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**O PENSAMENTO CRÍTICO NA CONSTRUÇÃO DE SOLUÇÕES CRIATIVAS: CONTRIBUTOS DO PROJETO PROLEARN4ALL**  
**CRITICAL THINKING TO BUILD CREATIVE SOLUTIONS: PROLEARN4ALL PROJECT CONTRIBUTIONS**  
**EL PENSAMIENTO CRÍTICO EN LA CONSTRUCCIÓN DE SOLUCIONES CREATIVAS: CONTRIBUCIONES DEL PROYECTO PROLEARN4ALL**

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## RESUMO

**Introdução:** Maletas Pedagógicas para TODOS (ProLearn4ALL) é um projeto que pretende aumentar a consciência das crianças do 1º Ciclo do Ensino Básico para a diferença, através de produtos acessíveis em multiformato, construídos por estudantes do ensino superior. Este processo, fundamentado nas metodologias de Aprendizagem Baseada em Problemas (ABP), tem como principais fases a conceptualização de protótipos; o teste piloto; a revisão, reformulação e validação de produtos e, por fim, a produção de uma maleta pedagógica e respetiva disseminação.

**Objetivos:** O artigo apresenta a metodologia ABP como um processo ativo para desenvolver o pensamento crítico, através da procura de soluções que resolvam problemas não rotineiros.

**Métodos:** Aplicando a metodologia ABP, partiu-se da contextualização teórica dos quatro grandes domínios da deficiência (motora, visual, surda, intelectual) e da criação, por estudantes das áreas das Ciências Sociais e Educação, de protótipos que evidenciassem as características de cada um desses domínios. Posteriormente, os estudantes das áreas das Artes e do Design foram convidados a desenvolver produtos lúdicos e acessíveis, baseados nos protótipos previamente construídos.

**Resultados:** Os estudantes posicionaram-se no lugar das pessoas com deficiência, usando restrições específicas, criadas como introduções temáticas aos desafios propostos. Nesse sentido, os recursos foram construídos com maior nível de consciência, pois os estudantes eram simultaneamente produtores e recetores.

**Conclusões:** As múltiplas reflexões, durante e após a produção, permitiram um constante processo de investigação, validação e exclusão de soluções que levaram progressivamente à construção de uma Maleta Pedagógica.

**Palavras-chave:** Aprendizagem Baseada em Problemas; Pensamento Crítico; Ensino Superior; Projeto ProLearn4ALL

## ABSTRACT

**Introduction:** The Learning Products for ALL (ProLearn4ALL) is a project which aims to make children aware of difference in the primary schools, with accessible multiform products, developed by higher education students. This process, which is founded on Problem Based Learning (PBL) methodologies, has as its main phases: the conceptualization of products and prototypes; pilot test; revision, reformulation and validation of products; and, finally the production and dissemination of a pedagogical kit.

**Objectives:** The paper presents the PBL methodology as an active process used to develop critical thinking through the use of proposed prototype solutions to solve non-routine problems.

**Methods:** Applying PBL methodology, the process started with the theoretical contextualization of the four main domains of disability (hearing, intellectual, motor, visual) and with the creation of prototypes, by students in the areas of Social Sciences and Education, to highlight the characteristics of each domain. Subsequently, Arts and Design students were asked to create playful and accessible products, based on the prototypes that were previously built.

**Results:** Students were challenged to put themselves in the places of people with disability by using specific restrictions, created as thematic introductions to the proposed challenges. In this sense, the products were made with higher level of awareness, as students were simultaneously producers and users.

**Conclusion:** The multiple reflections, during and after the production of the resources, allowed a constant process of research, validation and exclusion of solutions to occur, which progressively led to the construction of the final Pedagogical Kit.

**Keywords:** Problem-based Learning; Critical Thinking; Higher Education; ProLearn4ALL Project

## RESUMEN

**Introducción:** Maletas Pedagógicas para TODOS (ProLearn4ALL) es un proyecto cuyo objetivo es aumentar la conciencia de la diferencia en niños y niñas del 1º Ciclo de Enseñanza Básica (6-10 años), a través de productos disponibles en multiformato, elaborados por estudiantes de la enseñanza superior. Este proceso, asentado en las metodologías de Aprendizaje Basada en Problemas (ABP), tiene como principales fases la conceptualización de prototipos; la prueba piloto; la revisión, la reformulación y la validación de productos y, por último, la producción de una maleta pedagógica y correspondiente difusión.

