COORDINATORS:
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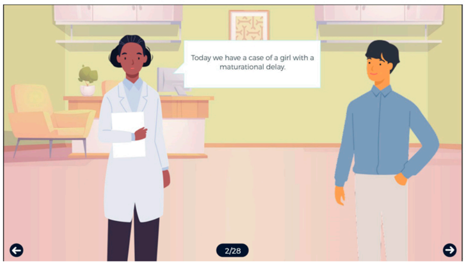
RAÚL MARTICORENA SÁNCHEZ

e-EarlyCare-T

MANUAL FOR THE DEVELOPMENT OF SELF-REGULATED VIRTUAL LABORATORIES



UNIVERSIDAD DE BURGOS

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2024

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Foreword

Dr. Francisco José García Peñalvo

University Professor in the Department of Computer Science and Automation at the University of Salamanca (USAL).

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He is director of the Consolidated Research Unit of the Junta de Castilla y León (UIC 81).

Digital transformation is the key to all business domains' development and competitiveness. It was already perceived as an essential aspect, but the global COVID-19 pandemic marks a clear turning point, after which organisations are approaching their digital transformation with greater maturity as a result of the lessons learned during this critical period for society.

The education sector is no exception to this reality, particularly within the field of healthcare, where lifelong learning is a necessity for all professionals. Here, the development of advanced technologies has become an essential tool for improving training and clinical practice.

In this context, self-regulated virtual laboratories have emerged as an innovation that allows students and health professionals to acquire practical and theoretical competencies efficiently and effectively.

This handbook, developed within the framework of the eEarlyCare-T project, provides detailed guidance on the creation and use of these laboratories, bringing a new dimension to education in early care and other health fields.

Self-regulated virtual labs represent an interesting intersection between technology and education. Specifically, in the area of healthcare, where accuracy, practice and experience are vital, these labs allow for realistic simulation of clinical scenarios to facilitate hands-on learning without the risks associated with real environments. They allow users to practice procedures, make decisions and learn from mistakes in a safe, controlled environment.

Traditional healthcare education has historically relied on classroom instruction and practice in supervised clinical settings. However, the pandemic demonstrated the need to adapt quickly to new teaching and learning contexts that cannot rely exclusively on a physical presence. This is where self-regulated virtual laboratories play a crucial role, providing continuity in education through digital platforms, combining extended realities and intelligent systems, to enable immersive, self-regulated learning.

The eEarlyCare-T project, funded by the European Union, stands out for its commitment to specialised, up-to-date training for early care professionals. The project is coordinated by the University of Burgos and its main objective is to improve the quality of life of children with various conditions and their families by training professionals in the use of advanced technologies.

Within the framework of eEarlyCare-T, self-regulated virtual laboratories are a fundamental tool for achieving these objectives. These labs not only facilitate acquisition of technical and practical knowledge, but also promote self-regulation of learning, an aspect that has become fundamental for developing competences in an increasingly digitalised, autonomous world.

These laboratories provide a technology to base educational innovations on by involving students actively learning, confronted with simulated clinical situations that reflect real cases. This methodology not only improves knowledge retention, but also fosters the development of transversal skills, with special emphasis on problem solving and critical thinking.

The use of self-regulated virtual laboratories in the health area allows for seamless integration of theory and practice. Students can apply the concepts they have learned in a virtual environment and get immediate feedback that helps them to continuously improve. In addition, the ability to repeat procedures as many times as necessary without risk reinforces learning and boosts their confidence in their skills.

One of the most striking features of these labs is their ability to encourage active, engaged participation. Unlike traditional teaching methods, which are often one-way, virtual labs require participants to make decisions, interact with the environment and respond to challenges in real time.

Interactivity is enhanced through dynamic clinical scenarios that simulate real-life situations. For example, it is possible to practice addressing cases of prematurity, maturational delay, and autism spectrum disorders, among others. Each scenario is designed to challenge the student, promoting a deep understanding of the content and the development of essential practical skills.

Self-regulated learning is key in these virtual labs. This approach allows users to manage their own learning processes, setting their own goals, monitoring their progress and adjusting their strategies as necessary. Self-regulation is especially important in healthcare education, where professionals must be able to continuously learn and adapt in a constantly evolving field.

The use of metacognitive dialogues in laboratories is a key element in promoting self-regulation. These dialogues, which simulate conversations between therapists and students, encourage reflection and critical thinking, helping them to internalise and apply acquired knowledge.

These virtual labs integrate advanced technologies such as *eye tracking* and data mining, which improve the quality and accuracy of training. *Eye tracking* allows students to understand and improve their attention patterns and focus during clinical tasks. Data mining, on the other hand, provides valuable information on student performance and progress, enabling data-driven personalisation of learning.

These technologies not only enrich the learning experience, but also facilitate the evaluation and continuous improvement of the virtual laboratories. The data can be used to adjust and improve scenarios, ensuring that they remain relevant and effective for the training objectives.

Speaking of personalisation of learning, one of the great benefits of these virtual labs lies in the ability to provide personalised, real-time feedback. Each learner receives immediate feedback on their actions and decisions, allowing for error correction and continuous improvement. In addition, this feedback can be tailored to each person's individual needs, providing more targeted, relevant support. This feedback focuses not only on outcomes, but also on process, helping learners understand why certain approaches are more effective than others, which is key to self-regulated learning.

The example labs presented in this manual are one of its strongest points. Each virtual lab is based on real clinical cases, providing an authentic, relevant learning experience. This allows you to practice solving complex situations that are typical of your professional practice, such as cases of prematurity, Lennox-Gastaut syndrome, and cerebral palsy, among others.

These cases allow not only the application of knowledge in a practical context, they also help in developing critical clinical skills. Exposure to a variety of clinical cases in a virtual environment prepares students to face similar challenges in the real world with greater confidence and competence.

Metacognitive assessment is an essential component of virtual labs. Through self-reflection and critical analysis of their own actions and decisions, students develop greater awareness of their own learning processes. This continuous evaluation allows identification of strengths and areas for improvement, promoting more holistic personal and professional development.

The metacognitive dialogues used in the laboratories are designed to guide students in this process of self-reflection. The questions and comments from the therapist and student avatars stimulate critical thinking and help students better understand learning strategies and how they can be improved.

Virtual labs are adaptable and flexible, making them suitable for a wide variety of educational contexts and the needs of your students. These labs can be used in both face-to-face and distance education, providing consistent, high-quality training regardless of the environment.

This handbook goes beyond presenting the functionality of virtual laboratories by providing empirical evidence of their benefit and positive impact in the area of health. To this end, a pilot study has been conducted to evaluate their usability and effectiveness. The results of the study show that virtual labs not only improve academic performance, but also increase motivation and engagement. The data from the study provides a solid basis for continuous improvement of the labs, ensuring that they remain up-to-date and aligned with the needs of students and healthcare professionals.

The eEarlyCare-T project and its virtual laboratories represent a significant contribution to knowledge and educational practices in early care and other areas of health. These labs provide an innovative tool for training, but also open up new opportunities for research and development in the field of health education.

In particular, this manual offers a detailed guide to the creation and use of self-regulated virtual laboratories, providing both educators and practitioners with a valuable tool for improving health education.

The combination of theory and practice, together with the use of advanced technologies and self-regulated learning methods, sets a new standard for education in this field.

In conclusion, the “Manual for the development of self-regulated virtual laboratories” is an essential, valuable resource for health education. Combining state-of-the-art technologies and innovative methodologies, it offers a comprehensive guide to creating and using virtual laboratories that significantly improve healthcare professionals’ training. This is supported by the European eEarlyCare-T project, with a focus on specialised, up-to-date training that demonstrates the transformative potential of self-regulated virtual laboratories in healthcare education and provides a valuable tool for the development of practical and theoretical competencies in a safe, controlled environment.

Institutional prologue

Dr. Begoña Prieto Moreno

Vice-Rector for Teaching and Digital Education. University of Burgos

The book, in open edition, *"Manual for the development of self-regulated virtual laboratories",* coordinated by the professors of the Faculty of Health Sciences of the University of Burgos María Consuelo Sáiz Manzanares and Raúl Marticorena Sánchez, constitutes a difficult and relevant challenge of the innovative project co-funded by the European Union "Specialized and updated training on supporting advance technologies for early childhood education and care professionals and graduates" and coordinated by the University of Burgos. The effective coordination has allowed the collaboration of three universities (University of Burgos, University of Roma Tre and Faculty of Medicine of the University of Rijeka) from three countries (Spain, Italy and Croatia) together with the collaboration of the technological SME Gestionet and the consultancy specialised in Research, Development and Innovation Kveloce for the achievement of innovative results absolutely necessary at a time when technology and artificial intelligence have burst suddenly and continuously to also benefit human behaviour when they are applied in a reflexive way after a rigorous observation. This is the paradigmatic case of this project. It represents an important boost in training and specialisation in early care in all its areas - training, research, transfer and services - through the sharing of different experiences and the analysis of the achievements that will ultimately lead to a transfer of knowledge from which society as a whole will benefit. As Vice Chancellor of the University of Burgos, I would like to express my congratulations and recognition to the coordinators, the participating universities and the authors, whom I encourage to continue working on this project, which will promote cooperation and improvement in our institutions.

I. Introduction

Dr. María Consuelo Sáiz Manzanares

eEarlyCare-T Project Coordinator. University of Burgos

The **second intellectual project** within the **European project "Specialized and updated training on supporting advance technologies for early childhood education and care professionals and graduates" No. 2021-1-ES01-KA220-SCH-000032661 -** eEarlyCare -T - is funded by the European Union and coordinated by the University of Burgos in partnership with the University of Roma Tre, the Faculty of Medicine of Rijeka (MEDRI) in Croatia, and the SMEs Gestionet and Kveloce. The project aims include the creation of Self-Regulated Virtual Laboratories for the **development of practical competences in early intervention, through the specialisation and training for practising professionals in early care settings and graduates** (professionals from Health Science degrees such as Psychology, Occupational Therapy, Nursing, etc. and from Engineering degrees such as Health Engineering, Computer Science, Mechanics, Electronics, etc.) who work in **early care** settings to improve the **quality of life of children with different affectations and their families**. Chapter II describes Self-regulated Virtual Laboratories, Chapter III examines the application of Self-regulated Virtual Laboratories to practical learning in Health Sciences, Chapter IV addresses the design of virtual laboratories from a pedagogical and computer science point of view, Chapter V presents examples of Self-regulated Virtual Laboratories for developing **practical competences** aimed at resolving different clinical cases of pathologies at early ages, as well as designing and using intelligent resources for observation and intervention in different disorders at early ages (eye tracking technology and personal voice assistants). Finally, Chapter VI presents the conclusions of the work carried out as part of the second intellectual project in the e-EarlyCare-T project.

