo?

Your answer

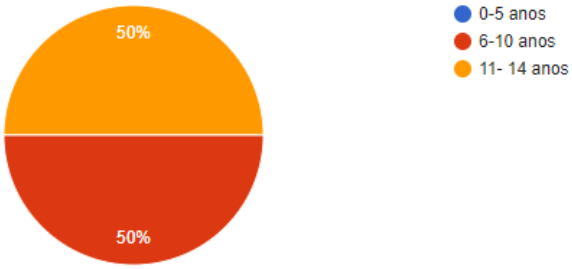
Back Submit

B.4.1 *Summary of Results*



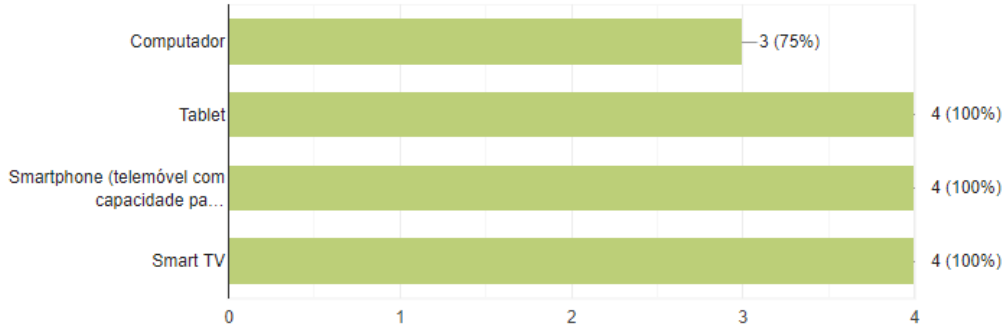
Qual o seu intervalo de idades?

4 responses



Dispositivos que costuma utilizar:

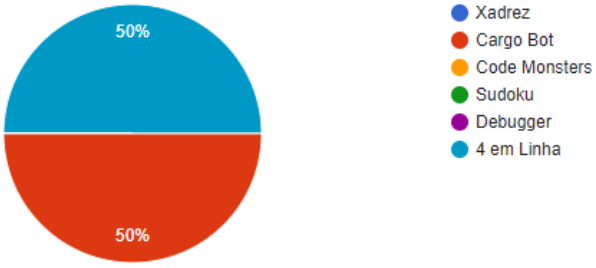
4 responses



Jogos

Qual o primeiro jogo que escolheu?

4 responses



Por favor selecione as opções do que a criança NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

0 responses

No responses yet for this question.

Porque escolheu este jogo? Qual a sua opinião relativamente ao jogo?

4 responses

Já conheço e sei que gosto.

Gosto muito das caixas e das cores.

Parece-me divertido. Gosto dos desenhos. Pareceu-me o mais engraçado de todos. Acho que é muito atrativo para crianças.

O jogo é muito fixe. Já o conheço e gosto de jogar.

Qual o segundo jogo que escolheu?

1 response

Por favor selecione as opções do que NÃO GOSTOU no jogo. (Caso tenha gostado de tudo, deixe em branco.)

0 responses

No responses yet for this question.

Porque escolheu este jogo? Qual a sua opinião relativamente ao jogo?

1 response

Parece fixe e divertido.