**Objetivos:** El artículo presenta la metodología ABP en tanto que proceso activo para desarrollar el pensamiento crítico, mediante la búsqueda de soluciones que resuelvan problemas no rutinarios.

**Métodos:** Siguiendo la metodología ABP, se partió de la contextualización teórica de los cuatro grandes dominios de la discapacidad (motora, visual, auditiva, intelectual) y de la confección, por parte de estudiantes de las áreas de las Ciencias Sociales y de la Educación, de prototipos que pusiesen de manifiesto las características de cada uno de aquellos dominios. Posteriormente, se pidió a los estudiantes de las áreas de las Artes y del Diseño que desarrollasen productos lúdicos y accesibles, basados en los prototipos previamente confeccionados.

**Resultados:** Los estudiantes se pusieron en el lugar de las personas con discapacidad, utilizando restricciones específicas, creadas como introducciones temáticas a los desafíos propuestos. En ese sentido, los recursos fueron elaborados con un mayor nivel de consciencia, teniendo en cuenta que los estudiantes eran a la vez productores y recetores.

**Conclusiones:** Las numerosas reflexiones, durante y después de la elaboración, permitieron un constante proceso de la investigación, validación y exclusión de soluciones que condujeron progresivamente a la confección de una Maleta Pedagógica.

**Palabras Clave:** Aprendizaje Basado en Problemas; Pensamiento Crítico; Enseñanza Superior; Proyecto ProLearn4ALL

## INTRODUCTION

The Learning Products for ALL (ProLearn4ALL) is a project created to increase the knowledge of primary school children on Special Needs in a recreational-pedagogical way. It is important to reinforce work and research in this area, because “Globally, children with disabilities experience marginalization within the educational system and also traditionally experience varying forms of discrimination from mainstream society” (Mantey, 2017, p.18).

The project has been carried out by a consortium of Social Sciences, Education and Arts Faculties of Polytechnic of Leiria and Polytechnic of Coimbra, the *Cooperativa de Ensino e Reabilitação de Crianças Inadaptada* (CERCILEI) and the Municipal Hall of Leiria. In this collaborative platform, students, professors and researchers create synergies of knowledge for the benefit of local communities in what regards social inclusion, through the creation of ludic-pedagogical resources in the following main phases: conceptualization and prototype of the products; pilot test; revision of the outcome, reformulation and validation; and, production and dissemination.

The strategies applied encouraged the team to find creative and critical possible solutions to develop a complete kit which was founded on Problem Based Learning (PBL) principals, as an active process to develop critical thinking in order to propose prototype solutions for non-routine problems (Ulger, 2018).

The options followed throughout the project are described in this article.

## 1. THEORETICAL FRAMEWORK

The educational inclusion is a global goal, with Portugal having a high level compared to international standards: in 2016/2017 98.8% of students with Special Needs were assigned to regular schools (Liebowitz, González, Hooge & Lima, 2018). It is known, however, that in order to achieve effective educational inclusion, it is not enough for everyone to be in the same school space, it is essential to adopt strategies and use accessible resources that respect the characteristics of each one (Okongo, Ngao, Rop & Nyongesa, 2015).

If we consider children and young people who have one of the four domains of disability (hearing, intellectual, motor, visual), this care is even more important, taking into account the specificities of each typology.

According to the American Psychiatric Association (2014) and Guerreiro (2018), these four domains can be defined in the following way:

- i) Hearing disability (or deafness) is a hearing loss or deficit, which can be mild to profound, reducing or making sense distinction and attribution impossible to sounds; it may be associated with a difficulty in accessing the oral language and the consequent obstacles in communication and social interaction;
- ii) Intellectual disability which is characterized by deficits in intellectual functioning (reasoning, problem solving, planning, discernment, abstract thinking and academic learning) and in adaptive functioning (conceptual, social and practical difficulties);
- iii) Motor disability consists of a dysfunction that conditions physical response to stimuli, related to the Central Nervous System and its regulatory centres (brain, cerebellum and brain stem), with spinal cord lesions or malformations, or muscle and nerve dysfunctions;
- iv) Visual disability is associated with the deprivation of the sense of vision, and may have several levels, considering low-vision the weakening of visual sensitivity and blindness to the severe loss of vision.