II. Self-regulated Virtual Laboratories

Dr. María Consuelo Sáiz Manzanares

eEarlyCare-T Project Coordinator. University of Burgos

2.1. VIRTUAL LABORATORIES

The progressive advance of technology (Advanced Learning Technologies -ALT -) offers multiple digital tools that facilitate the teaching and learning process (PEA) in e-Learning (e-L) and b-Learning (b-L) environments. This development has become even more important since the COVID-19 health crisis. It is therefore necessary to design teaching methodologies that include the use of digital resources to promote an effective PEA. One of these is the use of virtual laboratories based on Self-Regulated Learning (SRL). This methodology has been shown to be very effective in eLearning (e-L) and b-Learning (b-L), as it facilitates SRL and increases motivation and personalised *feedback*. In view of this, the aim of this project is to design virtual laboratories to support teaching in the early care professionals' professional development and in the specialisation of graduates.

The use of virtual laboratories in university education, specifically in Health Sciences and Engineering degrees, is related to reinforcement of scientific knowledge, promotion of problem solving, and critical thinking (Downer et al., 2021; Özbay and Çınar, 2021; Sáiz-Manzanares et al., 2022). These are all necessary competences in today's society, as stated by the European Union (Official Journal of the European Union of 22 May 2018). This type of methodology provides students with a better understanding of procedural knowledge and increases their use of metacognitive strategies during the learning process, increasing their motivation. According to current research, using metacognitive strategies is a strong predictor of student learning outcomes (Veenman and Alexander, 2011). During the COVID-19 pandemic, virtual laboratories were shown to be as effective in teaching as in-person laboratories (Massey et al., 2021). In addition, the development of practice is supported by the Teaching Based on Training Simulation (TBTS) instructional methodology. This teaching method has been shown to be very effective for learning practical content (Ke et al., 2021).

2.2. SELF-REGULATED LEARNING

SRL can be applied to facilitate learning for all kinds of tasks in various knowledge branches. In addition, machine learning techniques and artificial intelligence will make it easier for researchers to process these records. They will then be able to interpret the results in order to gain a better understanding of the cognitive, metacognitive and motivational processes involved in their students learning processes (Mayer and Rausch, 2023). More specifically, researchers will be able to learn about different cognitive load indicators (Sáiz-Manzanares et al., 2023a). Ultimately, this interpretation will make it easier for teachers to analyse each student's learning process and, based on the results, be able to design tailored curricular activities (Azevedo et al., 2022; Sáiz-Manzanares et al., 2019b).

2.3. USING GAMIFICATION TO ACHIEVE SELF-REGULATED LEARNING

Meta-analytical studies show that using Game-Based Learning Environments (GBLEs) in educational instruction improves learning outcomes over more traditional teaching approaches. The effect sizes of using GBLEs ranges from $d = 0.45$-$d = 0.72$. Likewise, using gamification is related to an increase in students' motivation towards the object of learning (Sáiz-Manzanares et al., 2022b; Silva et al., 2021) and to the development of deeper learning (Sáiz-Manzanares et al., 2021c; Soboleva et al., 2021). Along these lines, serious games have been shown to be an important tool to promote effective, motivated learning. Moreover, as noted above, SRL is an important area within the "Psychology of Instruction" and brings into play cognitive, metacognitive, behavioural, motivational and emotional aspects (Zimmerman and Schunk, 2011). These aspects are developed during the process of knowledge acquisition. SRL has also been found to enhance the development of intrinsic motivation in learning, which is key within the motivational process (Donnermann et al., 2021). The changes that SRL promotes are self-awareness and self-reflection on the learning process and product. This functionality enhances autonomy in the learning process. In addition, feedback *resources*, such as information messages during the learning process (text messages or through avatars) promote more reliable, more autonomous learning (Nurmi et al., 2020). This can facilitate educational inclusion for students with special needs (Alcantud-Marín and Alonso-Esteban, 2021).

Gamification processes generally include the following aspects (Donnermann et al., 2021):

1. Provision of immediate *feedback* on the response to serious play and information on progress within the gamified environment.
2. Use of *badges*, which are visual components (medals, stars, etc.) that give *feedback* about results.
3. Inclusion of different levels of difficulty within the same type of serious game. Learners are also given feedback on their progress in acquiring the content at different levels of difficulty.

However, care must be taken when designing the game and its rewards to prevent learners from only being guided by external reinforcement, such as points or *badges,* avoiding motivation only being extrinsic, which may inhibit intrinsic motivation. In short, self-regulated gamification is a tool that is proving very useful for the acquisition of autonomous, deep learning (Kim and Castelli, 2021).

The methodology used to analyse data recorded during GBLEs is a sequential pattern mining algorithm. Studies on the effectiveness of GBLEs (Taub et al., 2018) indicate that the learning patterns used by students during GBLEs are more effective than those used by learners in traditional learning tasks. Furthermore, analysis of those patterns leads to further research including the effect of other student variables (cognitive level, motivational level, emotions linked to the type of game, execution times related to reaction times, etc.) that may influence learning outcomes beyond the processes used in GBLEs (Taub et al., 2018). In addition, emotional aspects (confusion, frustration, joy, etc.) related to each game have been shown to be an important element for both the flow of a gamified activity and its resolution (Taub et al., 2020). Considering these aspects of GBLEs will help in the design of tasks and gamified learning environments that are more accurately targeted to each student's learning needs (cognitive, affective, motivational, etc.) (Taub et al., 2020). The task characteristics are another important aspect, i.e. how the game has been designed, what strategies are needed to solve it, and what prior knowledge is needed to complete it successfully (Taub and Azevedo, 2019). Finally, it is important to note that not all gamified processes are the same. In GBLE environments there are simple games (crossword puzzles, word games, word search, voice games, etc.) and others that involve more sophisticated technology such as games that use virtual or augmented reality. This is another important area for research in SRL applied to GBLEs, as the processing characteristics for solving different tasks will involve different types of reasoning (Taub et al., 2017). This framework inevitably leads to reflection on the serious games methodology applied and the phases it entails. Therefore, design of the methodology is an essential element that must include a careful definition of the objectives in terms of competences [Bloom's taxonomy for the digital era is recommended (Churches, 2009)], design of the tasks and their implementation in virtual environments, and analysis of the characteristics of the student body and the particularities of the knowledge branch (Carrión-Toro et al., 2020). Similarly, in order to successfully implement activities based on GBLEs, both students and teachers need to receive *feedback*, for students through performance-based *feedback*, and for teachers via a teacher dashboard (Wiedbusch et al., 2021). All these requirements entail specific technological support and digital competences for teachers and students. It is also worth noting that the development of gamified processes can be analysed via macro- or micro-analytical studies. The former have larger samples of participants, which allows application of quantitative data analysis procedures. The latter use smaller samples and apply qualitative procedures in data analysis (Taub et al., 2021). Using both types of studies will provide important findings in this field of research. In short, analysis of self-regulated learning processes in GBLEs needs to be addressed through the work of **interdisciplinary teams** (psychology, computer science, design of virtual gamified environments, etc.) (Azevedo and Gašević, 2019).

There is a need, specifically in Health Sciences degrees, to implement simulation scenarios. These scenarios work on resolving practical cases related to intervention with patients or users, within what has been called "Evidence-Based Learning". Therefore, specially developed virtual simulation scenarios that involve dealing with situations that may occur in common workplace scenarios will provide students with a way of learning how, when and why to carry out a practical intervention. Virtual scenarios with step-by-step explanations of possible interventions will help students face real scenarios (in internships or in their future professions) with more confidence. Also, virtual scenarios that include a self-regulated voice-over to guide practice seem to be more effective (Choi et al., 2022). Specifically, e-learning scenarios that include SRL facilitate learning by doing and increase student motivation (Tang et al., 2022), and using virtual reality resources facilitates information retention (Veer et al., 2022). Finally, clinical simulation supports the teaching-learning processes in Health Sciences and has a great impact on the training of future graduates (Riveros et al., 2022). In fact, this teaching methodology is being implemented with great success in many Health Science faculties in the English-speaking world (Waghale et al., 2022).

III. Application of Self-Regulated Virtual Laboratories to Health Sciences

Dr. María Consuelo Sáiz Manzanares

eEarlyCare-T Project Coordinator. University of Burgos

3.1. SELF-REGULATED GAMIFICATION IN HEALTH SCIENCE STUDENTS

As mentioned in the previous section, gamification-based learning is being used increasingly often in Higher Education, specifically in Health Sciences degrees. This type of learning increases students' confidence, particularly in practical environments. This is highly relevant to teaching healthcare specialties as it facilitates students' acquisition and retention of practical knowledge (Gatt and Attard, 2023), one example being its use with nursing students (Anguas-Garcia et al., 2021). Furthermore, using gamification-based teaching has been found to lead to increased motivation in nursing and paramedical students (Katebi et al., 2020). The reasons students and teachers give are that using active methodologies in attractive, fun environments makes students more involved in their learning processes, which increases their autonomy and motivation. Along these lines, serious games based on digital crossword puzzles have been shown to be very useful tools in psychology (mental health and public health), laboratory and medical subjects (Mosalanejad and Abdollahifar, 2019). That kind of research has used both quantitative and qualitative analysis methods to evaluate the effectiveness of gamified procedures. Quantitatively, there were higher scores for the criteria of the method's usefulness, transparency, comprehensibility, and ease of use. These results were confirmed in the qualitative responses, including student motivation about using it (Mosalanejad and Abdollahifar, 2019). At the same time, gamified procedures have been found to increase academic engagement and improve the interaction environment in pharmacology subjects in medicine, nursing, pharmacy, psychotherapy and veterinary medicine degrees (dos Reis Lívero et al., 2021). Gamification in surgical practices and in the curricula for obstetric residents has also been shown to improve confidence and knowledge retention (Felinska et al., 2023). However, longitudinal studies are needed to assess its long-term impact (Sáiz-Manzanares et al., 2022a).

