Erasmus+

Elearning Course

Educational Programming and Robotics @ Learning Scenarios

Report and Evaluation

(Intellectual Output 2)

Educational Robotic and Programming and Learning Scenarios
2020-1-PT01-KA201-078670

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Introduction

This course was designed to offer an enriching and dynamic learning experience, covering a wide range of interdisciplinary themes, from understanding microcontrollers to creating virtual environments and materializing three-dimensional objects through 3D printing. Organized into strategically structured modules, this course aimed to enable participants to acquire theoretical knowledge and apply practical skills in a real scenario in the area of Educational Robotics and Programming using learning scenarios for secondary education.

Education is currently undergoing a remarkable transformation, with online learning becoming an integral part of the global educational landscape. In this context, the creation of effective online courses has become a priority for both educational institutions and professionals who wish to provide quality educational content to a diverse audience. However, successfully developing and implementing an online course is not a simple task. It requires careful planning, choosing the right e-learning platform, designing the course, and selecting strategies that meet the needs of participants.

This report aims to document all phases of creating the online course, as well as carrying out its evaluation. It will address the course design and development process, the choice of the e-learning platform, the content structure, the pedagogical strategies implemented and the way in which the learning assessment was conducted. The results obtained, the participants' perceptions and the challenges faced throughout the process will be analyzed. The course evaluation will be carried out based on the KirkPatrick model, aiming to guarantee the quality and effectiveness of the online course.

Methodology

The methodology of an E-Learning course is fundamental to creating an effective and engaging virtual learning environment. In methodological terms for creating the E-Learning course, there were a set of steps that led to the creation of a course that, we believe, is well structured.

E-LEARNING PLATFORM SELECTION

Choosing an E-Learning platform is a crucial moment and must bring together a set of characteristics such as being user-friendly, stable and offering resources for hosting content, managing participants, facilitating communication and the possibility of checking progress. After a discussion between all partners, the decision was made to use Moodle, a popular and open source e-learning platform widely used by educational institutions, companies and organizations. There are several reasons why Moodle was chosen as an e-learning platform:

(i) Moodle is open source software, which means it is free to use and customize, allowing it to be adapted according to specific needs and without license costs.
(ii) Moodle has an active global community that contributes to improvements and offers support, ensuring it is constantly evolving and updating.
(iii) Moodle is highly customizable and the platform's appearance, functionality and workflow can be changed to meet the needs of the partnership.
(iv) Supports a variety of content types, including text, video, audio, quizzes, discussion forums, which allows you to create diverse resources and activities.
(v) Offers access control and security features
(vi) Moodle supports several languages, a factor considered critical in this course.
(vii) It allows the promotion of collaborative learning through discussion forums, chats, wikis and other tools that encourage interaction between participants.

Moodle was, therefore, the obvious choice for the e-learning platform, because, in addition to the previous reasons, it was already known to all partners. Partners were already familiar with the platform, which accelerated adaptation and acceptance of the technology. Furthermore, Moodle's rich features and flexibility allowed us to customize the environment according to specific needs, ensuring an engaging learning experience.

COURSE DESIGN

This phase involved structuring the course content in a logical and coherent manner. The material was divided into modules, created with interactive activities as well as relevant assessments:

MODULE 0 – PRESENTATION AND OBJECTIVES -SC(PT)

This module plays a key role in introducing an online course. It was intended to provide teachers with an overview of the course and establish clear expectations from the beginning. The following guidelines were defined:

Create a welcome message:

Provide an overview of the course, explaining its structure, content and schedule

Describe the learning objectives that teachers should achieve upon completing the course

Explain the methodology that will be used in the course.

Present the forms of evaluation, including evaluation criteria and delivery dates.

Present the tools and resources that teachers will use, such as the e-learning platform, supporting materials, relevant links and any other additional resources.

Include a Questions section to address common teacher questions and provide answers to questions that may arise.

Encourage teacher interaction in this module.

This module serves as an essential starting point to guide teachers and establish a solid foundation for the online course, ensuring everyone has a clear understanding of the objectives, methods, and expectations.

MODULE 1 – LEARNING SCENARIOS – EMT(TR)

GOALS

The intent of a goal-based scenario is to provide motivation, a sense of accomplishment, a support system, and a focus on skills rather than facts.

GOALS

Understand the Structure and Components of a Learning Scenario:

Recognize the Benefits of Learning Scenarios:

APPROACHES

The aim is to enable teachers to understand what constitutes a learning scenario, including its structure, components and purpose. This will enable students to gain a solid understanding of key concepts related to learning scenarios, enabling them to create, analyze and adapt learning scenarios effectively in diverse educational contexts.

SELF-EMPLOYMENT

It is intended that teachers analyze the proposed structure for the learning scenario and adapt it to their needs and context.

ASSESSMENT

After completing the module, as part of the assessment, teachers must answer closed questions related to the topics covered.

RESOURCES

A set of resources will be provided so that teachers are able to reflect on the application of learning scenarios in their teaching practice.

MODULE 2 – USE OF ARDUINO AND SENSORS - AEAC(PT) and ANPRI(PT)

GOALS

Understand the functionalities of a microcontroller;

Discuss electronic board programming techniques;

Create electronic circuits with different sensors and actuators using the Arduino board.

APPROACHES

Install and configure the Arduino IDE or using Tinkercad.

Creation of circuits, observing the correct connection of the different components.

Implementation of code necessary to activate sensors and actuators.

SELF-EMPLOYMENT

The aim is for the teacher to build an electrical circuit, with the appropriate components, that allows solving/simulating an everyday problem integrated into pedagogical practice.

ASSESSMENT

After completing the module, as part of the assessment, teachers must complete two practical tasks.

RESOURCES

To implement this module in practice, the following Arduino starter kit material is recommended (Arduino Uno; LEDs; resistors; breadboard; LDR; potentiometer; jumpers; push buttons. If you choose the simulation, you should use TinkerCad.

MODULE 3 – VIRTUAL REALITY – LCL(IT)

GOALS

Enable graduates to create and interact effectively in virtual environments, including building avatars, navigating virtual worlds, and using communication and collaboration tools.

Foster collaboration and effective communication in virtual environments.

Understanding the Integration between Immersion and Virtual/Augmented Reality (VR/AR)

APPROACHES

Immersive Software Installation (EDMODO)

Personal Avatar Creation and Exploration:

Building the Immersive World from Scratch:

Integration with VR/AR through Another Online Platform:

SELF-EMPLOYMENT

Teachers will create an avatar and their learning environments.

ASSESSMENT

At the end of the module there will be an assessment activity consisting of closed questions.

MODULE 4- 3D MODELING AND PRINTING-TEB(PL)

GOALS

The main objective is to familiarize participants with 3D printing.

Starting with the drawing, then cutting the design until it is ready for printing.

APPROACHES

1. Preparation of the project using the Inventor program
2. Familiarization with the principles of 3D printing.
   - how the 3D printer works
   - what is the first layer
   - what is a stand and how to use it
   - how to prepare a file for printing
3. Basics of using the PrusaSlicer program

SELF-EMPLOYMENT

As they work, students will create their own projects using the Inventor program. They will then export this step file for further processing using the PrusaSlicer program, prepare the project for printing using appropriate printing parameters depending on the purpose of the project. Ultimately, students will supervise the printing process and respond appropriately to any difficulties that arise.

ASSESSMENT

At the end of the module there will be an assessment activity consisting of closed questions.

MODULE 5- CHALLENGES TO THE IMPLEMENTATION OF EPR@LC-SC(PT)

GOALS

Create, apply and evaluate a learning scenario containing the exploration of ERP and its application in an educational context.

APPROACHES

Presentation of a flexible model for creating learning scenarios.

Discussion of strategies for applying learning scenarios - creating a collaborative mind map about learning scenarios for EPR

Prepare a learning scenario and apply it in a pedagogical context:

- Design the LC
- Implementation of LC in the classroom
- Assessment
- Student perceptions
- Teacher's reflection

SELF-EMPLOYMENT

Participants are tasked with creating a specific learning scenario for use in a real pedagogical context, such as a classroom, using what they have learned in previous modules. This scenario will be implemented in a real classroom situation. After implementing the learning scenario, teachers conduct an evaluation to determine the success and effectiveness of the scenario in achieving the learning objectives.

The autonomous work continues with a reflection phase, where participants analyze the information collected, evaluate their own performance as instructors and identify opportunities for improvement in the learning scenario.

STRATEGIC OPTIONS

When creating this course, the partnership defined a set of strategic options that guided the creation of the online course.

1. Partnerships and specialization

Each module of this online course was developed by the partner who had the knowledge and experience in the specific area. This approach ensured that each module was enriched with the knowledge of experts in the field. Nevertheless, all partners collaborated at all stages, making the course more comprehensive and offering diverse perspectives, enriching the teachers' learning experience.

2. Flexible Structure and Cross-border Contributions

A striking feature of this course is the flexible structure of the learning scenarios, which was created with contributions from all partners. This approach allows the course structure to be adaptable to different educational contexts and teaching preferences. The richness of transnational experience is also reflected in the flexibility of the course, which can be customized to local and global needs.

3. Presentation of Modules through Learning Scenarios

Each module of this course is presented through a learning scenario, offering an engaging and practical approach. Learning scenarios encourage the appropriation of knowledge, allowing teachers to actively engage with the concepts presented. How the use of learning scenarios contributes to a more immersive and meaningful learning experience will be explored.

4. Consistent Structure:

Although the course has a flexible structure that can be adapted, the internal structure of each module remains consistent. This ensures that trainees know what to expect, regardless of the module. This consistency in structure makes it easier for teachers to navigate and understand, promoting a more effective experience.

5. Challenging Activities

The activities proposed in each module were carefully designed to be challenging.

6. Multilingual Support

A distinctive aspect of this course is the availability in several languages, corresponding to the languages of the partners. The inclusion of multiple languages makes the course accessible to an international audience and strengthens intercultural understanding and collaboration. In addition to the platform supporting the multilingual component, all content and activities were translated into English (the partnership's working language) and later into Turkish, Portuguese, Italian and Polish.

7. Training certification mechanisms

Continuous training is a fundamental pillar for improving education. In particular, teacher training plays a critical role in ensuring that educators are up to date with best practices and the latest trends. In this context, certification mechanisms play a vital role, not only validating the effort and dedication of teachers, but also significantly impacting the evolution of their careers.

Certification represents formal recognition of the effort and commitment of educators in pursuit of professional improvement. In addition to validating the successful completion of a training program, it also demonstrates that the teacher has acquired specific skills and knowledge. When we designed a training course, we always had the issue of certification in mind. This issue was somewhat complex as it brought together countries with different educational systems and different procedures. Two distinct forms were identified:

- In Portugal, training must be certified before being implemented. The Scientific Council for Continuous Teacher Training is responsible for various functions and responsibilities with regard to the continuous training of teachers in Portuguese territory. Among them is the approval of continuous training plans proposed by training entities, ensuring that they are aligned with the needs of teachers and the country's educational policies. In this sense, a rather lengthy procedure was followed in order to have this training recognized for the purposes set out in paragraph 1 of article 8 and article 9 of the Legal Regime for Continuing Teacher Training. After long months of waiting, the training was officially accredited in Portugal, leading to a teaching career.