In ProLearn4ALL project, a kit was developed with different types of ludic-pedagogical items that aim to make children more aware of the supra-mentioned domains. During the products’ conceptualization and prototype phase, students of higher education were involved, which meant that the educational strategies had to be re-thought according to current challenges (Pereira, 2017), in order to solve the increasing need to have people with the abilities and courage to solve problems in our society (McDaniels & Skogsberg, 2017). In this sense, “the development of today’s students into strong and committed global citizens” (Bishop & Bittner, 2018, p.15) becomes essential. To achieve this development, youths must start to have a more critical reasoning, to raise questions and to look for answers.

Critical thinking, defined by Paul and Elder (2020, p. 9) as “the art of analysing and evaluating thought processes with a view to improving them”, allows students to: learn how to ask fundamental questions; interpret data, gather relevant information; achieve possible solutions and test them; have an open mind, seek alternative paths and corresponding implications; communicate with others in order to find solutions to complex problems; and, have skills to select reliable information, to make reasoned arguments or to make well-informed decisions.

Problem-Based Learning (PBL), a methodology that enables learning through the research for solutions to real context issues (Yew & Goh, 2016), allows students to research, gather and analyse data that will influence their decision-making process to solve problems (Pedro & Matos, 2015), meeting the critical thinking assumptions. According to Yew and Goh (2016) this type of methodology allows student to retain knowledge and know how to use it in future practices, by creating analogies between contexts. PBL has as its main features: the fact that the problem is the starting point, and not the theory or the curricular concepts; this starting point may be based on problems that may arise in the student’s future practices; the student is responsible for his/her own learning and must present a proposal of solutions, obtaining qualitative feedback (Hallinger & Bridges, 2016).

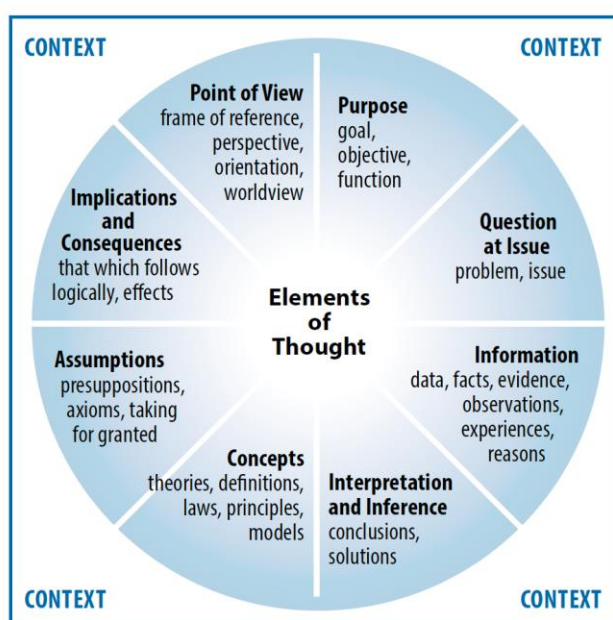


Figure 1 - Elements of thought (Paul & Elder, 2010, p.14)

Paul and Elder (2020) present, in Figure 1, the eight basic elements of thought, from the starting point of view, which has a specific purpose, to the corresponding implications and consequences. There are paths that allow students to raise questions, gather and interpret data and confront concepts and ideas, in order to make assumptions that may answer questions to a particular problem, leading to a critical thinking process.

## 2. METHODS

Higher education students of the Polytechnic of Leiria and the Polytechnic of Coimbra, from the areas of Social Sciences and Education, were challenged to freely create products that highlighted the characteristics of each disability domain. In this sense, the students proposed the creation of characters, in order to represent specific types of disability (hearing, intellectual, motor, visual). A text was created for each character, as a way of presenting them, focusing on their main features. In order to transmit a positive message, there were no explicit comments about each character’s condition, reinforcing their differences as specific characteristics and their main abilities.