Serious play (García-Cabot et al., 2020) has two phases: the planning phase and the design phase. In the first phase, teachers have to answer three questions: (1) "what is going to be gamified", (2) "what is expected to be obtained with gamification", and (3) "who is it aimed at? In the second phase, the teacher has to consider the design of the game itself and the rewards to be provided to the students. In addition, the teacher has to plan the analysis of different indicators during the activity, using different monitoring tools. There are four phases in the process of monitoring the learner: discovery, incorporation, scaffolding, and completion of the game. First, players investigate the reason for the game and establish an attitude towards it. Next, in the onboarding phase, players familiarise themselves with the game by completing the first tasks and learning the basic mechanics. Next, in the scaffolding phase, having learned the rules of the game, the player reaches a certain level. Finally, in the completion phase of the game, the player's motivation must be maintained and application of the knowledge and skills that the learner has acquired must be encouraged through tasks that involve new challenges (Jiménez-Hernández et al., 2020).

Gamified tasks are more effective if they are short and the awarding of points in the final grade of the subject should be applied. Students who follow gamified processes perform better than students who do not. This is based on the fact that students analyse and interpret the content and train essential subject skills by playing the game (Zorrilla-Pantaleón et al., 2021). On the other hand, for the gamified process to have positive effects on information processing during task resolution, the learner needs to acquire gamification work competencies. These are directly related to the faithfully following the learning process. This procedure has different phases, in the initial phase feedback is external (points or qualification), although in successive phases it becomes internal feedback of progress and achievement towards the goal. The first type of feedback corresponds to extrinsic motivation and the second to intrinsic motivation (Jamshidifarsani et al., 2021). Therefore, evaluation of the process and of the effectiveness of gamified activities is essential to advance in this area of research.

IV. Design of Self-Regulated Virtual Laboratories

Dr. María Consuelo Sáiz Manzanares

eEarlyCare-T Project Coordinator. University of Burgos

4.1. INSTRUCTIONAL DESIGN OF THE VIRTUAL LABS

Dr. María Consuelo Sáiz Manzanares

eEarlyCare-T Project Coordinator. University of Burgos

Instructional design of Self-regulated Virtual Laboratories requires application of a self-regulated instructional design based on the self-regulated metacognitive guidance indicated in the work of Ann Brown and collaborators (Brown and DeLoache, 1978), and on the instructional training from Meichenbaum and Goodman (1969; 1971). Designers should also bear in mind the work of Veenman and colleagues (Dignath and Veenman, 2021; Van der Stel, and Veenman, 2008; Veenman, 2015; 2017; Veenman and Alexander, 2011; Veenman et al, 2006) on structuring metacognitive strategies and the work by Sáiz-Manzanares et al. (Sáiz-Manzanares et al., 2019; Sáiz-Manzanares et al., 2021a;2021b; Sáiz-Manzanares et al., 2022a;2022b; Sáiz-Manzanares et al., 2023a;2023b).

In order to create the instructional design of the Self-regulated Virtual Laboratories, a metacognitive instructional analysis is performed through self-questions carried out by avatars, which play the role of therapist and student or teacher and student. The next chapter will analyse the dialogues in each example laboratory, with the self-questions implemented and their relationship to the metacognitive strategies they aim to activate in the real students.

4.2. COMPUTER DESIGN OF THE VIRTUAL LABORATORIES

Marko Txopitea
Gestionet

1. Based on the laboratory script, the presentation of the laboratory is prepared in Google Slides. Validate with the client.
2. The file is exported to a PowerPoint file.
3. The presentation is opened with PowerPoint and the content is scaled to Full HD resolution.
4. Subsequently, an Articulate Storyline project is created by importing the PowerPoint and then the following steps are performed:
    - Add the navigation system and character voice animation.
    - Add the voices to the scenarios, create voice synthesis audios that are embedded in the project.
    - Create the slides corresponding to the exercises or questions at the end of the lab.
    - Export the project to be published online in Articulate Review 360. Validate with the client.
    - Export the project as a SCORM package.
5. Finally, import the SCORM package into the Gestionet platform as a SCORM type chapter of a course. Validate with the client.

The translation of the laboratory into the other project does not repeat the whole process, but builds on the work done in the first language:

- Duplicate the Storyline file and we work on the copy.
- Modify the texts to the new language.
- Make the necessary visual adjustments to the new texts.
- Create the speech synthesis audios in the new language.
- Export to the Articulate cloud and finally as a SCORM package.
- Storyline supports several voices in different languages, but does not have Croatian. Therefore, we created the audios independently in TTS Free and incorporated them into the Croatian Storyline project.

4.3. INCLUSIVE DESIGN OF VIRTUAL LABS

Dr. María Consuelo Sáiz Manzanares
eEarlyCare-T Project Coordinator. University of Burgos

Marko Txopitea
Gestionet

The design of the avatars representing the figures of therapist, teacher, and student was inclusive in terms of gender and ethnicity. Therefore, figures of different genders and ethnicities have been put in the different laboratories. The avatars used are shown in Figure 1.

Figure 1. *Inclusive avatars used in the eEarlyCare-T project.*

The avatars used in each Self-Regulated Virtual Laboratory are presented below.