- In the case of other partnership countries, the process is slightly different. After completing the training, the certificate of completion and supporting documents are sent to the entities that carry out your accreditation. This process is done by each teacher. In this sense, all teachers who complete the training will be issued a certificate and documents will be made available so that, from now on, they can apply for certification.

This is considered essential, not only to motivate teachers, but also to highlight the seriousness and value attributed to continuous training. Obtaining a certification in a teacher training course increases educators' self-confidence and motivation.

8. Protocol with EDMONDO

LCL(IT) – partner from Italy – played a fundamental role in our educational project, bringing with them skills in virtual reality. The deep understanding and experience in this field was invaluable, especially in integrating Virtual Reality (VR) into training. Furthermore, the close collaboration between the Italian partner and Edmondo, an online VR learning platform, significantly enriched the course. Edmondo is an online 3D virtual world dedicated exclusively to teachers and students to innovate learning in the classroom. It is an initiative of INDIRE, the National Institute of Documentation for Innovation and Educational Research and recognized by the Italian Ministry of Education. Proof of Edmondo's commitment to transforming education through technology was its creator's participation in a significant event that took place in Italy. During the Multipler Event that took place in Italy, the creator of Edmondo himself, Andreas Benassi, shared his visionary ideas about the potential of this technology in education. This meeting was the beginning of a productive partnership.

With the technical experience of the Italian partner and Edmondo's influence, we were able to leverage the best practices and insights in the sector, making our initiative even more impactful. Furthermore, Edmodo's generous gesture in making its platform available at no cost to the project was an act of great generosity and commitment. This allowed our participants to have access to a high-quality learning tool, without financial burden.

Structure of the training course

This course was designed to offer an enriching learning experience, covering a wide range of interdisciplinary topics, from understanding micro-controllers to creating virtual environments and materializing three-dimensional objects through 3D printing. Organized into strategically structured modules, this course aimed to enable participants to acquire theoretical knowledge and apply practical skills in a real scenario.

According to the methodology presented in the previous section, Moodle was installed and configured and courses were created in each language of the partnership. Access was through the project website (https://epr-lc.eu):

Figure 1- Link to access the course from the project website

After clicking on the menu, the user is taken to a space with Moodle, where the different versions of the course are shown, with the name of the training in the language of each country. In addition to the platform assuming the language in all dimensions, all content and activities presented, as already mentioned, were translated. The following image shows the different versions available:

Figure 2- Courses available on the project's Moodle platform

To access the course, each partner created a registration form where the teacher's email address was requested. After this registration process, the access key to the respective course was sent.

Once on the platform, and once again in accordance with what was defined in the methodology, teachers had access to the course modules, as illustrated in the following image:

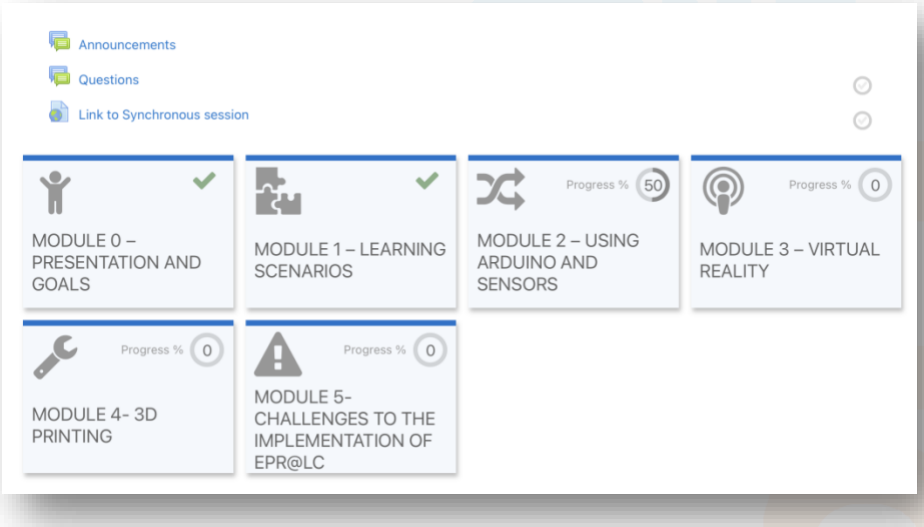

Figure 3- Modules available for each course on the project's Moodle platform

The forums created for announcements and for asking questions stand out. The link to the synchronous videoconference sessions was also made available.

Module 0 - Course Presentation

This introductory module established the context and structure of the course. The main objective is to give participants an overview of the training program, understand the educational objectives, the relevance of each subsequent module, as well as the evaluation criteria. Full details of resources and methodological approaches were provided to ensure a comprehensive understanding of the training provided.

In this module, participants had access to the following options:

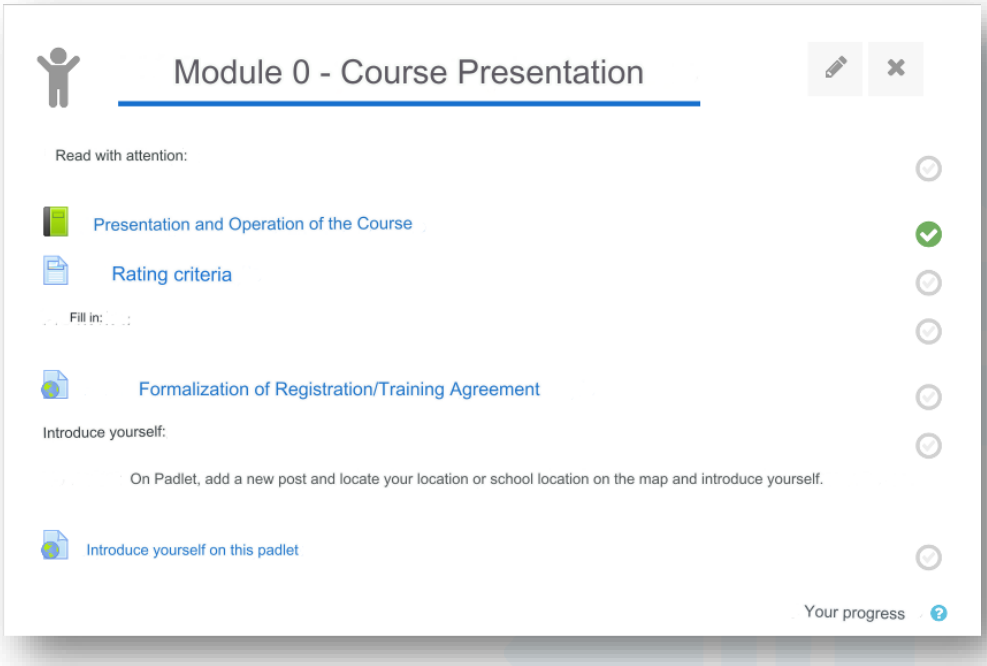

Figure 4- Structure of Module 0 – Course Presentation

With the “Presentation and Operation of the Course” option, participants had access to a “training book” as explained in the following image:

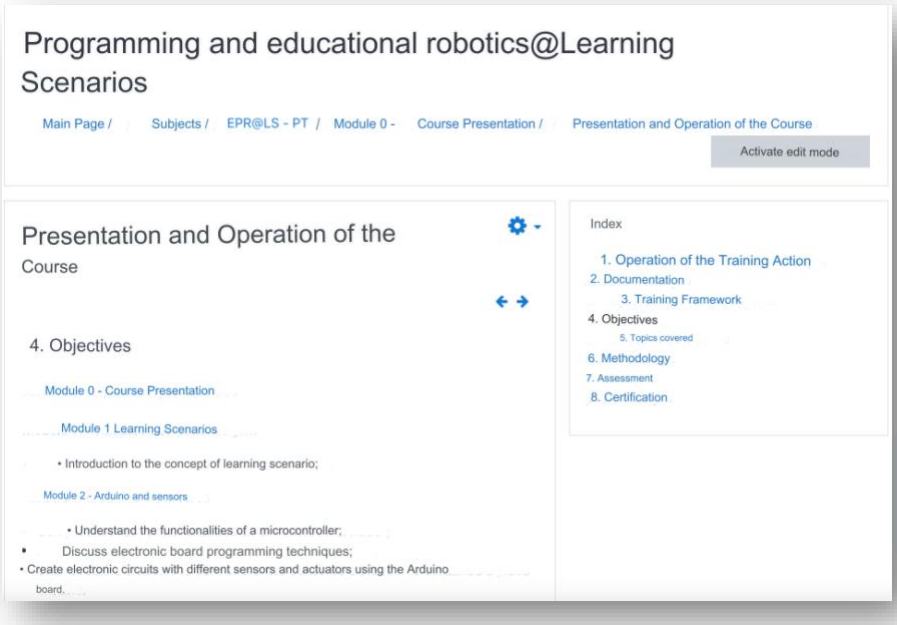

Figure 5- Structure of Module 0 – Course Presentation

This book is divided into:

Training Action Operation: In this section, the training action operation mode was explained, including the calendar, duration, times and any requirements or conditions for participation.

Documentation: The necessary documentation for participation in the training was provided, such as registration forms, course materials and any additional documentation that the trainees needed.

Training Framework: The context and justification for the training were described, including the target audience and the relevance of the training for the participants.

Objectives: The general and specific objectives of the training were clearly and concisely indicated, that is, what the trainees were expected to achieve at the end of the course.

Topics covered: The topics and subjects that were covered during the training were listed, offering an overview of the areas of knowledge that were explored.

Methodology: It was explained how the training was provided, including teaching methods, tools, learning strategies, practical activities, among other details about how the contents were transmitted to the trainees.

Assessment: The assessment methods and criteria that were used to measure the progress and performance of trainees were covered, as well as expectations regarding participation and achievement of objectives.

Certification: It was explained how trainees would be certified upon completion of training, including details about the certificates, diplomas or recognitions that were awarded.