Based on the texts, students of the Professional Course in Illustration and Graphic Production (Polytechnic of Leiria) that were enrolled in the subject of Graphic Production and Illustration for Children and Youth were asked to create ludic pedagogical and accessible work to raise awareness about Special Needs amongst young children, challenging them to make several illustration narratives. As ways of presenting the problem to students, different exercises and small games were developed in accordance with two renowned authors: Katsumi Komagata (b. 1953) – contemporary author of children's picture books, whose work focuses on the development of sensory narratives and more recently the development of books for people with visual impairment - and Bruno Munari (1907-1998), designer of various remarkable experiences that were made with and for the children.

"Influenced by Piaget's theories, Munari believed that in the first years of life, children learned about and discovered their surroundings with all five senses. He thus designed a series of twelve 10 x 10 cm "object-books" small enough to fit into a child's hands and easily browsed and touched" (Campagnaro, 2019, p. 91)

Through observation and time, children discover the book's details.

By uncovering the hidden details, children test the perceived limits of the book. Children's sensory receptiveness is stimulated by these touch-and-feel experiences. Thanks to these books, pre-readers learn to be patient, by pushing the visual and physical limits and not passively accepting obstacles. Based on Munari and Komagata, several Leporellos were developed using simplified cut-outs and shapes. The Leporello uses a folding technique so that the pages form a continuous concertina. Also called accordion binding, several lengths of folded pages are glued together to create the extension of the book, with the joints planned to match the fold of the pages.

As part of the methods used, students were challenged to put themselves in the places of people with disability by using specific restrictions, created as thematic introductions to the proposed problems. In this sense, the students were simultaneously placed in the roles of creators and users.

Throughout the process, several moments of group discussion were included to foster critical and reasoned reflection on the chosen options, on the new problems that were emerging and on the proposals for new solutions. The teachers who followed up on and guided the work developed by the students, made participating observations, having registered their grades and comments about the classroom activities in field notes (Edmonds & Kennedy, 2017), whose results are described in the next topic.

### 3. RESULTS

Students were invited to empathize with children with visual impairment by entering class and embarking on their usual path with a blindfold. This simple exercise allows them to imagine how difficult it is for a person to separate from day to day as a task becomes much more complex than they imagined. The importance of the test and the insecurity sensation that they experimented in all the way was crucial to focus on the work to be developed.

The students explored the grammage of the various papers, the possibilities of overlap through transparency, as well as the various sensations given by the texture. Regarding color, the chromatic palettes were tested to function as contrasts (complementarity, saturation, temperature). Still, within this series of exercises, the notion of tactile narrative and continuity was introduced. This is a complex concept for students, as the reading of a sighted child is drastically different from a child with visual impairment reading. For instance, the students immediately discovered that it would be impossible to include essential elements in the back cover of the book, because when reading with their hands the child with visual impairment touches the cover and the back cover at the same time.

Working on a Leporello for children with visual impairment, the students were invited to create simple and expressive work by cutting silhouettes and textures with scissors. While blindfolded, they also tried to identify through tact the work produced by the colleagues. With this exercise they found that working with simplified forms instead of complex ones was highly demanding for a successful reading. They also noticed that the texture of the paper has a very important role in the recognition of the cut shape. They also understood that the mental idea and reference of a certain object is very different when acquired and expressed without the use of vision. The reflections allowed the students to optimize the created forms, the selected materials, the composition and narrative, stimulating the desire to produce, as well as the curiosity, never neglecting the role of the illustrator as an author, with his own voice and creative approach. This was also a major challenge for the students involved: simplifying the forms, composition and narrative to facilitate tactile reading without losing their own individuality as illustrators.

Working on a Leporello for deafness, all students were invited to use headphones, in classes, in order to experience lower levels of hearing or no hearing ability while working creatively, inhibiting or not allowing verbal communication between each other and between themselves and the teacher. While working, students had to find alternative ways to communicate ideas and images without speaking. They realized how the gesture and the body posture is crucial to engage communication. Simple and sequential images and pop-ups were some of the formats that were explored as a result of this experiment. Narratives were created exploring paper folding and different placement of the illustrations. In between these explorations, students played the game Pictionary, trying to express themselves with gestures, in order to decipher the various words in the game was suggesting to them. This was a group experience that was crucial for students to understand the importance of body language, facial expressions and gestures in communication.

Working on a Leporello for physical disability, the given text describes a child who is in a wheelchair. As one of the class students was bound to a wheelchair in his daily life, his shared experience served as a leading example. Students were invited to explore notions of movement, speed and mass. As a way of sensitization and production, other activities were proposed to the students, such as games that implied movement restrictions and awareness of the wheelchair scale. The presence of a student with physical disability was an asset during production, helping to a better understanding of some particularities of people with Special Needs.