4.3.1. Self-Regulated Virtual Laboratory 1.

Figure 2. *Inclusive avatars used in Virtual Lab 1.*

4.3.2. Self-regulated Virtual Laboratory 2. Resolution of a case of maturational delay.

Figure 3. *Inclusive avatars used in Virtual Lab 2.*

4.3.3. Self-regulated Virtual Laboratory 3. Resolution of a case of Communication and Language Delays

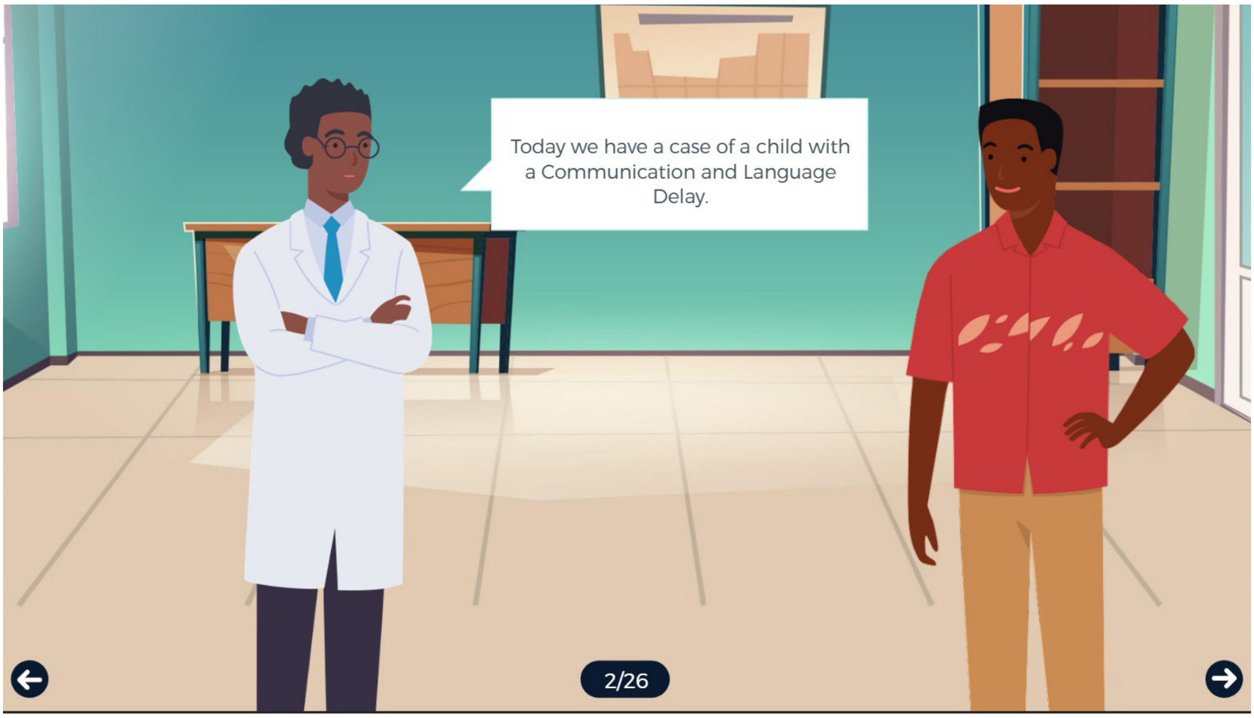

Figure 4. *Inclusive avatars used in Virtual Lab 3.*

4.3.4. Resolution of a case of Lennox-Gastaut Syndrome.

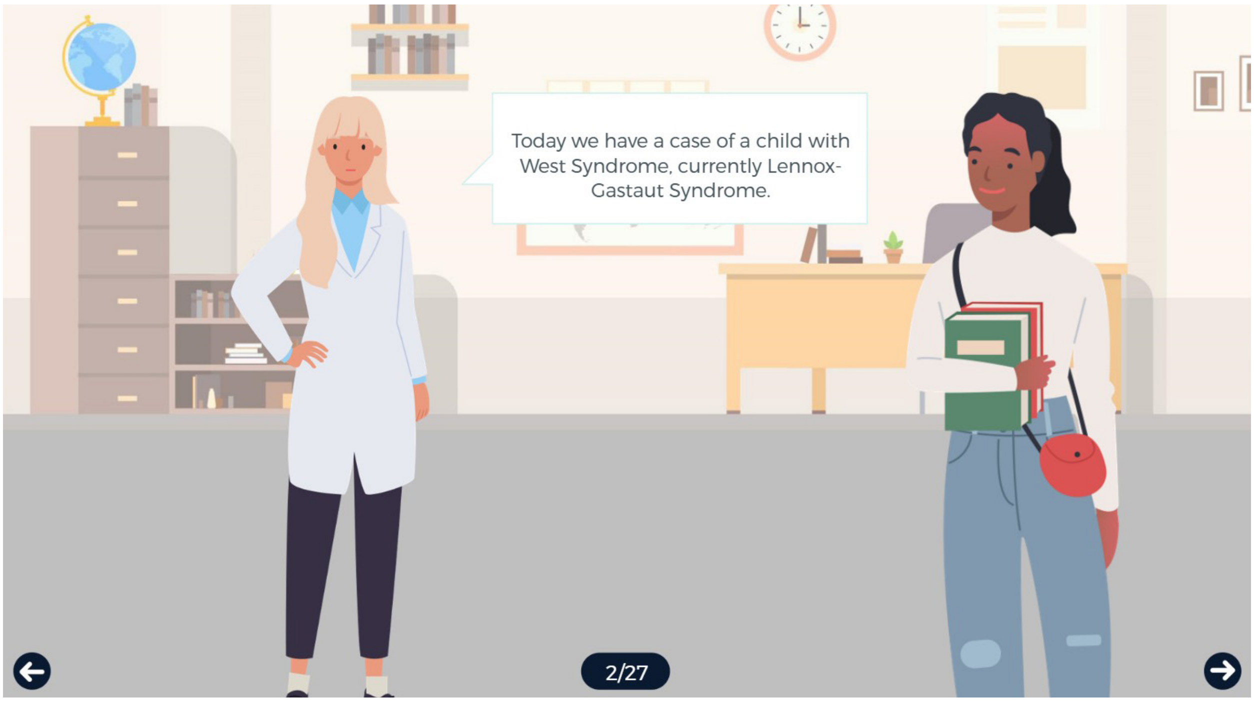

Figure 5. *Inclusive avatars used in Virtual Lab 4.*

4.3.5. Resolution of a Cerebral Palsy case.

Figure 6. *Inclusive avatars used in Virtual Lab 5.*

4.3.6. Self-regulated Virtual Laboratory 6. Resolution of a case of Autistic Spectrum Disorder.

Figure 7. *Inclusive avatars used in Virtual Lab 6.*

4.3.7. Self-regulated Virtual Laboratory 7. Application of *eye tracking* technology to early intervention.

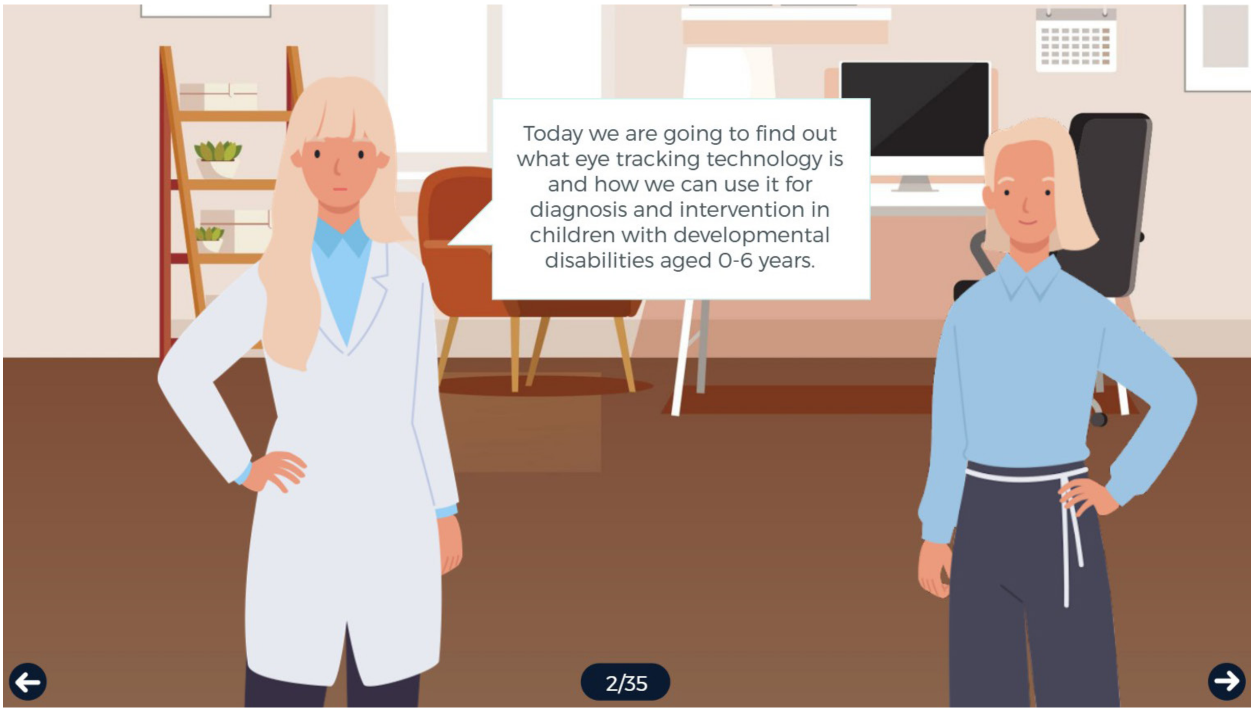

Figure 8. *Inclusive avatars used in Virtual Lab 7.*

4.3.8. Self-regulated Virtual Laboratory 8. Realisation of the observation using integrated multi-channel *eye tracking* technology.

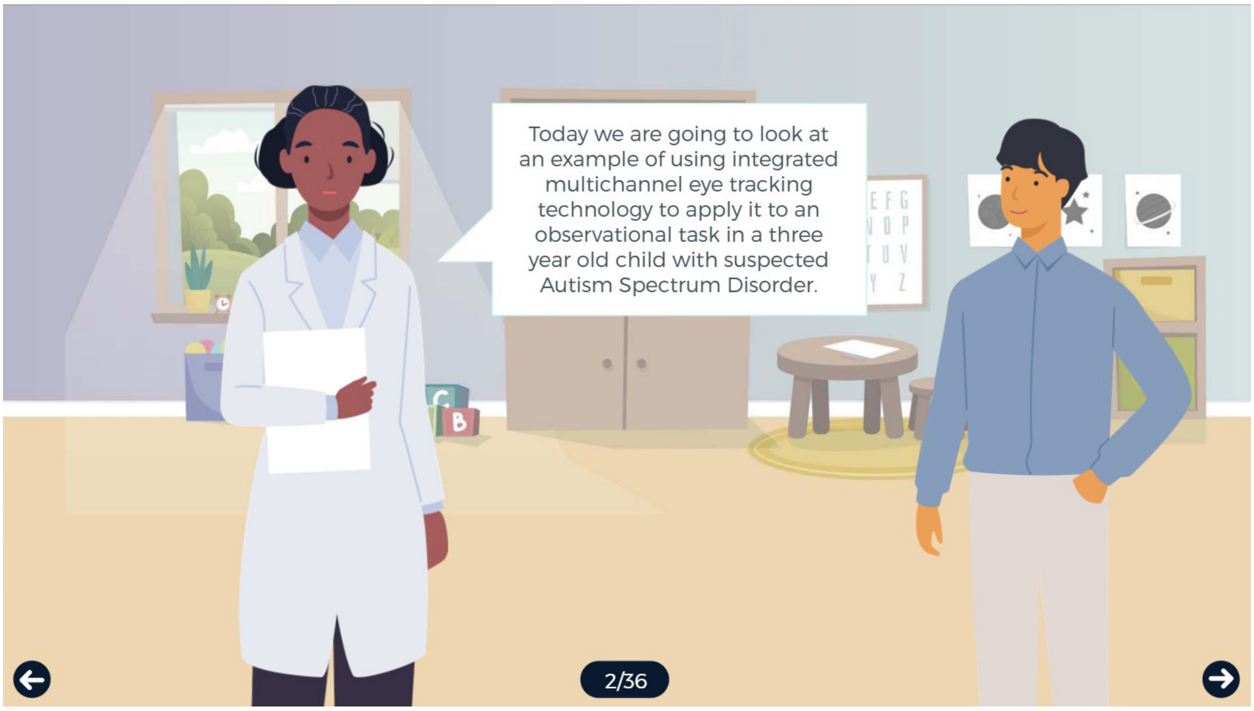

Figure 9. *Inclusive avatars used in Virtual Lab 8.*

4.3.9. Use of Systematic Observation techniques applied to the observational analysis of behaviour in young children.

Figure 10. *Inclusive avatars used in Virtual Lab 9.*

4.3.10. Self-regulated Virtual Laboratory 10. Application of Data Mining techniques in the behavioural analysis of young children.