In the methodology section, it was defined that activities should be implemented that allowed teachers to interact, namely through an initial collaborative activity. In this sense, a georeferenced Padlet was created, taking into account the international context in which the training took place. Although the teachers were divided into different courses taking into account the language, this space marked the beginning of transnational collaboration. The following image illustrates some of the teachers' interactions:

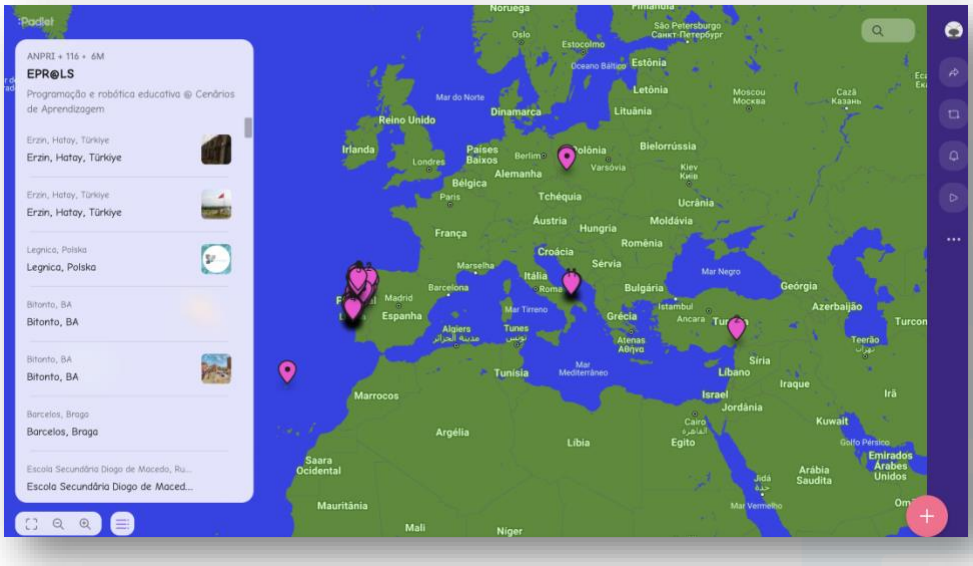

Figure 6- Module 0 – Course Presentation – Collaborative Padlet

Module 1 - Learning Scenarios

The Learning Scenarios module explores the power of diverse learning environments. We will analyze the importance of alignment between the structure of the learning scenario and educational objectives. By exploring traditional and innovative learning scenarios, participants will have the opportunity to develop an in-depth understanding of how appropriate scenario selection can improve the teaching and learning process.

The following image illustrates the module 1 area:

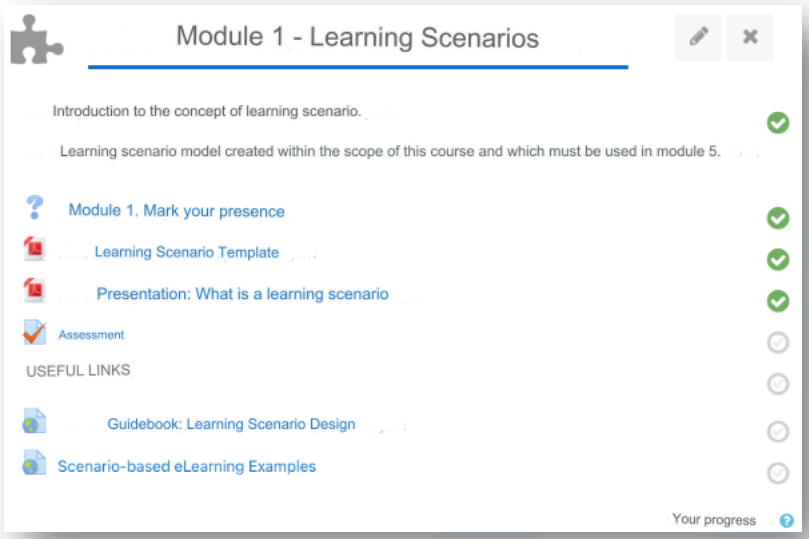

Figure 7- Module 1 – Structure

This module is made up of the following components:

Attendance Mark: This element is a reminder for teachers to mark their presence in the module.

Learning scenario template: Template that can be used to create learning scenarios created by the partnership

What is a learning scenario: Resource containing a document that provides a definition of a learning scenario and the benefits of its use.

Assessment: Self-assessment questionnaire

USEFUL LINKS: This element provides links to useful resources such as a learning scenario design guide and examples of eLearning-based learning scenarios.

Module 2 - Arduino and Sensors

This module addresses the universe of electronics and programming through the exploration of micro-controllers, with a primary focus on the popular Arduino micro-controllers. Teachers were able to have contact with the intrinsic functionalities of these devices, understanding how to control and interact with sensors and actuators. In addition to acquiring programming skills, participants learned how to interconnect electronic elements, enabling the creation of functional and interactive systems.

The following image illustrates the structure of the module, as defined in the methodology section.

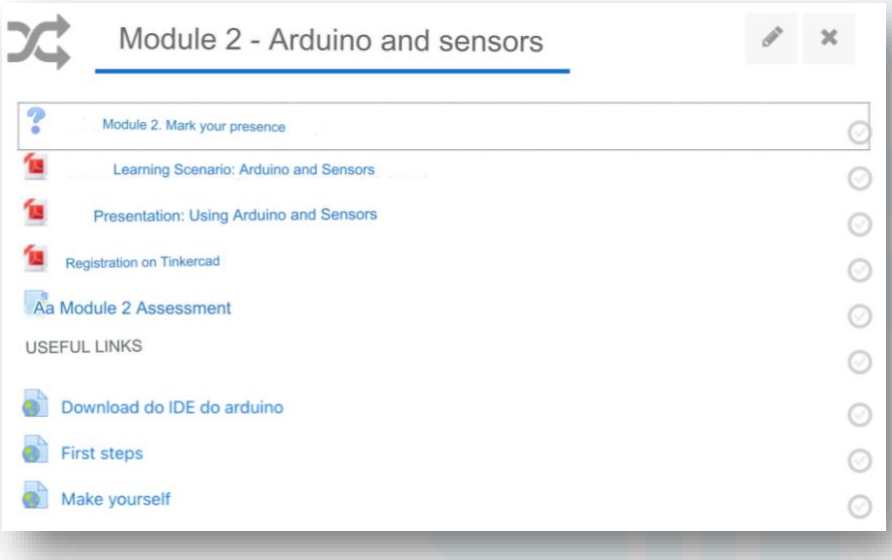

Figure 8- Module 2 – Structure

Module 3 - Virtual Reality

In the Virtual Reality module, participants were led through the creation and exploration of immersive virtual environments. Installing the necessary software (EDMONDO) allowed interaction with a virtual scenario, while the creation of a personal avatar provided an immersive and personalized experience. The process of developing their own virtual world provided participants with the opportunity to experience digital creation. Furthermore, the integration of virtual reality with other online platforms was explored, expanding the possibilities of immersion in educational contexts.

The following image illustrates the structure of the module, as defined in the methodology section.

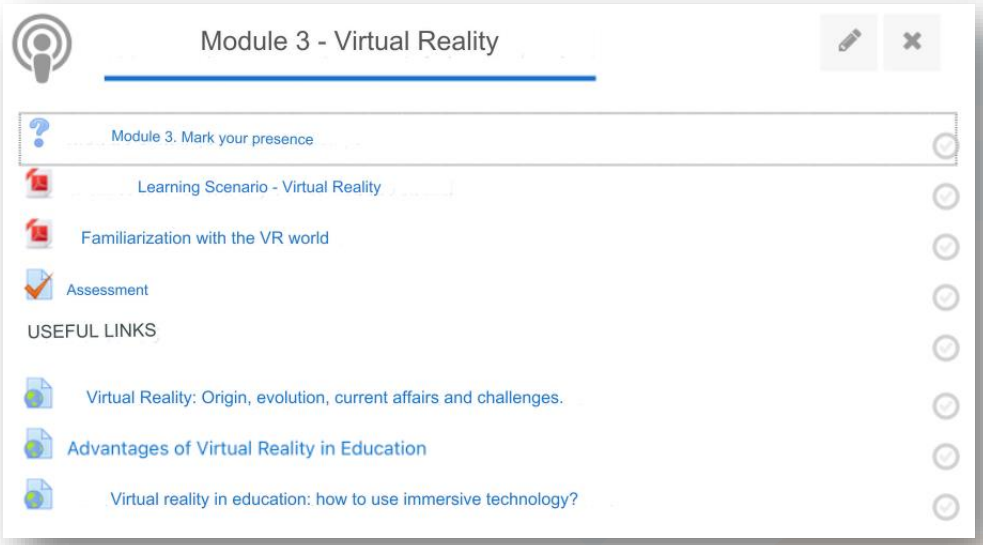

Figure 9- Module 3 – Structure

Module 4 - 3D Modeling and Printing

In Module 4, participants were challenged to start 3D modeling and printing. Using the Inventor program, they designed simple projects, acquiring or improving their design skills and spatial understanding. The introduction to the fundamental principles of 3D printing allowed participants to materialize their projects into tangible objects. Additionally, the basics of PrusaSlicer were covered, preparing the models for 3D printing.

The following image illustrates the structure of the module, as defined in the methodology section.

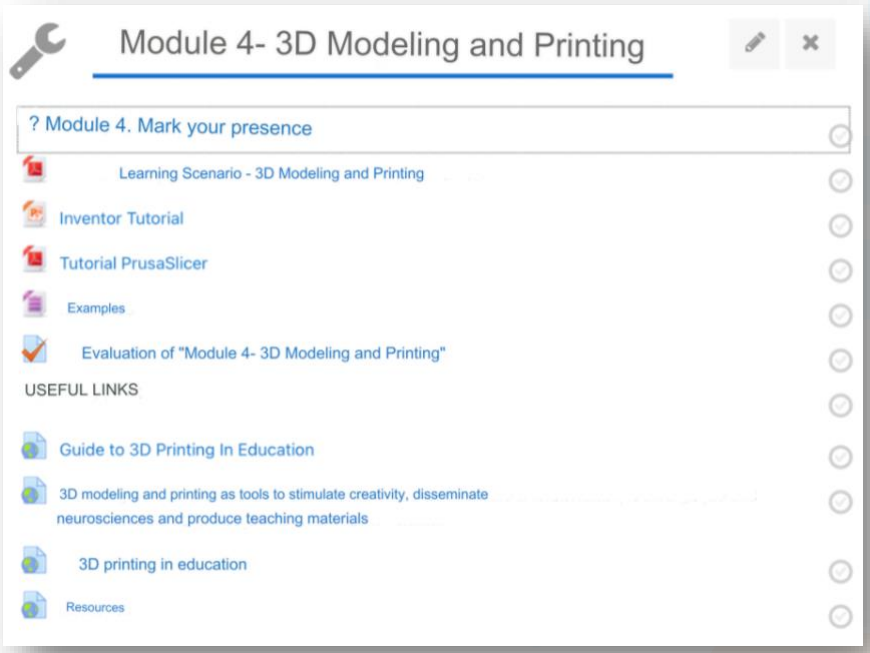

Figure 10- Module 4 – Structure

Module 5 - Challenges for Implementing EPR@LC

In the last module, a flexible template was presented for creating learning scenarios that meet the needs of the current educational environment. Participants were challenged to prepare and apply learning scenarios in pedagogical contexts. This final stage of the course addressed the practical applicability of the acquired skills, emphasizing the connection between theory and practice in the educational field.

The entire course is designed to inspire and empower participants to become adept at technology and innovation, acquiring solid knowledge and applying it in a practical and creative way.

The following image illustrates the structure of the module, as defined in the methodology section.