In the area of intellectual disability, the starting point of the work was based on the idea of building a game that would allow the creation of a collaborative story. In this sense, children have to combine scenarios and situations, diversifying different paths. With this purpose, it was discussed in groups what would be the best materials to create several narrative possibilities and, at the same

time, allowed several graphic configurations. After the discussion in class, the students decided to explore the creation of a magnetic game with pieces that could be combined on a board in order to create stories and another game by overlaying transparencies, in order to create stories by combining illustrated elements. At this stage, the sharing of experiences from students who have family members or friends with intellectual disabilities was crucial.

#### 4. DISCUSSION

The recognition of specific characteristics and difficulties allows “targeted interventions in order to enable access to mainstream development processes” (Skoog, 2017, p. 349) that, in this case, have been accomplished through the creation of the graphic products with an added value. Placing the students in a position of experiencing some amount of disability, through the creation of restrictions, stimulated a continuous reflection on these people’s features and their possible differences, namely about the:

- a) use or not of complex forms that influence visual and haptic reading when in composition;
- b) use of color and contrast;
- c) amount of relief to be created;
- d) ratio of tactile readability to the size of each character and the spacing between the characters;

also allow the reflection about tactile reading of information presented simultaneously on the front and on the back of paper sheets. Reflexions were produced regarding the size of the products and the rules for their usability, like the creation of a hopscotch based game from the proportions of a wheelchair, with new rules. A card game related to deafness was built by exploring the idea of cards with sequential images of sign language showing simple words and the mechanics of a bingo game.

The students were led to explore their own senses as ways of understanding and creating communication objects that were shared and tested in the classroom. By working with specific points of view, testing possible solutions and discussing the work in progress, the graphic products gained specific characteristics, such as the size, format and way of opening books.

These considerations, generated during and after several phases of exploring and production, allowed a constant process of validation and exclusion of proposals. Reflecting while producing allows to find different ways to explore materials and achieve improved solutions. Reflecting on the production act allows to analyze the choices and tests carried out, pointing to conclusions. In this sense, sketches, mock-ups, prototypes have emerged as means to test and establish hypotheses in the quest for communication. Experimentation, often intuitive and casual, was tested and created knowledge, “there is a two-way relationship between the research problem, the goals, and the associated research questions and/or hypotheses” (Ellis & Levy, 2008, p.20).

The working method allowed the creation of differentiated solutions for each of the books that intends to contextualize the four major domains of disability, by considering the proposed goals to achieve, the continuous exploration of themes and specific restrictions, the feedback, and graphic accessibility issues. This method fed a production that became conscious and that progressively (step by step) constructed the proper body of product. A body impossible to imagine in the beginning of the project, that emerges as a consequence of the successive search for creative and critical solutions.

#### CONCLUSIONS

The ProLearn4ALL project sought, through a problem-based methodology, to stimulate critical thinking in higher education students as producers of creative solutions that met two purposes: raising the awareness of primary school children for difference in human being, and the construction of accessible products in multiformat.

“The starting point for learning is a problem, not a theory” (Hallinger & Bridges, 2016, p.3). The process of trying to solve illustration and communication problems by creating empathy towards the people that are the target audience, resulted in graphic objects that allowed students growing as individuals and as creatives. By allowing the work to find individual paths and possible solutions in a creative, critical and pondered way, the students progressively showed less concern with the application of preconceived formulas, placing their focus on the individual development of each product and idea. Solving problems by first experiencing restrictions helped finding different research paths and different graphic solutions, helping each student to find specific variations and interests during the development of their proposals.

These students became active performers in the process of finding ways to solve nonroutine problems, instead of adopting a passive stand and apply previously tested methods and solutions that had already been implemented by others.

Although the results show that the initial objective was achieved, it would be relevant to involve other students, particularly from other levels of higher education (degrees and masters), in order to enrich the creative process. The need to meet a predefined schedule approved by the project funding entity, which included the development of several phases, made it impossible to happen. However, this challenge could be taken into account in future studies, in which it is appropriate to involve more people with different types of disabilities who could contribute to test and validate the built resources, ensuring they are as accessible as possible.

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