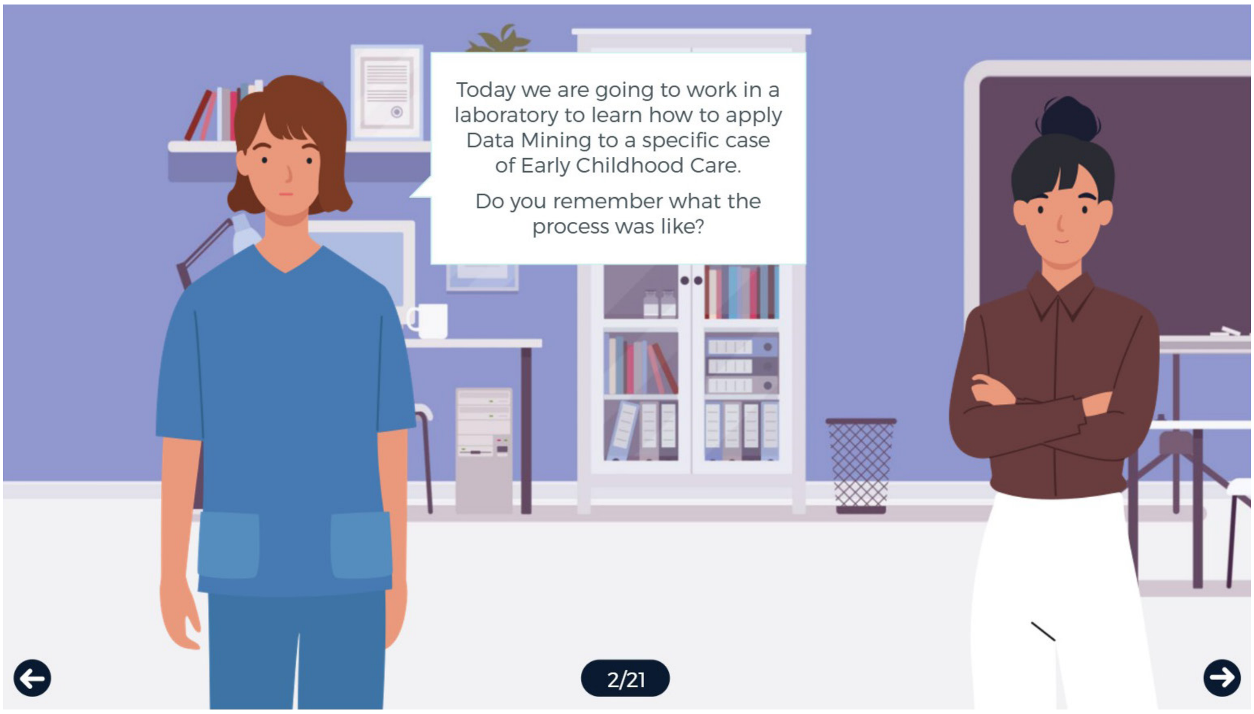

Figure 11. *Inclusive avatars used in Virtual Lab 10.*

4.3.11. Self-regulated Virtual Laboratory 11. Design and use of conversational assistants in early childhood care

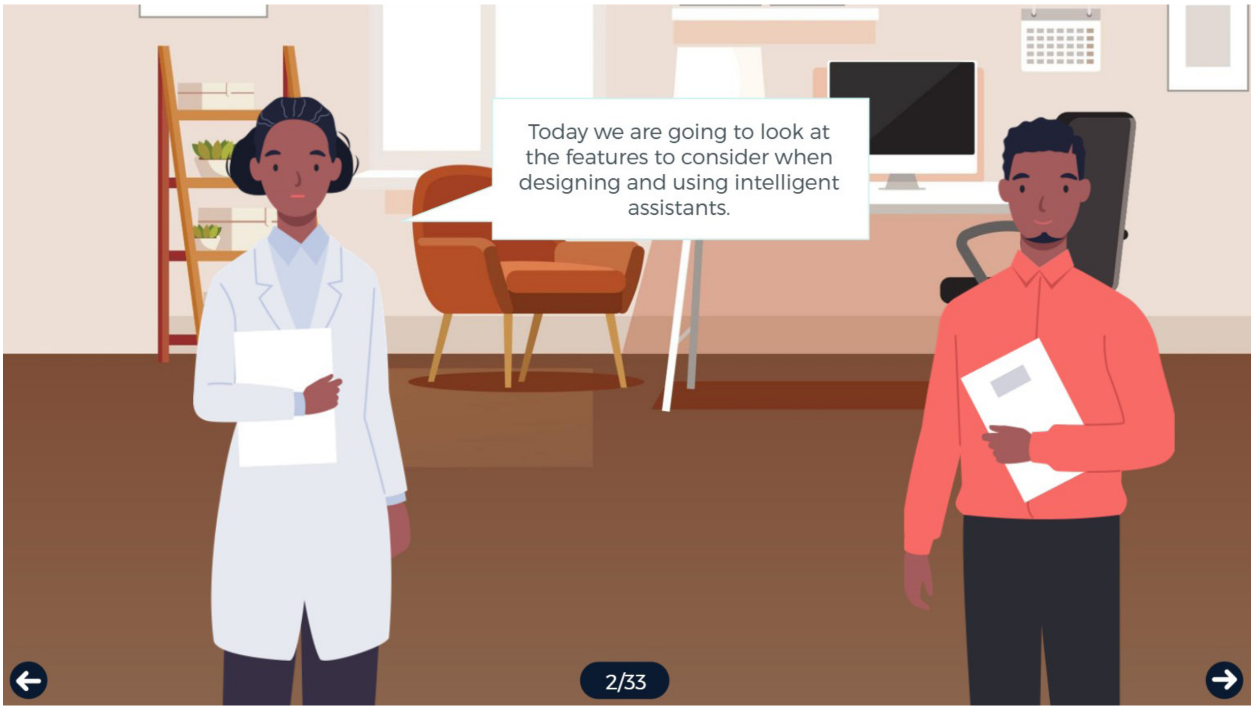

Figure 12. *Inclusive avatars used in Virtual Lab 11.*

4.3.12. Self-regulated Virtual Laboratory 12.

Figure 13. *Inclusive avatars used in Virtual Lab 12.*

V. Examples of Self-Regulated Virtual Laboratories in the eEarlyCare-T project

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5.1. VIRTUAL LAB 1. RESOLUTION OF A CASE OF PREMATURITY

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5.1.1. Design of the dialogue Self-regulated Virtual Laboratory 1

Technical specifications

a) Objective of virtual laboratory 1: to study a clinical case of prematurity in order to initiate intervention.

b) Scenario: simulation centre.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: "Today we have a case of a child with developmental problems due to prematurity".

Student: "OK, what's the first thing we have to do?"

Therapist: "We need to look at the child's medical history. Let's review it".

Current chronological age. 2 years old.

Medical history:

Normal pregnancy, premature birth at 32 weeks. There is a difference of about 5 weeks, approximately 1 month, from 38 weeks, therefore the evaluation will be with respect to the chronological age from birth and not the gestational age. Birth weight 1560 gr.

Current development:

- **Psychomotor development:** has an approximate development of 8 months.
    - At the level of *gross psychomotor skills*: does not crawl or move. Can roll over and raise himself up on his forearms.
    - At the level of *fine psychomotor skills*: He has difficulties with precision, he mainly uses his right hand and although he also has mobility in his left hand, he tends to keep it closed.
- **Communication and language development:** within the expected range for his chronological age.
- **Cognitive development:** developmental age of 14 months.
    - Can perform verbalisations during the execution of actions, imitation patterns are good, but lack of motor precision leads to less than fully satisfactory execution.
    - He is initiating the development of Symbolic Play by performing simple actions on passive agents and toys are the initiators of play.
- **Development of socialisation and personal autonomy:** has a developmental age of approximately 18 months.
    - *Personal autonomy:*
        - He has not acquired the ability to sit upright.
        - Does not move autonomously (does not crawl or creep).

- No sphincter control.
- Does not eat autonomously, eats mashed food and starts chewing some semi-mashed food.
- No swallowing problems, drinks water from a bottle.
- Does not have full control over drooling.
- Assists in dressing and undressing.

○ *Social interaction:*

- It is appropriate both with adults and with the peer group.

Therapist: “What do you think we need to do next?”

Student: “Well, the truth is that I’m not really sure”.

Therapist: “Let’s analyse which developmental area(s) are most affected”.

Student: “How are we going to do that?”

Therapist: “First we are going to analyse what difference between the child’s chronological age and the developmental age for each of the areas”.

Look, in the area of psychomotor development he has a developmental age of approximately 8 months, how old is she chronologically?”

Student: “He is 24 months old chronologically”.

Therapist: “So what’s the difference?”

Student: “The difference is 16 months”.

Therapist: “OK, write down on a chart the developmental age and the chronological age and the differences in the areas of development”.

Student: “OK”.

Therapist: “Moving on, in the language development area, is there a gap?”

Student: “No, his developmental and chronological ages are similar, so there is no mismatch”.

Therapist: “Very good, moving on to Cognitive Development”.

Student: “He has a developmental age of 14 months, so the difference is 10 months”.

Therapist: “Very good, and in the Area of Development of Socialisation and Personal Autonomy?”

Student: “He has a developmental age of approximately 18 months, so the difference is 6 months”.

Therapist: “Good, let’s order them from most to least affected areas of development in this patient”.

e) Self-checking game of acquired knowledge

The student should order the areas from the most affected to least affected based on the information in the dialogue.

1. Psychomotor development: 16 months lag. Difficulty in ambulation and fine psychomotor precision.

2. Cognitive Development: he is 10 months behind. The problems are specific to psychomotor precision, which makes it difficult for him to do cognitive tasks that require motor actions. Also, the development of symbolic play should be reinforced.

3. Development of socialisation and personal autonomy: there is a difference of 6 months, focusing on sitting and walking, sphincter control, feeding and drooling control.

4. Communication and Language Development: Chronological age and developmental age are not mismatched in this developmental area.

Therapist: "Perfect, so now we know which are the most and least affected areas and within them the most important aspects to start the therapeutic intervention".

Therapist: "See you in the next Virtual Lab 😊".

5.1.2. Analysis of the metacognitive dialogue applied in Lab 1

The dialogue of lab 1 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"What is the first thing we have to do?"	Orientation	
Therapist	"What do you think we need to do second?"	Planning	
Therapist	"So what's the difference?"	Elaboration	
Therapist	"Very well, we continue, with regard to the Area of Cognitive Development".	Planning	Reinforcement during the resolution process
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Perfect, we now know which are the most affected areas from most to least affected and within them the most relevant aspects to start the therapeutic intervention".	Elaboration	Final reinforcement

5.2. VIRTUAL LABORATORY 2. RESOLUTION OF A CASE OF MATURATIONAL DELAY

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5.2.1. Design of the dialogue Self-regulated Virtual Laboratory 2

Technical specifications

a) Objective of the virtual laboratory: to study a clinical case of maturational delay in order to initiate intervention.

b) Scenario: simulation centre.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: "Today we have a case of a girl with a maturational delay".

Student: "Okay, what's the first thing we have to do?"

Therapist: "We need to look at the girl's medical history. Let's review it".

Current chronological age. 2 years 4 months.

Medical history:

- Pregnancy with problems and delivery at 36 weeks.
- She had difficulties in sucking, but this has now improved.
- She started walking at 16 months.

Current development:

- **Psychomotor development:** Approximately 27 months old.
  - *Gross psychomotor skills*: Can walk independently. Can bend down to pick up objects from the floor. Can kick a ball on command, but shows some static-dynamic instability.
  - At the level of *fine psychomotor skills*: there are problems related to psychomotor precision.
- **Communication and language development:**

  Comprehension: This is approximately at their chronological age level.

  Expression: Developmental age is approximately 17 months. Has about 20 words which are mostly nouns, not yet making word combinations. She has vowel imitation. There is some orofacial hypotonia.
- **Cognitive development:** Presents a developmental age of 24 months. She tends not to perform tasks that require her to make more effort. Responds to social reinforcement.
- **Development of socialisation and personal autonomy:** The developmental age is approximately 24 months.
  - *Personal autonomy:*
    - Does not eat autonomously.
    - Assists in dressing and undressing.
    - No sphincter control.

○ *Social interaction:*

- No interaction problems with adults or peer group.

Therapist: "What do you think we need to do next?

Student: "Well, I'm afraid I'm not sure".

Therapist: "Let's analyse which developmental area(s) are most affected".

Student: "How do we do that?"

Therapist: "First we are going to analyse any differences between the child's chronological and the developmental age for each of the areas".

"Look, in psychomotor development she has a developmental age of approximately 27 months, how old is she chronologically?"

Student: "Chronologically, she's 28 months old".

Therapist: "So what's the difference?"

Student: "The difference is 1 month".

Therapist: "Perfect, in the table, note the developmental age and the chronological age and the differences in the areas of development".

Student: "OK".

Therapist: "Moving on, is there a gap in the area of language development,?"

Student: "At the level of comprehension, no, she has a similar developmental and chronological ages, so there's no gap. But at the level of expression she has a developmental age of approximately 17 months. So there is a gap of approximately 11 months with her chronological age".

Therapist: "Very good, moving on to the area of Cognitive Development".

Student: "She has a developmental age of 24 months, so the difference is 4 months".

Therapist: "Good, what about Development of Socialisation and Personal Autonomy?"

Student: "She has a developmental age of approximately 24 months, so the difference is 4 months".

Therapist: "Very good, let's order them from the most to the least affected areas of development for this patient".

e) Self-testing game of acquired knowledge

The student should order the areas from most to least affected based on the information in the dialogue.