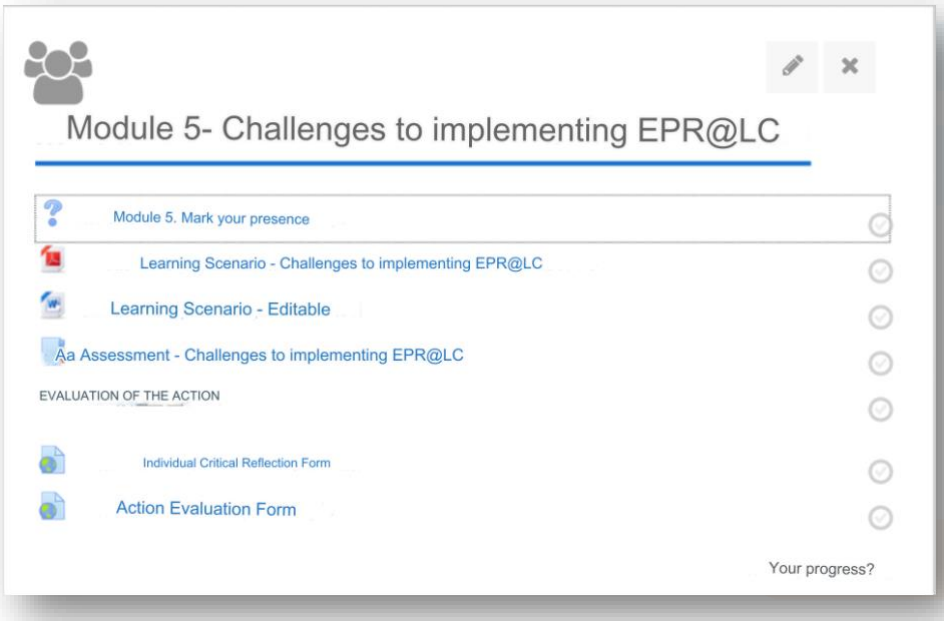

Figure 11- Module 5 – Structure

As this is the final module, it is also important to highlight the assessment strategy for this module. Participants were challenged to create a learning scenario involving one or more contents from the previously covered modules and apply them to their educational practice – whether in a classroom context or in pedagogical contexts. The following image shows the launch of this challenge.

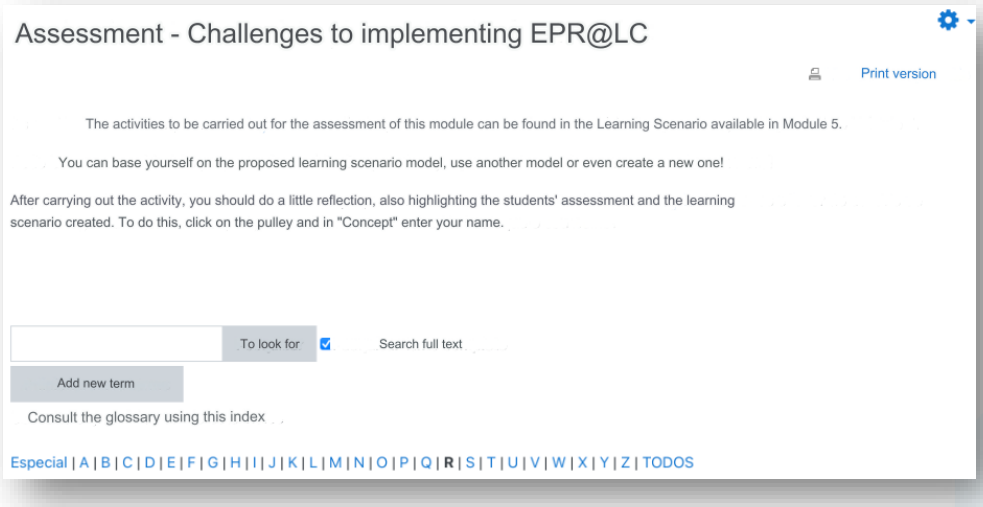

Figure 12- Module 5 – Public Work Submission Area

The works were submitted using the "Glossary" tool and were public to all participants, as illustrated in the following image:

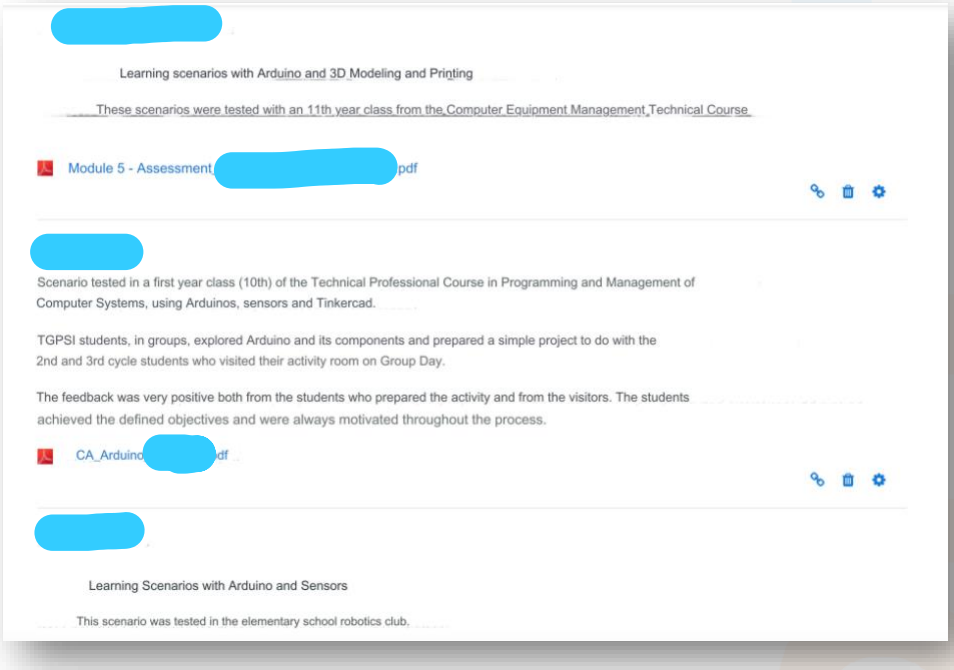

Figure 13- Module 5 – Example of the layout of submitted works

This strategic decision provided greater dynamics, in which all participants were able to explore and have access to each other's work. This, in turn, created an environment conducive to sharing ideas, experiences and knowledge, whilst encouraging active collaboration between those involved. Through this reciprocal access to individual contributions, participants were able to enrich their own perspectives, learn from colleagues, and build an interactive and collaborative learning environment.

At the end of the course, and despite other forms of certification and validation of the skills already mentioned in the methodology section being considered, a certificate was issued to all participants, as shown in the following image:

Figure 14- Example of a course completion certificate

It should only be noted that the option to issue the certificate is only available after a participant has completed all the tasks proposed throughout the training.

Assessment

The pandemic brought challenges of unprecedented magnitude, profoundly changing the foundations of several sectors of society, including education. In this constantly evolving scenario, the role of teachers has gained increased relevance, and online training has emerged as a crucial tool to enable teachers to face the new paradigms triggered by this era of digital transformation (Carneiro & Ferreira, 2021; Crawford et al. , 2020). Physical distancing has precipitated the widespread adoption of online teaching, requiring rapid adaptation by teachers to meet the needs of students in virtual environments. Online training not only gives teachers flexibility to improve their skills at their own pace, but also provides a space to explore educational innovations aligned with the demands of contemporary digital society (Crawford et al., 2020).

It was in this emerging and highly favorable context that the training course in "Educational Programming And Robotics @ Learning Scenarios" took place. Programming and robotics encourage more practical and interactive pedagogical approaches. Teachers proficient in these areas have the ability to create immersive learning environments that stimulate students' creativity, critical thinking skills, and problem solving (Resnick, 2017). However, this training aimed to go even further by training teachers to integrate technologies into their pedagogical practices. By deeply understanding how these tools can be intricately woven into curricula, teachers rise to the level of learning facilitators, capable of preparing students for the challenges and opportunities of an increasingly digital world. Robotics and programming transcend the status of mere disciplines of the future, becoming transformative resources that make the learning experience more attractive, engaging and enriching.

In the dynamic context of online environments, assessment emerges as a central vector that transcends conventional assessment and investigates the complexities of educational improvement. This multifaceted process not only encompasses evaluating the effectiveness of training, but also through tangible educational outcomes. Conventionally, a combination of formative and summative assessment techniques are employed to gather knowledge about the dynamics of training (Kirkpatrick, 1994). These cover participant engagement, knowledge assimilation and recommendations for refining the modules, thus providing a panoramic perspective on the effectiveness of the program and opportunities for refinement (Kraiger, Ford, & Salas, 2017). However, contemporary understanding of the effectiveness of online teacher education programs goes far beyond participant satisfaction and rote knowledge retention. Research highlights the importance of the continuous application of knowledge in the classroom, encapsulated in the “knowledge transfer” paradigm (Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012). The crucial point of successful training now lies not only in the acquisition of knowledge, but rather in the discernible translation of that knowledge into teaching and learning practices that prove to be effective. It is in this synergy of training efficiency and its practical ramifications that the true essence of training effectiveness lies.

Quantitative assessment

Firstly, it was important to see how the participants of the elearning course were distributed across different countries. This situation is depicted in the following graph:

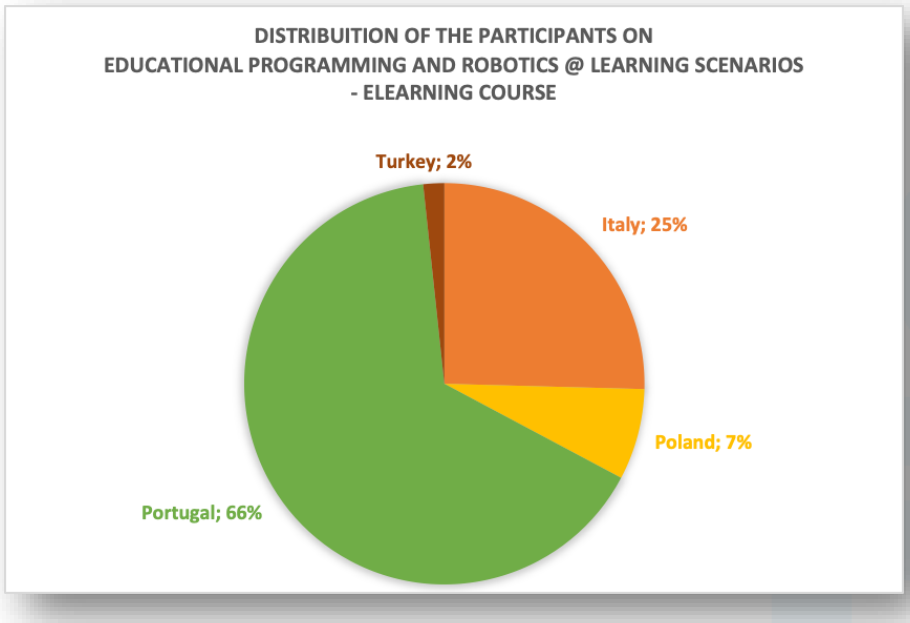

Figure 15- Distribution of course participants by country

The majority of participants, 66%, are from Portugal, followed by Italy with 25%. Poland and Turkey have a smaller representation, with 7% and 2%, respectively. Turkey's low participation is related to the timing of the course, in the post-earthquake period.

The following graph shows the average ratings of the evaluation activities of the Educational Programming And Robotics @ Learning Scenarios - Elearning Course training. As already mentioned, only modules M1 (Learning Scenarios), M3 (Virtual Reality) and M4 (3D Modeling and Printing) included a quantitative assessment activity, in the form of a questionnaire with multiple choice questions.

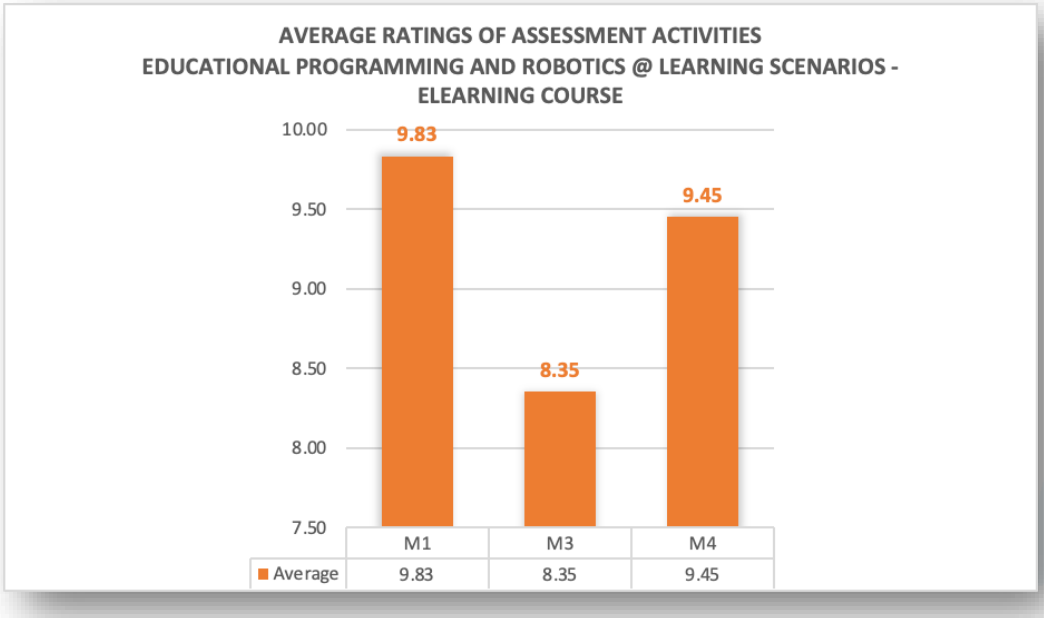

Figure 16- Average ratings of assessment activities - Educational Programming and Robotics @ Learning Scenarios - Elearning Course

The chart has three bars, each representing an assessment activity. The Module 1 assessment obtained the highest average, with 9.83. The Module 3 assessment obtained the lowest average, with 8.35. The average rating for all activities was 9.2. The graph shows that course evaluations were very positive. The overall average was 9.2, which is an indication that participants achieved their objectives.

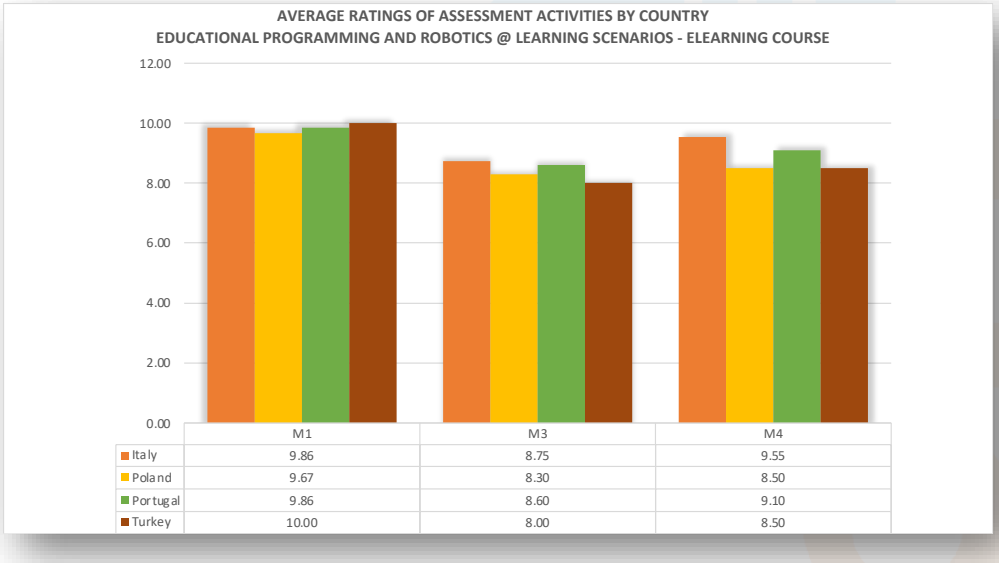

Figure 17– Average ratings of assessment activities by country
Educational Programming And Robotics @ Learning Scenarios - EleArning Course

The Module 1 assessment obtained the highest average, with 9.86 in Portugal and 10.00 in Turkey. The Module 3 assessment obtained the lowest average, with 8.75 in Portugal and 8.30 in Italy.

The deviation of the classifications of assessment activities by country and module in relation to the average of the Educational Programming and Robotics Course @ Learning Scenarios - eLearning was also considered important. The result of this analysis is shown in the following graph:

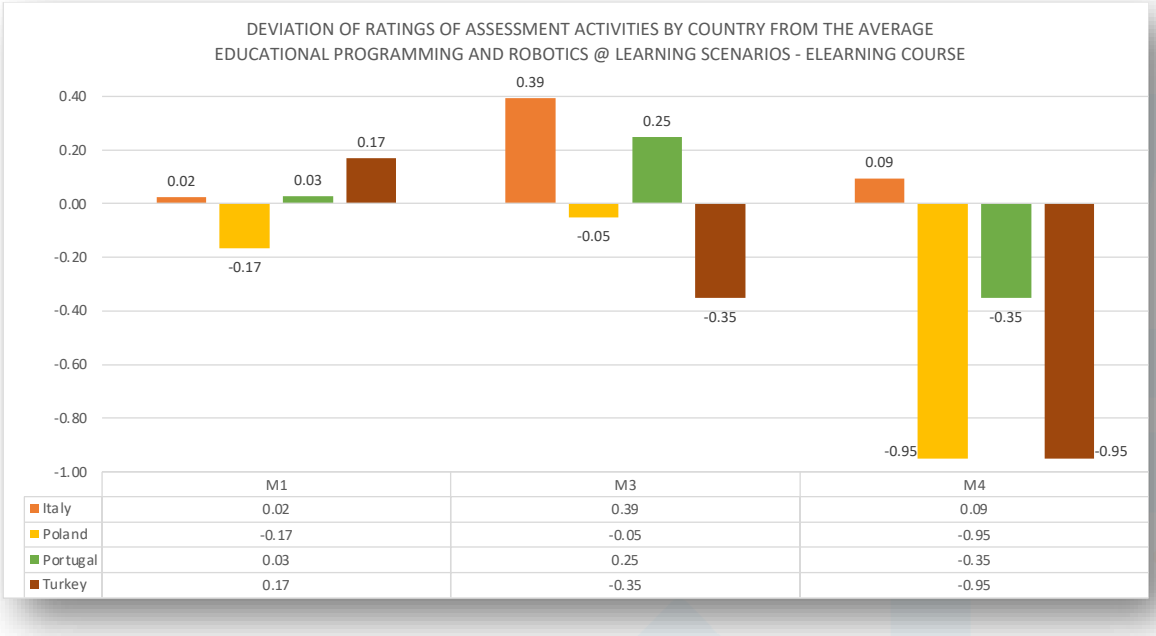

Figure 18- Deviation Of Ratings Of Assessment Activities By Country From The Average Educational Programming And Robotics @ Learning Scenarios - Elearning Course

The image shows a scatterplot that represents the deviation of assessments from assessment activities for the course "Educational Programming and Robotics @ Learning Scenarios" by country. The X-axis represents the deviation of ratings from the average, while the Y-axis represents the country.

The graph shows that course reviews were generally positive. Most of the points are concentrated in the upper right corner of the graph, which means that the ratings were, on average, higher than average.

However, there are some differences between countries. Portugal and Italy have a greater concentration of points in the upper right corner, which suggests that participants from these countries were more satisfied with the course. Poland and Turkey have a smaller concentration of points in the upper right corner, which suggests that participants from these countries were less satisfied with the course.

A more detailed description follows:

Portugal

The majority of points are concentrated in the top right corner, which suggests that Portuguese participants were more satisfied with the course. The evaluation of Module 1 had the largest positive bias, which suggests that Portuguese participants were particularly satisfied with this module. The evaluation of Module 3 had the smallest negative deviation, which suggests that Portuguese participants were relatively satisfied with this module.

Italy

The majority of points are concentrated in the top right corner, which suggests that Italian participants were more satisfied with the course. The evaluation of Module 1 had the largest positive bias, which suggests that Italian participants were particularly satisfied with this module. The Module 3 assessment had the smallest negative bias, which suggests that Italian participants were relatively satisfied with this module.

Poland

The distribution of points is more even, which suggests that Polish participants were more satisfied with some modules and less satisfied with others. The evaluation of Module 1 had the largest positive bias, which suggests that Polish participants were particularly satisfied with this module. The assessment for Module 3 had the smallest negative bias, which suggests that Polish participants were relatively satisfied with this module.

Türkiye:

The distribution of points is more even, which suggests that Turkish participants were more satisfied with some modules and less satisfied with others. The evaluation of Module 1 had the largest positive skew, which suggests that Turkish participants were particularly satisfied with this module. The Module 3 assessment had the smallest negative bias, which suggests that Turkish participants were relatively satisfied with this module.

KirkPatrick Evaluation Model

The Kirkpatrick Model, developed by Donald L. Kirkpatrick in the 1950s, is one of the most recognized and used frameworks for evaluating the effectiveness of training programs. This model proposes a four-level approach to evaluating the impact of a training program, considering different aspects of the effect of training on participants and the organization as a whole.

1. **Level of Reaction:** In this initial stage, the evaluation focuses on the participants' reaction to the training. This includes gathering opinions about participant satisfaction, the quality of the training, the relevance of the content and the effectiveness of the trainer (Kirkpatrick, 1994).

2. **Learning Level:** At this second level, the evaluation aims to measure how much participants learned during training. This involves evaluating the increase in knowledge, skills and abilities acquired. Assessment methods may include tests, practical assessments, simulations or other activities that demonstrate the acquisition of new knowledge (Kirkpatrick & Kirkpatrick, 2006).