1. Communication and Language development, the difference is 11 months. The problem is development at the expressive level in the morphosyntactic code (combination of words and formation of sentences) and problems of orofacial hypotonia.

2. Socialisation and Personal Autonomy Development
In this area she has a delay of 4 months. She has difficulties in feeding and sphincter control tasks.

3. Cognitive Development There is a delay of 4 months. The problems are in the execution of tasks that present difficulties for her.

4. Área de desarrollo Psicomotor
1 month lag, in static-dynamic accuracy and motor accuracy.

Therapist: "Perfect, now we know which are the most affected and least affected areas and within them the most important aspects to start the therapeutic intervention".

Therapist: "See you in the next Virtual Lab 😊".

5.2.2. Analysis of the metacognitive dialogue applied in Laboratory 2

The dialogue of lab 2 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"What is the first thing we have to do?"	Orientation	
Therapist	"What do you think we need to do second?"	Planning	
Student	"And how are we going to do that?"	Planning	
Therapist	"So what's the difference?"	Elaboration	
Therapist	"We continue, with regard to the Area of language development, is there a gap?"	Planning	
Therapist	"All right, let's move on, with regard to the Area of Cognitive Development?"	Planning	Reinforcement during the resolution process
Therapist	"Very good, and the Area of Development of Socialisation and Personal Autonomy?"	Planning	Reinforcement during the resolution process
Therapist	"All right, let's order this patient's development areas from most to least affected".	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Perfect, we now know which areas are most to least affected and within them the most relevant aspects to start the therapeutic intervention".	Elaboration	Final reinforcement

5.3. VIRTUAL LAB 3. SOLVING A CASE OF COMMUNICATION AND LANGUAGE DELAY

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5.3.1. Design of the dialogue Self-regulated Virtual Laboratory 3

Technical specifications

a) Objective of virtual laboratory 3: to study a clinical case of Communication and Language Delay in order to initiate intervention.

b) Scenario: simulation centre.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: "Today we have a case of a child with a Communication and Language Delay".

Student: "OK, what's the first thing we have to do?"

Therapist: "We need to look at the child's medical history. Let's review it".

Current chronological age. 2 years 2 months.

Medical history:

- Normal pregnancy and childbirth.

Current development:

- **Psychomotor development:** Has a developmental age that corresponds to their developmental age.
- **Communication and language development:**

  Comprehension: Presents a developmental age of approximately one year. Responds to very familiar and contextualised commands and does not respond to simple commands directed at real and present objects.

  Expression: Developmental age of about one year. Has begun to develop first words and can play interactive games such as "peek-a-boo". Can imitate onomatopoeic sounds, although not systematically.

- **Area of cognitive development: Presents a developmental age of 18 months.**
  - Demonstrates object permanence.
  - Initiates interactions towards objects: sucks on them, bangs them and make some of them rattle.
  - Imitative patterns are impaired, and exhibits attentional problems.
  - In terms of the development of Symbolic Play, there is no action planning, the child uses the substitution of some objects in relation to referential actions.
- **Development of socialisation and personal autonomy:** The child has a developmental age of approximately 13 months.
  - *Personal autonomy:*
    - Eats autonomously.
    - Uses a spoon.

- No sphincter control.

○ *Social interaction:* Interacts well in familiar contexts but has problems interacting with peers and adults in other contexts.

Therapist:"What do you think we need to do next?"

Student: "Well, I'm afraid I'm not entirely sure".

Therapist:"Let's analyse which developmental area(s) are most affected".

Student: "How do we do that?"

Therapist:"First we're going to examine the difference between the child's chronological age and their developmental age for each area".

"So in psychomotor development, the child has a developmental age that corresponds to her developmental age. Is there a gap?"

Student: "No, in this case there's no gap".

Therapist: "Perfect, in a table, write down the developmental age and the chronological age and whether there are differences in each area of development".

Student: "OK".

Therapist: "Moving on, is there a gap in the language development area?"

Student: "Yes, at the level of comprehension there is a 14-month gap and there's also one in the level of expression".

Therapist: "Very good, moving on to the Area of Cognitive Development".

Student: "The child has a developmental age of 18 months, so the difference is 8 months".

Therapist:"Very good, and in the Development of Socialisation and Personal Autonomy?"

Student: "The developmental age is approximately 13 months, so the difference is 13 months".

Therapist: "Very well, let's list them from most to least affected areas of development for this patient".

d) Self-checking game of acquired knowledge

The student should order the areas from most affected to least affected based on the information in the dialogue.

e) Self-testing game of the acquired knowledge

The student should order in sequential steps the most affected areas from most to least affected with respect to the information given in the dialogue.

1. Communication and language development, there is a gap of 14 months between developmental age and chronological age in comprehension and expressive level. The problem is a delay in language development, but not in communication.

2. Development of Socialisation and Personal Autonomy, there is a difference of 13 months. The most important difficulties are in sphincter control and social interaction, specifically interaction with adults and unfamiliar peers.

3. Cognitive development, there is a delay of 8 months. The issues are attentional problems, problems in planning task resolution and problems in symbolisation.

4. Psychomotor development, there is no difference between chronological age and developmental age in this developmental area.

Therapist: "Perfect, so now we know which are the most affected and least affected areas and the most important aspects in each to start the therapeutic intervention".

Therapist: "See you in the next Virtual Lab 😊".

5.3.2. Analysis of the metacognitive dialogue applied in Lab 3

The dialogue of lab 3 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"What is the first thing we have to do?"	Orientation	
Therapist	"What do you think we need to do second?"	Planning	
Student	"And how are we going to do that?"	Planning	
Therapist	"All right, let's move on, with regard to the Area of Cognitive Development?"	Planning	Reinforcement during the resolution process
Therapist	"Very good, and the Area of Development of Socialisation and Personal Autonomy?"	Planning	Reinforcement during the resolution process
Therapist	"All right, let's order this patient's development areas from most to least affected".	Evaluation during the reso-lution process	Reinforcement during the resolution process
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Perfect, we now know which areas are most to least affected and within them the most relevant aspects to start the ther-apeutic intervention".	Elaboration	Final reinforcement

5.4. VIRTUAL LABORATORY 4. RESOLUTION OF A CASE OF LENNOX-GASTAUT SYNDROME.

Dr. María Consuelo Sáiz Manzanares
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5.4.1. Design of the dialogue Self-regulated Virtual Laboratory 4

Technical specifications

a) Objective of virtual laboratory 4: to study a clinical case of a West Syndrome currently Lennox-Gastaut Syndrome in order to initiate intervention.

b) Scenario: We are inside the simulation centre.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: "Today we have a case of a child with West Syndrome, currently Lennox-Gastaut Syndrome".

Student: "OK, what's the first thing we have to do?"

Therapist: "We need to look at the child's medical history. So let's review it".

Current chronological age. 4 years (48 months).

Medical history:

- Normal pregnancy and delivery.
- Psychomotor development below chronological age was observed at around 5 months of age.
- At 9 months old, he was diagnosed with West Syndrome.
- Current diagnosis Lennox-Gastaut syndrome (variant of childhood epilepsy occurring between the ages of two and six years and characterised by frequent seizures often accompanied by intellectual disability and behavioural problems).

Current development:

- **Psychomotor development:** He has a developmental age of approximately 16 months.
  - At present, difficulty with head control.
  - Uses his right hand better than his left.
  - Begins the execution of presses with both hands.
  - He tries to remove a scarf covering his head when he is on his back.
- **Communication and language development:**

  It is difficult to establish a specific age of development, as this case involves involutional impairment, i.e. loss of acquired functions due to the lesions produced by the seizures.

  Comprehension: discriminates between familiar and unfamiliar people. Can also recognise familiar people in photos or video images. Developmental age is approximately 16 months.

  Expression: communicates through facial expressions and gestures. Says a few words such as "dada", "mama", "hello". Can express "Yes" and "No" with his eyes and head. When he "poops" he lets you know by crying. Developmental age is approximately 16 months.

- **Cognitive development:**

  His developmental age is approximately 12 months, and his motor limitations must be taken into account in this assessment, which may influence the overall assessment.

  ○ He exhibits object permanence.

  ○ He can follow objects with his gaze as long as they are within his field of vision.

  ○ Can pick up objects that come close to him, but keeps them in his hand for a short time.

- **Development of socialisation and personal autonomy:** He has a developmental age of approximately 12 months.

  ○ *Personal autonomy:* does not eat independently, but can chew food.

  ○ *Social interaction:*

    - Can laugh at events that provoke laughter.
    - Can wave goodbye.
    - May include prohibitions.

Therapist: "What do you think we need to do next?"

Student: "Well, I'm not really sure".

Therapist: "Let's analyse which developmental area(s) are most affected".

Student: "How are we going to do that?"

Therapist: "First we are going to analyse any differences between the chronological age of the child and the developmental age for each of the areas".

"Look, in psychomotor development she has a developmental age of 16 months, is there a gap?"

Student: "Yes, the gap is 32 months".

Therapist: "Perfect, in a table write down the developmental age and the chronological age and whether there are differences in each area of development".

Student: "OK".

Therapist: "So, is there a gap in the Communication and Language Development area?"

Student: "Yes, at the level of comprehension and expression, there is a gap of 32 months".

Therapist: "Very good, moving on to the Area of Cognitive Development".

Student: "She has a developmental age of approximately 12 months, so the difference is 36 months".

Therapist: "Good, what about Development of Socialisation and Personal Autonomy?"

Student: "She has a developmental age of approximately 12 months, so the difference is 36 months".

Therapist: "Very well, let's put these in order from most to least affected areas of development for this patient".

e) Self-testing game of the acquired knowledge

The student should list the most affected to least affected areas based on the information in the dialogue.

1. Development of Socialisation and Personal Autonomy, there is a difference of 36 months can be seen.

2. Cognitive Development, there is a difference of 36 months.

3. Communication and Language Development, there is a time lag of 32 months.

4. Psychomotor development, there is a gap of 32 months.

Therapist: "Perfect, now we know which are the most affected and least affected areas and the most important aspects within them to start the therapeutic intervention".

Therapist: "See you in the next Virtual Lab 😊".