3. **Behavioral Level:** The third level focuses on transferring learning to the work environment. It is assessed whether participants are applying the skills and knowledge acquired during training in their daily activities. This may involve direct observation, feedback from supervisors or colleagues, and analysis of related performance indicators (Alliger, Tannenbaum, Bennett Jr, Traver, & Shotland, 1997).

4. **Outcome Level:** The fourth level focuses on the broader outcomes of training for the organization. The impact of training on organizational objectives is evaluated, such as increasing productivity, reducing errors, improving the quality of the product or service and other measurable results. Data collection at this level may involve analysis of key performance indicators (KPIs), comparison of results before and after training, and cost-benefit analysis (Kirkpatrick, 1998).

The following image, by Kirckpatrick himself, illustrates the four levels specified above:

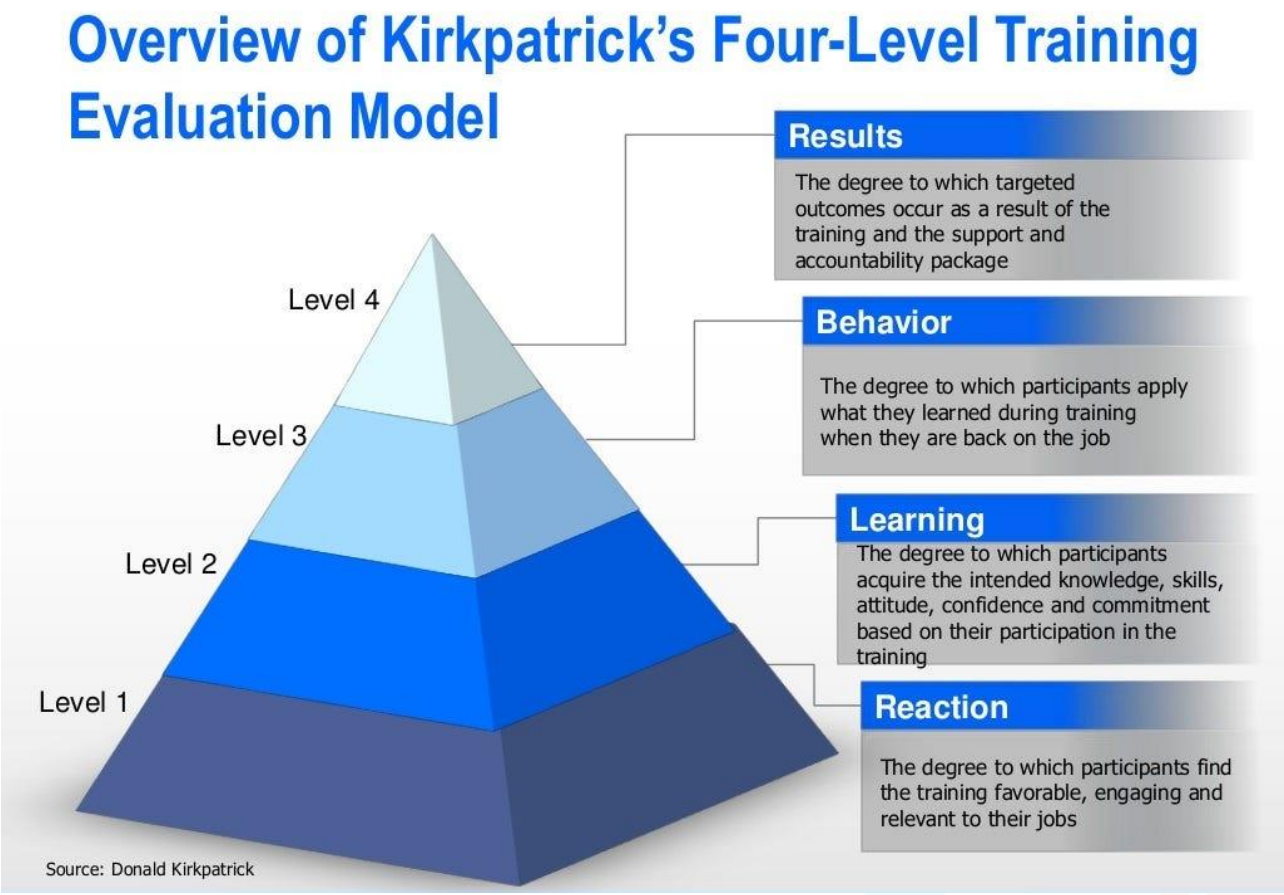

Figure 19- Overview of the Kirkpatrick Model and foundational principles[1]

It is essential to highlight that each level of the model is not necessarily a sequential step, but rather a holistic assessment approach that can be adapted to the specific context of the training program. The Kirkpatrick Model offers a comprehensive framework for evaluating the impact of training across multiple aspects, enabling organizations to better understand the effectiveness of their investments in people development.

Training evaluation - the Kirkpatrick model

Bearing in mind the 4 levels foreseen in Kirkpatrick's model, Suraj (2023) proposes a set of questions, based essentially on the participants' perception:

[1] Imagem retirada de https://kloudlearn.medium.com/overview-of-the-kirkpatrick-model-and-foundational-principles-1d9a349a9ae3

Parameters	Questions
Reaction	Did you like the training? Was the training of adequate duration? Did the training meet expectations?
Learning	Did you learn what you were supposed to? Did the materials available cover the topics covered?
Behavior	Were the skills and knowledge used in pedagogical practice?
Results	In the future, will you apply the skills and knowledge in pedagogical practice? Was the training useful? Were you able to complete all the training tasks with quality?

Figure 20- 4 levels predicted in the model

The evaluation of the training was carried out through the presentation of a critical reflection report where the previous questions were indirectly addressed. In this way, content analysis was used as an approach, allowing answers to the previous questions to be obtained. Analysis categories were created, based on the previous questions on how to classify the content of the reports. The results of this process are presented in the following sections, organized by each question proposed by Suraj (2023).

Reaction - Did you like the training?

The image shows a circular graph that represents the overall evaluation of the course "Educational Programming and Robotics @ Learning Scenarios". The graph has two slices, one for "Yes" and one for "No".

Figure 21– Reaction Level – Did you like the training?

The "Yes" slice represents 98% of participants who responded that they liked the course. The "No" slice represents 2% of participants who responded that they did not like the course. In general, the graph shows that the overall evaluation of the course was very positive. 98% of participants enjoyed the course, which suggests the course was considered to be of high quality.

Some possible explanations for the overall positive evaluation of the course include:

The course was well organized and structured.

The course content was relevant and interesting.

The course trainers were qualified and experienced.

The course offered practical learning opportunities.

Since the participants' reflections were also analyzed, it is important to highlight the perceptions they recorded:

"The training was well put together, with resources for beginners that can be reused by us in our teaching practice and will be an excellent starting point, I really liked it."

"Regarding the evaluation of this training, I give it an excellent mention. "

"I consider that I have excellently fulfilled all the objectives and activities/challenges proposed. "

"The training exceeded my initial expectations. This training was very good with 5 different areas of learning. "

"I consider that this training activity was excellent, as I learned much more than I expected. The knowledge transmitted by the trainer, the challenges proposed, and the sharing of the experiences of other trainees contributed to this."

"In short, and overall, I was satisfied with the training action "Programming and educational robotics@Learning Scenarios" and I consider that it contributed to an improvement in my practices."

Reaction - Was the training of adequate duration?

The image shows a pie chart that represents the answer to the question "Was the duration of the training adequate?" of the course "Educational Programming and Robotics @ Learning Scenarios". The graph has three slices, one for "Yes", one for "No", and one for "Not Applicable".

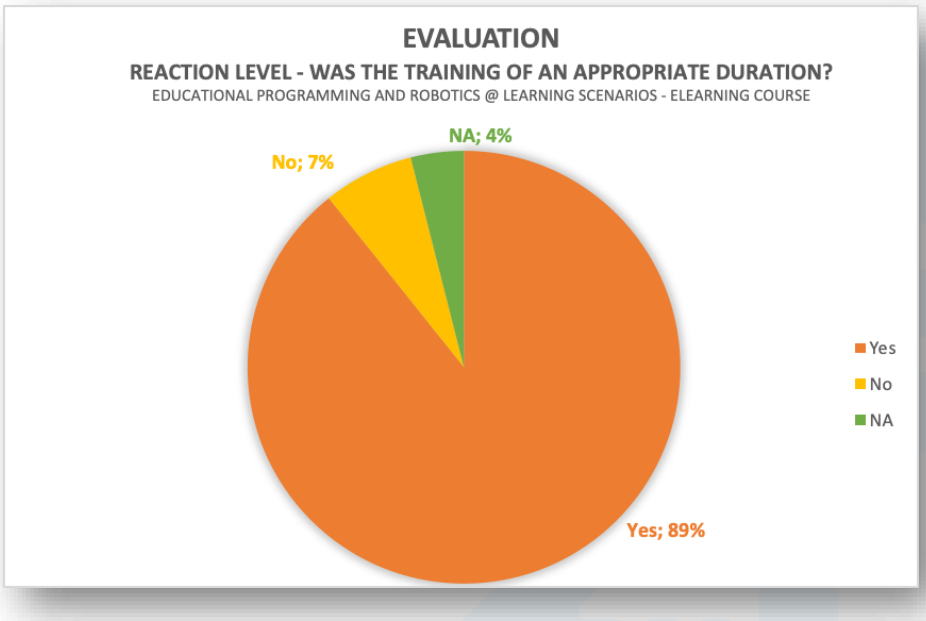

Figure 22– Evaluation Reaction level – was the training have appropriate duration?

The "Yes" slice represents 89% of participants who responded that the training duration was adequate. The "No" slice represents 7% of participants who responded that the duration of the training was not adequate. The "Not Applicable" slice represents 4% of participants who responded that the question was not applicable to them.

Overall, the graph shows that the response to the question was very positive. 89% of participants responded that the duration of the training was adequate, which suggests that the duration was considered sufficient to learn the course contents.

In details:

Yes: 89% The "Yes" slice represents 89% of participants who responded that the duration of the training was adequate. This suggests that the duration was considered sufficient to learn the course contents.

No: 7% The "No" portion represents 7% of participants who responded that the duration of the training was not adequate. This suggests that a small minority of participants found the duration insufficient to learn the course content.

Not Applicable: 4% The “Not Applicable” slice represents 4% of participants who responded that the question was not applicable to them. This suggests that these participants did not answer the question.

Some possible explanations for the overall positive response to the question include:

The course was well organized and structured, so that participants were able to learn the content in the time available.

The course content was relevant and interesting, which motivated participants to continue learning.

The course trainers were qualified and experienced, which helped participants learn the content.

Here it is also important to consider some comments that participants mentioned throughout the reports analyzed:

> *“In relation to the level and volume of the proposed activities, they were quite adjusted to the duration of the activity.”*
>
> *“As for the duration of the action, I consider it to be adequate”*
>
> *“As for the duration of the action, it also seemed ideal to me”*
>
> *“I think the action should have had more online sessions”*

Reaction - Did the training meet expectations?