5.4.2. Analysis of the metacognitive dialogue applied in Lab 4

The dialogue of lab 4 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"What is the first thing we have to do?"	Orientation	
Therapist	"What do you think we need to do next?"	Planning	
Student	"And how are we going to do that?"	Planning	
Therapist	"So, is there a gap in the Communication and Language Development area?"	Planning	Reinforcement during the resolution process
Therapist	"Very good, moving on to the Area of Cognitive Development"	Planning	Reinforcement during the resolution process
Therapist	"Good, what about Development of Socialisation and Personal Autonomy?"	Planning	Reinforcement during the resolution process
Therapist	"All right, let›s order this patient's development areas from most to least affected".	Evaluation during the resolution process	Reinforcement during the resolution process
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Perfect, we now know which areas are most to least affected and within them the most relevant aspects to start the therapeutic intervention".	Elaboration	Final reinforcement

5.5. VIRTUAL LABORATORY 5. RESOLUTION OF A CASE OF CEREBRAL PALSY.

Dr. María Consuelo Sáiz Manzanares
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5.5.1. Design of the Self-regulated Virtual Laboratory dialogue 5

Technical specifications

a) Objective of this virtual laboratory: to study a clinical case of a child affected by Cerebral Palsy, right hemiplegia and mild hypoacusis.

b) Scenario: simulation centre.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: “Today we have a case of a child with cerebral palsy and right hemiplegia. Mild hearing loss.”

Student: “OK, what’s the first thing we have to do?”

Therapist: “We need to look at the child’s medical history. Let’s review it”.

Current chronological age. 3 years 4 months (40 months).

Medical history:

- Cerebral Palsy. Right hemiplegia.
- Cephalic support at around 16 months.
- First words at 18 months.
- He has a hearing loss of 20 dB in his right ear.

Current development:

- **Psychomotor development:** he has an approximate developmental age of 10 months.

  Gross psychomotor skills: can stand with support. With assistance can take a few steps. With support, can lift and support one foot while standing.

  Fine psychomotor skills: for almost everything he uses his left hand due to his right hemiparesis. Can fill a cup with cubes. He can place the circular piece on a pegboard. Can put the tablet in the bucket. Scribbles faintly after a demonstration. Turns pages of a book. Builds a tower with two cubes.

- **Communication and language development:**

  Comprehension: Developmental age of approximately 18 months. He understands almost all commands given to him. We could say conserved comprehension. However, there are some actions that he is unable to carry out due to his motor impairment.

  Expression: communicates through facial expressions and gestures. Says some words such as “dada”, “mama”, “hello”. Can express “Yes” and “No” with his eyes and head. When he “poops” he lets us know by crying.

- **Area of cognitive development:** developmental age is approximately 21 months. He can:

  ○ Lift a cup upside down and pick up the bucket underneath.

- ○ Pick up the tablet using thumb and forefinger.
- ○ Pull the hoop closer by pulling the cord.
- ○ Ring the bell.
- ○ Find a toy hidden under a handkerchief.
- ○ Put the bucket in the cup and take it out after a demonstration.
- ○ Place the three pieces on the fitting board.
- ○ Make towers out of large cubes.

- **Area of development of socialisation and personal autonomy:** has a developmental age of approximately 25 months.

  Personal autonomy:

  - ○ Can help with dressing and undressing.
  - ○ Can drink using a cup and a glass.
  - ○ Can use a spoon to eat.
  - ○ Has sphincter control.

  Social interaction:

  - ○ Reacts to familiar words.
  - ○ Waves goodbye and thanks.
  - ○ Includes prohibition.
  - ○ Can give something when asked with words or gestures.
  - ○ Can repeat simple acts that have caused laughter.
  - ○ Can ask for food and drink.

Therapist: “What do you think we need to do next?”

Student: “Well, I’m afraid I’m not really sure”.

Therapist: “Let’s analyse which developmental area(s) are most affected”.

Student: “How do we do that?”

Therapist: “First we are going to analyse the difference between the child’s chronological age and the developmental age for each of the areas”.

“So, in psychomotor development he has a developmental age of 10 months, is there a gap?”

Student: “Yes, the gap is 30 months”.

Therapist: “Perfect, write the developmental age and the chronological age in a table and note if there are differences in the areas of development”.

Student: “OK”.

Therapist: “Moving on, in language development, is there a gap?”

Student: “Yes, at the level of comprehension and expression, there is a 22-month gap”.

Therapist: “Good, so next, Cognitive Development”.

Student: “She has a developmental age of approximately 21 months, so the difference is 19 months”.

Therapist: “Very good, and in Development of Socialisation and Personal Autonomy?”

Student: “She has a developmental age of approximately 25 months, so the difference is 15 months”.

Therapist: “Very well, let’s order the development areas from most to least affected for this patient”.

e) Self-testing game of acquired knowledge

The student should order the areas from most to least affected based on the information in the dialogue.

1. Psychomotor development, there is a gap of 30 months .

2. Communication and Language development, there is a gap of 22 months.

3. Cognitive development, there is a difference of 19 months.

4. Development of Socialisation and Personal Autonomy, there is a difference of 15 months.

Therapist: “Excellent, now we know which are the most and least affected areas and within them the most important aspects to start the therapeutic intervention”.

Therapist: “See you in the next Virtual Lab 😊”.

5.5.2. Analysis of the metacognitive dialogue applied in Lab 5

The dialogue of lab 5 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Student	“All right, what›s the first thing we have to do?”	Orientation	
Therapist	“What do you think we need to do next?”	Planning	
Student	“And how are we going to do that?”	Planning	
Therapist	“Moving on, in language development, is there a gap?”	Planning	Reinforcement during the resolution process
Therapist	“Good, so next, Cognitive Development”	Planning	Reinforcement during the resolution process
Therapist	“…and in Development of Socialisation and Personal Autonomy?”	Planning	Reinforcement during the resolution process
Therapist	“All right, let›s order this patient’s development areas from most to least affected”.	Evaluation during the resolution process	Reinforcement during the resolution process
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	“Perfect, we now know which areas are most to least affected and within them the most relevant aspects to start the therapeutic intervention”.	Elaboration	Final reinforcement

5.6. VIRTUAL LABORATORY 6. RESOLUTION OF A CASE OF AUTISTIC SPECTRUM DISORDER.

Dr. María Consuelo Sáiz Manzanares
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5.6.1. Design of the Self-regulated Virtual Laboratory dialogue 6

Technical specifications

a) Objective of this virtual laboratory: to study a clinical case of a child with suspected Autistic Spectrum Disorder.

b) Scenario: we are inside the simulation centre.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: "Today we have a case of a child with a suspected Autistic Spectrum Disorder".

Student: "OK, what's the first thing we have to do?"

Therapist: "We need to look at the child's medical history. Let's review it".

Current chronological age. 3 years (36 months).

Medical history:

Normal pregnancy and childbirth.

- Birth weight 3500 gr.
- Appeared normal during the first half of life. Social smile.
- Delay in acquiring independent sitting; acquired in the ninth month.
- By the age of 9 months he showed a normal interest in objects.
- From 12 to 18 months he developed intentional communicative behaviours, although no declarative gestures appeared.
- He said his first words at 20 months, and they were functional words such as "water", "bread", "daddy", "mummy", which are only used with proimperative and not protodeclarative functions. Echolalic repetition of phrases is observed.
- Some tendency to tiptoe.
- Resists change and novelty.

Current development:

- **Psychomotor development:** has a developmental age of approximately 32 months.

  Gross psychomotor skills: Has autonomous gait and good dynamic static balance.

  Fine psychomotor skills: has development comparable to his chronological age. Scribbles. Can build a tower with 8 cubes.

- **Communication and language development:** has an approximate development of 28 months.

  Comprehension: can understand simple commands and can identify both objects and real actions, although new contexts require cues to help him understand the message.

  Expression: has morphosyntactically structured language that corresponds to his chronological age level, although development of pragmatic aspects is impaired.

- **Cognitive development:** developmental age is approximately 23 months.
    - ○ Can make towers of up to 8 cubes, but not before being asked to do so.
    - ○ Can scribble randomly but without control, can point to what they want (proto-imperative)".
    - ○ Can place cubes in a train (but not in direct imitation of adult). Can use pronouns, but always reverses them.
    - ○ Can place the pieces on an interlocking board.
- **Socialisation and personal autonomy:** The age of development is approximately 26 months.

    Personal autonomy:

    - ○ Can drink from a cup or glass.
    - ○ Can use the spoon in a rudimentary way.
    - ○ Can assist with dressing and undressing.
    - ○ Controls sphincters during the day but not at night.

    Social interaction: does not establish direct interactions either towards adults or towards the peer group.

Therapist: "What do you think we need to do next?"

Student: "Well, the truth is that I'm not really sure".

Therapist: "Let's analyse which developmental area(s) are most affected".

Student: "How do we do that?"

Therapist: "First we are going to analyse the difference between the child's chronological age and the developmental age for each of the areas".

"So, in Psychomotor Development he has a developmental age of 32 months, what is the gap?"

Student: "The gap is 4 months".

Therapist: "Perfect, in a table, write down the developmental age and the chronological age and whether there are differences for each area of development".

Student: "OK".

Therapist:"Moving on, is there a gap in Communication and Language Development?"

Student: "Yes, in terms of comprehension and expression, there is a gap of 8 months".

Therapist: "Excellent, and in Cognitive Development?".

Student: "He has a developmental age of approximately 23 months, so the difference is 13 months".

Therapist: "Very good, what about Development of Socialisation and Personal Autonomy?"

Student: "She has a developmental age of approximately 26 months, so the difference is 10 months".

Therapist: "Good, let's order the development areas from most to least affected in this patient".

e) Self-testing game of acquired knowledge

The student should order the areas from most to least affected based on the information in the dialogue.

1. Cognitive development, there is a difference of 13 months. Difficulties are around the contextual understanding of some commands.

2. Development of Socialisation and Personal Autonomy, there is a gap of 10 months. The problem lies in interaction with adults and with the peer group, both known and unknown.

3. Communication and Language development, there is a delay of 8 months. Difficulties are centred on the development of the pragmatic function of language and situational understanding in contexts.

4. Psychomotor development, there is a delay of 4 months. Difficulties are around following a contextualized command.

Therapist: “Perfect, now we know which are the most to least affected areas and within them the most important aspects to start the therapeutic intervention”.

Therapist: “See you in the next Virtual Lab ”.