The image shows a circular graph that represents the overall evaluation of the course "Educational Programming and Robotics @ Learning Scenarios". The graph has two slices, one for "Yes" and one for "No".

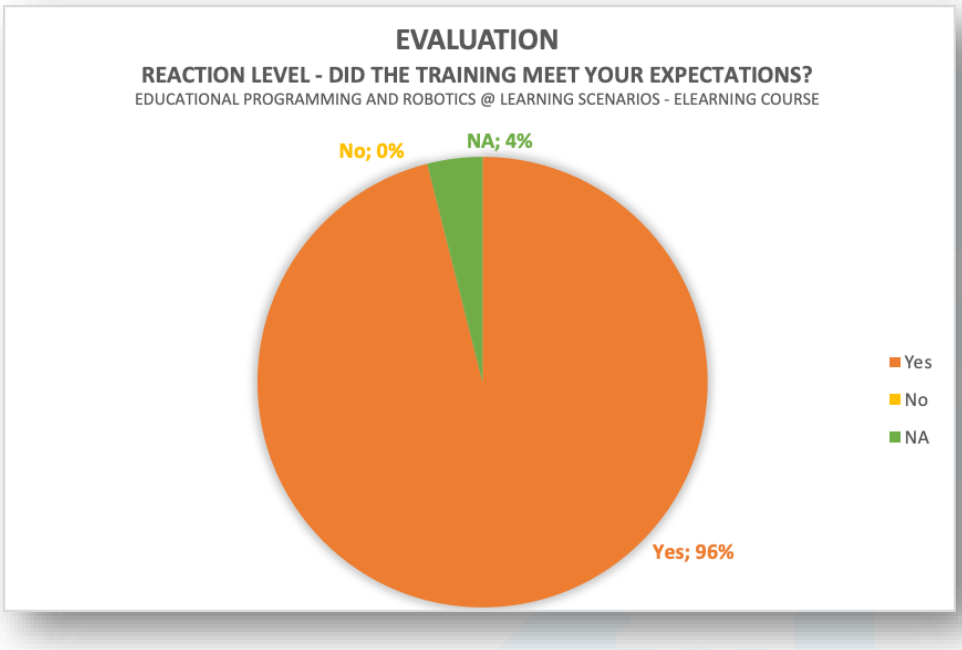

Figure 23- Evaluation Reaction level – did the training meet your expectations?

The "Yes" slice represents 96% of participants who responded that they liked the course. The "No" slice represents 4% of participants who responded that they did not like the course. In general, the graph shows that the overall evaluation of the course was very positive. 96% of participants enjoyed the course, which suggests the course was considered to be of high quality. These data reveal that participants considered that:

The course was well organized and structured.

The course content was relevant and interesting.

The course trainers were qualified and experienced.

The course offered practical learning opportunities.

These data were consistently confirmed by content analysis, as demonstrated in the following testimonies:

> *"The training fully met my expectations, as during the course I learned how to implement programming and educational robotics in an effective and creative way."*
>
> *"I consider that the frequency of this action exceeded my expectations. "*
>
> *"I confess that the training went beyond my expectations, the program is very well structured."*
>
> *"This course exceeded my expectations as it allowed me to learn together and share, acquire very deep and diverse knowledge (in terms of programming and robotics), to be used now and in the future in the classroom context. "*
>
> *"My expectations were not disappointed with the quality of the training action, throughout its entirety. Autonomy, time management and our work played an active role in the success of this action, in the design and construction of knowledge in the sharing of content and doubts and construction of our work. I consider the quality of this action to be excellent, a very positive contribution."*

Learning - Did you learn what you were supposed to?

The image shows a pie chart showing the percentage of students who learned what they were supposed to learn in training:

Figure 24- Evaluation Learning level – did you learn what were supposed to?

The "Yes" slice is the largest, indicating that 98% of students learned what they were supposed to learn. The "No" slice is the smallest, indicating that 0% of students did not learn what they were supposed to learn. "NA" slices represent students who did not respond to the assessment.

Based on the information provided, it is possible to conclude that the programming and robotics course was a success, with the vast majority of students learning what they were supposed to learn.

This data was consistently validated through content analysis, as evidenced in the following statements:

> *I consider that the action was very useful for my teaching activity, contributing to the acquisition of new knowledge and creating conditions and capabilities that will allow me to improve my professional performance.*

This training path provided opportunities that I will continue to explore.

To this end, the following matters:

• The objectives have been fully achieved;

• The contents are very current and relevant;

• The impact on teaching practice will be very positive, due to the high probability and

applicability in my teaching practice;

• The learning materials were of excellent quality.

This training action lived up to my expectations, and was frankly fruitful, as everything that was transmitted and made available to me, from the extremely informative and functional videos, to the presentations and tutorials provided by the trainers and even the organization of the action itself, gave me the possibility of acquiring various knowledge in this area, which will allow me to more effectively apply the content to be developed with my students.

Learning - Did the materials available cover the topics covered?

The following image shows a circular graph that represents the coverage level of materials available for this training.

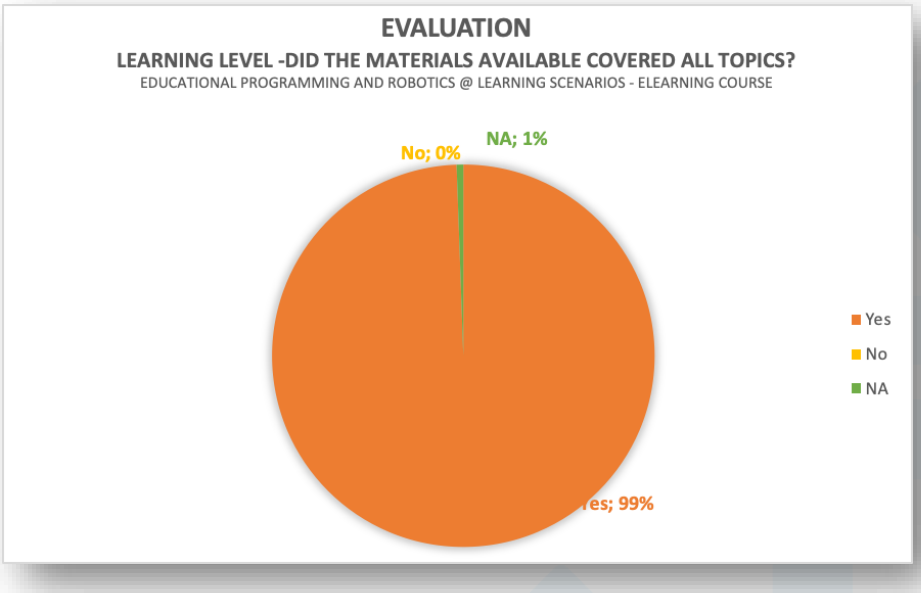

Figure 25Evaluation Learning level – did the material cover all topics?

The graph shows that for 99% of participants, the available materials cover all course topics. This means that most of the materials available cover all course topics. The "No" and "NA" sectors are very small, representing just 1%.

The graph is an excellent indication that the materials available for the educational programming and robotics course are comprehensive and of high quality. The fact that most of the materials covered all course topics meant that participants had access to all the information they needed to learn about programming and robotics.

These data were duly corroborated through content analysis, as proven by the following statements:

The content covered and the materials made available were an added value, even if some already had knowledge, it is always possible to see new approaches.

I believe that the training is very well structured and that the support materials provided good learning of the content. I also think that the proposed tasks were adjusted to the objectives of each module.

The support material is also very well done as it is possible to carry out the tasks using it without having difficulties in solving them.

As a final work/project, it was proposed to develop/create a learning scenario with TinkerCad that could demonstrate the content covered throughout the action. Especially in the final work/project, I consider that a lot of effort was required from the trainees, in building the scenario with the requested requirements. Despite this, time was given for its construction. To prepare the final project, I had to resort to other tutorials to overcome some of the many difficulties I faced.

The quality of the information presented was very good, as the content was presented in a simplified and summarized way.

Behavior - Were skills and knowledge used in pedagogical practice?

The following graph shows the distribution of responses from teachers participating in the course regarding the effective use of the skills and knowledge acquired during training in pedagogical practice.

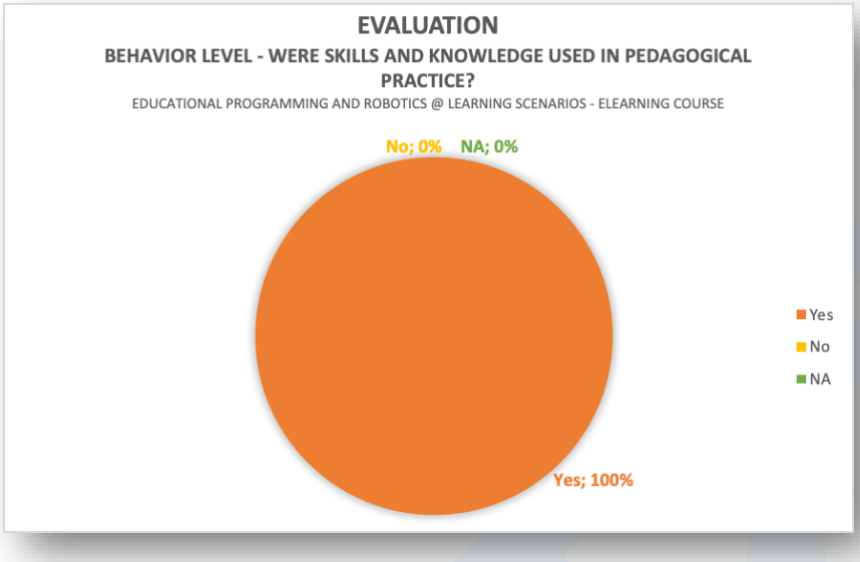

Figure 26-Evaluation - behavior level – where skills and knowledge used in pedagogical practice?

Although it may seem surprising that 100% of the responses indicate that there was an effective use of the skills and knowledge acquired in training in pedagogical practice, this fact should not seem surprising. As already mentioned, one of the modules (Module 5) consisted of creating and applying a learning scenario in teaching practice. Therefore, participants who completed the training did so.

These data were duly corroborated through content analysis, as proven by the following statements:

Although all the Modules were very enriching, I highlight Module 5 - Challenges to implementing EPR@LC, which applies content/tools/methodologies covered in previous Modules. Carrying out this task was very beneficial because it allowed me to apply it in my teaching practice and reflect on its use.

I therefore consider the implementation of this type of innovative active methodologies to be edifying. Specifically in my learning scenario, involving the construction of electrical circuits using Arduino boards, with simulation in Tinkercad and C programming, aiming to stimulate creativity, sharing and problem-solving skills in students.

The scenario was very well accepted by the students and was innovative because it had a partnership with another school where secondary students on the robotics course shared knowledge about Arduino and circuits with the basic students. We will continue to evaluate and create future scenarios using the knowledge acquired in this training course.

During the implementation of the learning scenario, the students were committed and very motivated in solving the proposed activities, therefore, I feel that through the use of this scenario produced for this action I provided more enriching and meaningful activities for my students.

I carried out the EPR@LC Implementation Challenge, with the title "Traffic light simulator". I designed and implemented the project's Logical Circuit and created a guiding Learning Scenario applied in practice with students. Carrying out this challenge was very objective, productive and became an excellent example for application in my teaching practice.

The creation of a learning scenario, in module 5, shaped what was expected from this training. In my case, a maturity in terms of how I could integrate these "tools" into my discipline and the benefit to be gained from their potential.

Results - Will you apply the skills and knowledge in pedagogical practice in the future?

The following graph shows the distribution of responses from teachers participating in the course regarding the future use of the skills and knowledge acquired in training in pedagogical practice.

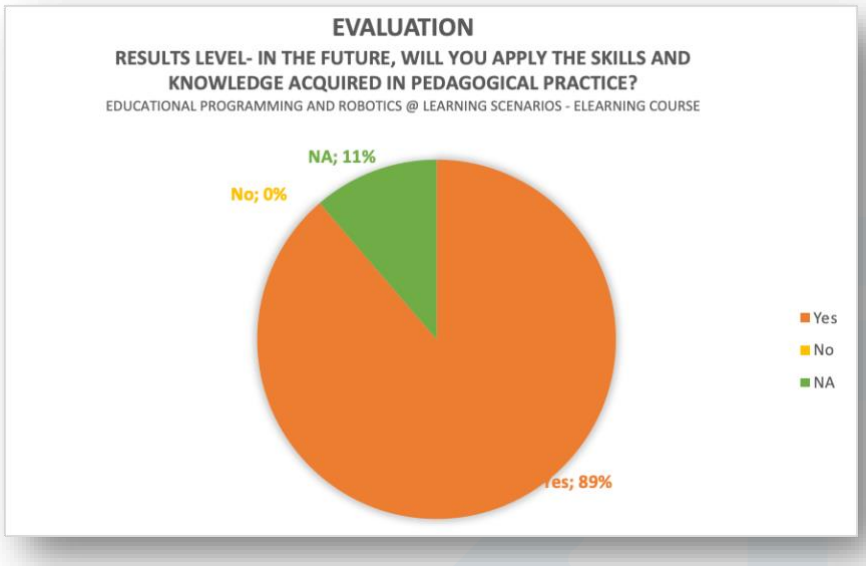

Figure 27Evaluation - results level – In the future, will you apply the skills and knowledge in pedagogical practice?

The graph shows that 89% of participants said they will apply the skills and knowledge acquired in the future. The graph is a good indication that educational programming and robotics courses are effective in imparting skills and knowledge relevant to the job market.

This data was constantly validated through content analysis, as illustrated in the following statements:

> *Personally, I will definitely change my teaching practices, whether in the subjects or in the projects that I organize, or even in informal activities, such as facilitating projects.*

> *We will continue to evaluate and create future scenarios using the knowledge acquired in this training course.*

I will try to apply what I learned in stimulating students' creativity and supporting and guiding them with better quality in their tasks.

I think it is now up to me, in the course of my teaching practice, to apply the knowledge acquired and create/explore other learning scenarios adapted to other themes and other levels of education.

Results - Was the training useful?

The following graph shows the distribution of responses from teachers participating in the course regarding the usefulness of the training:

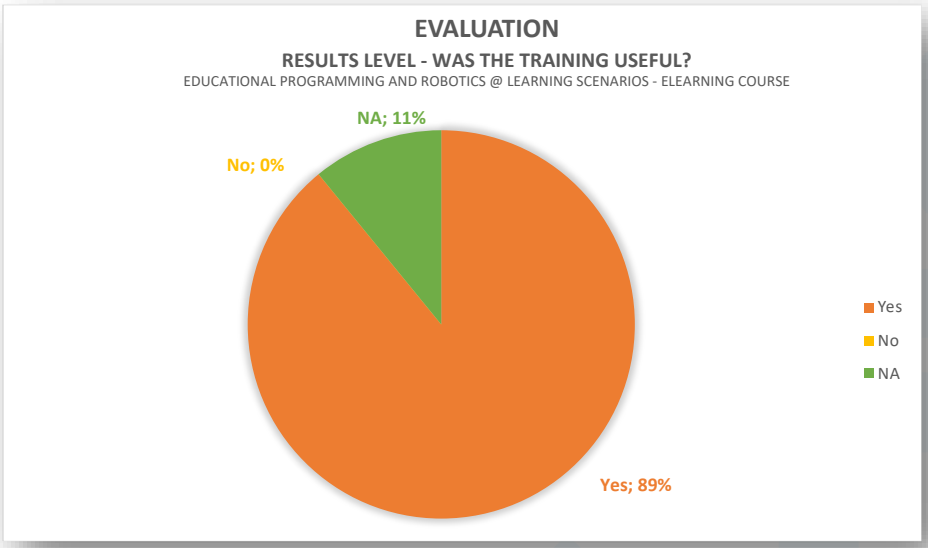

Figure 28– Evaluation – results level – Was the training useful?

The answer "Yes" is the largest share, representing 89% of participants. Content analysis revealed that this data was consistently validated, as evidenced in the following statements:

> *I would like to mention that all the points focused on training are relevant to implement in my pedagogical practices.*

> *Taking into account the starting point and the arrival point, I now feel more knowledgeable and better prepared in the field of the content learned, and can therefore conclude that the objectives proposed for this action were fully achieved. It was a moment of building more and better knowledge, which responded to my training needs.*

I tried to get the maximum yield from it so that I could later apply knowledge in pedagogical practice.

This training contributed to my teaching practice, having contributed to the enrichment of the materials/tutorials available to students in the classroom context.

Results - Were you able to complete all the training tasks with quality?

The following graph shows the distribution of responses from teachers participating in the course regarding the degree of fulfillment of all training tasks:

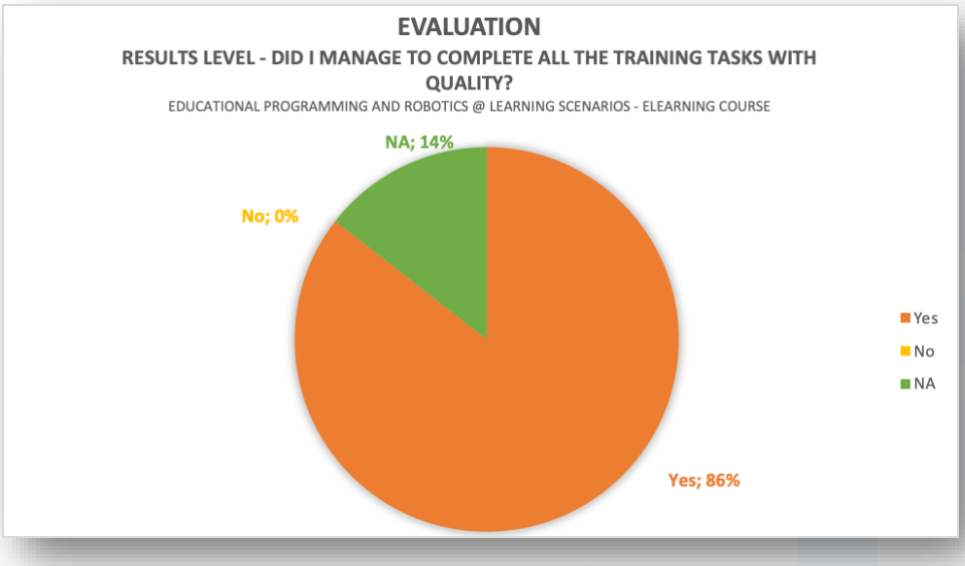

Figure 29Evaluation – result level – Did you manage to complete all the tasks?

The "Yes" sector is the largest, representing 86% of participants. This means that the majority of participants said they completed all training tasks with quality. The "No" and "NA" sectors do not have much representation - 14% of participants. In addition to the quantitative data, the content analysis demonstrated that this data was consistently validated, as evidenced in the following statements:

> *I carried out all the tasks proposed in the modules in order to acquire the proposed knowledge.*

> *The good structure of the sessions and the methodology used, allowing correct time management to complete the different tasks.*

> *I believe that in reality, I overcame all the limits I thought I had to be able to deliver everything within the required timing and with the quality I believe I demonstrated.*

In fact, the training required much more time on my part than the 30 hours that are credited to it.

The training was well organized and the time was sufficient, but as the assessment period ended, the implementation of the learning scenario was not completed. However, the scenario was very well accepted by the students and was innovative because it had a partnership with another school where secondary students on the robotics course shared knowledge about Arduino and circuits with the basic students.

Regarding the volume and level of the proposed activities, I have nothing to say, I was able to prepare them without embarrassment and they motivated me to advance in the study.

References

Suraj, N. (2023). Effectiveness of Virtual Training in the Post-Pandemic Period Using the Kirkpatrick Model.

Blume, B. D., Ford, J. K., Baldwin, T. T., & Huang, J. L. (2010). Transfer of training: A meta-analytic review. Journal of Management, 36(4), 1065-1105.

Kirkpatrick, D. L. (1994). Evaluating training programs: The four levels (Vol. 1). Berrett-Koehler.

Kraiger, K., Ford, J. K., & Salas, E. (2017). Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. Journal of Applied Psychology, 102(6), 913-934.

Phillips, J. J., & Phillips, P. P. (2012). Show me the money: How to determine ROI in people, projects, and programs. Berrett-Koehler.

Salas, E., Tannenbaum, S. I., Kraiger, K., & Smith-Jentsch, K. A. (2012). The science of training and development in organizations: What matters in practice. Psychological Science in the Public Interest, 13(2), 74-101.

Carneiro, R., & Ferreira, A. (2021). The Impact of the COVID-19 Pandemic in Education: An Analysis of Students' Perceptions. *Sustainability*, 13(15), 8349. doi:10.3390/su13158349

Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., & Magni, P. A. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*, 3(1). doi:10.37074/jalt.2020.3.1.7

Resnick, M. (2017). Lifelong Kindergarten: Cultivating Creativity through Projects, Passion, Peers, and Play. *MIT Press*.

Alliger, G. M., Tannenbaum, S. I., Bennett Jr, W., Traver, H., & Shotland, A. (1997). A meta-analysis of the relations among training criteria. *Personnel Psychology*, 50(2), 341-357.

Kirkpatrick, D. L. (1994). Evaluating Training Programs: The Four Levels. *Berrett-Koehler Publishers*.

Kirkpatrick, D. L., & Kirkpatrick, J. D. (2006). *Evaluating Training Programs: The Four Levels*. Berrett-Koehler Publishers.

Kirkpatrick, D. L. (1998). *Evaluating Training Programs: The Four Levels*. Berrett-Koehler Publishers.