5.6.2. Analysis of the metacognitive dialogue applied in Lab 6

The dialogue of lab 6 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Student	“All right, what›s the first thing we have to do?”	Orientation	
Therapist	“What do you think we need to do next?”	Planning	
Student	“And how are we going to do that?”	Planning	
Therapist	“First we are going to analyse the difference between the child’s chronological age and the developmental age for each of the areas”. “So, in Psychomotor Development he has a developmental age of 32 months, what is the gap?”	Planning Elaboration	
Therapist	“Moving on, is there a gap in Communication and Language Development?”	Planning	Reinforcement during the resolution process
Therapist	“Excellent, and in Cognitive Development?”	Planning	Reinforcement during the resolution process
Therapist	“Very good, and the Area of Development of Socialisation and Personal Autonomy?”	Planning	Reinforcement during the resolution process
Therapist	“Good, let›s order the development areas from most to least affected in this patient”	Evaluation during the resolution process	Reinforcement during the resolution process

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Perfect, now we know which are the most to least affected areas and within them the most important aspects to start the therapeutic intervention".	Elaboration	Final reinforcement

5.7. VIRTUAL LABORATORY 7. APPLICATION OF *EYE TRACKING* TECHNOLOGY TO INTERVENTION AT EARLY AGES

Dr. María Consuelo Sáiz Manzanares
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5.7.1. Design of the dialogue Self-regulated Virtual Laboratory 7

Technical specifications

a) Objective of virtual lab 7: to learn about eye tracking technology and its application in the field of early childhood care.

b) Scenario: we are in a space where we have a device with eye tracking technology.

c) Characters

- **Expert** eye tracking **therapist**
- **Student**

d) Dialogue

Therapist: "Today we are going to find out what eye tracking technology is and how we can use it for diagnosis and intervention in children with developmental disabilities aged 0-6 years".

Student: "OK, what is eye tracking technology and what is it for?"

Therapist: "Information about what eye tracking technology is and how we can use it in the context of early intervention is explained in Module VII.3. From your point of view, how could this technology be applied in the diagnostic phase of a disorder and what type of pathologies do you think it would be more advisable to use it with?"

Student: "Well, I'm afraid I'm not really sure".

Therapist: "Remember that eye tracking technology is an eye tracking system that can be applied with specific stimuli projected on a screen and with real objects in a laboratory setting. Also, this technology can be used in natural contexts through eye tracking devices in glasses. What do you think could be recorded?"

Student: "The attention that a child pays to specific stimuli or to the environment in general".

Therapist: "Perfect, very good. *Eye tracking* technology is used to detect the positioning of the pupil of the eye on a given stimulus, this parameter is called fixation and is an indicator of the interest and attention that a subject experiences with respect to a stimulus. It also gives us information on another parameter such as saccades, which indicate the passage from one fixation to another. Both parameters can also record indicators of speed, time, duration, etc. Knowing this, how can *eye tracking* technology help us in early diagnosis?"

Student: "It will give us information on a child's level of attention and on which stimuli or situations the child prefers".

Therapist: "Very good, that's right, and in which disorders could this technology be most useful in the diagnostic phase".

Student: "Maybe Autistic Spectrum Disorder (ASD)?"

Therapist: "Absolutely, in this type of impairment, *eye tracking* technology can be very useful, as it will allow the professional to see what stimuli a child with a suspected ASD is most interested in and, depending on the data, this will help in differential diagnosis. This is essential at an early age, as we will be able to check whether the child prefers interaction with objects to interaction with people and what types of objects they prefer (shiny objects, circular objects, etc.). What other conditions do you think *eye tracking* technology would be useful for*?"*

Student: "Well, perhaps in children with neurological disorders".

Therapist: "Indeed, in all those cases with significant motor impairment, the use of *eye tracking* technology would be very useful, as it could help the professional in observing attention to stimuli, where the gaze is directed when the child is given different response options. This technology can be very helpful in the differential diagnosis of conserved intelligence in disorders with notable motor impairment which inhibits responses that require mobility actions of both upper and lower limbs".

Student: "Can we use eye tracking technology for other conditions?"

Therapist: "Yes, in principle we can use eye tracking technology for all disorders as an aid to diagnostic observation. However, we must very carefully plan what we are going to use it for and how we are going to use it".

Student: "How can we use eye tracking technology in the therapeutic intervention phase?"

Therapist: "Very good question. In the therapeutic intervention phase, we can use *eye tracking* technology to precisely analyse the child's attentional level at the beginning of the intervention sessions and how it progresses throughout the therapeutic intervention. It would be advisable to make initial, intermediate and final measurements to subsequently compare the results".

Student: "Of course, that is very interesting because then we would have objective data on the progression of attention levels in different tasks".

Therapist: "Also, in module VII.3 there is information about other records that could be incorporated into *eye tracking*, do you remember what they were?"

Student: "Well, I think there was the Psychogalvanic Skin Response Record (GSR) and the Electroencephalographic (EEG) record".

Therapist: "Very good, and do you remember what these records could be used for in diagnosis and intervention at an early age?"

Student: "I think the GSR measured skin conductance and this is related to different emotional responses".

Therapist: "Excellent, sweating is regulated by the Autonomic Nervous System (ANS), specifically by the Sympathetic Nervous System (SNS), and if both are highly activated, the activity of the sweat glands increases. Therefore, we can infer states of stress, tiredness or interest in the user, i.e. the physiological responses associated with the manifestation of different emotions. And what data can the EEG provide us with?"

Student: "I believe that EEG recording provides information about brain activity in the frontal, prefrontal and occipital developmental areas".

Therapist: "That's right, EEG provides valence records that relate to positive or negative reaction to stimuli, memorisation which measures the workload experienced by the user and the level of attention to the stimulus and engagement. The values in all these metrics are measured in percentages from 0-100. They all provide information about information processing during the execution of different tasks. How do you think GSR and EEG recordings could be used in the diagnostic and intervention phases?"

Student: "Well, actually, I think the same as *eye tracking* metrics. So you would have more integrated metrics that could better support the results of the diagnosis and analysis of the progression of the therapeutic intervention".

Therapist: "That's right, in combination, all these indicators will give more reliable information on the therapeutic intervention processes. Now we are going to do a small test to check whether these concepts are clear".

e) Self-testing game of acquired knowledge

The student has to match the questions and answers based on the dialogue.

Questions	Answers
How can *eye tracking* technology help us in early diagnosis?	It will give information on the child's level of attention and which stimuli or which situations they exhibit a preference
Eye tracking technology could be most useful in the differential diagnosis of	Autistic Spectrum Disorder
	Analysis of preserved intelligence in severe motor impairment
How can eye tracking technology help us in early therapeutic intervention?	It will provide information on the progression of the levels of care in the initial, intermediate and final phases.
How can GSR technology integrated into eye tracking help us in early diagnosis?	It can provide information about the child's emotional states when doing different tasks.
How can EEG technology integrated into eye tracking help us in early diagnosis?	It provides information about information processing during the different tasks.

Therapist: "Great, now we know what multi-channel integrated eye tracking technology is and what it can be used for in the field of early care.

Therapist: "See you in the next Virtual Lab 😊".

5.7.2. Analysis of the metacognitive dialogue applied in Lab 7

The dialogue of lab 7 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Student	"All right, what is eye tracking technology and what is it for?"	Orientation	
Therapist	"Information about what eye tracking technology is and how we can use it in the context of early intervention is explained in Module VII.3. From your point of view, how could this technology be applied in the diagnostic phase of a disorder and what type of pathologies do you think it would be more advisable to use it with?"	Planning Elaboration	

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"Remember that eye tracking technology is an eye-tracking system that can be applied with concrete stimuli projected on a screen and with real objects in a laboratory environment. It can also be used in natural contexts through eye tracking devices inserted in glasses. What do you think could be recorded?".	Planning Elaboration	
Therapist	"Perfect, very good. Eye tracking technology is used to detect the positioning of the pupil of the eye on a given stimulus, this parameter is called fixation and is an indicator of the interest and attention that a subject experiences with respect to a stimulus. It also gives us information on another parameter such as saccade, which indicates the passage from one fixation to another. Both parameters can also record indicators of speed, time, duration, etc. Knowing this, how can eye tracking technology help us in early diagnosis?"	Planning Elaboration	Reinforcement during the resolution process
Therapist	"Very good, that's right, and where this technology could be most useful in the diagnostic phase".	Planning Elaboration	Reinforcement during the resolution process
Student	"Well, maybe Autism Spectrum Disorder (ASD)?"	Evaluation and Elaboration	
Therapist	"Absolutely, in this type of impairment, eye tracking technology can be very useful, as it will allow the professional to see what stimuli a child with a suspected ASD is most interested in and, depending on the data, this will help in differential diagnosis. This is essential at an early age, as we will be able to check whether the child prefers interaction with objects to interaction with people and what types of objects they prefer (shiny objects, circular objects, etc.). What other conditions do you think eye tracking technology would be useful for?"	Planning Elaboration Evaluation	Reinforcement during the resolution process
Student	"Can we use eye tracking technology for other conditions?"	Elaboration	
Therapist	"Yes, in principle we can use eye tracking technology for all disorders as an aid to diagnostic observation. However, we have to plan very carefully what we are going to use it for and how we are going to use it".	Planning Elaboration Evaluation	Reinforcement during the resolution process
Student	"And how can we use eye tracking technology in the therapeutic intervention phase?"	Elaboration	

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"Also, in module VII.3 there is information about other records that could be incorporated into eye tracking, do you remember what they were?"	Orientation Elaboration	
Therapist	"Very good, and do you remember what these records could be used for in diagnosis and intervention at an early age?"	Orientation Planning Evaluation during the resolution process Elaboration	Reinforcement during the resolution process
Therapist	"Excellent, sweating is regulated by the Autonomic Nervous System (ANS), specifically by the Sympathetic Nervous System (SNS), and if both are highly activated, the activity of the sweat glands increases. Therefore, we can infer states of stress, tiredness or interest in the user, i.e. the physiological responses associated with the manifestation of different emotions. And what data can the EEG provide us with?"	Planning Evaluation Elaboration	Reinforcement during the resolution process
Therapist	"That's right, EEG provides valence records that relate to positive or negative reaction to stimuli, memorisation which measures the workload experienced by the user and the level of attention to the stimulus and engagement. The values in all these metrics are measured in percentages from 0-100. They all provide information about information processing during the execution of different tasks. How do you think GSR and EEG recordings could be used in the diagnostic and intervention phases?"	Orientation Planning Evaluation Elaboration	Reinforcement during the resolution process
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Great, now we know what multi-channel integrated eye tracking technology is and what it can be used for in the field of early care".	Elaboration	Final reinforcement

5.8. VIRTUAL LAB 8. REALISATION OF THE OBSERVATION USING INTEGRATED MULTI-CHANNEL *EYE TRACKING* TECHNOLOGY.

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5.8.1. Design of the Self-regulated Virtual Laboratory dialogue 8

Technical specifications

a) Objective of virtual lab 8: to develop a task to be applied with integrated multi-channel eye tracking technology in the field of early childhood care.

b) Scenario: we are in a space where we have a device with integrated multi-channel eye tracking technology.

c) Characters

- **Expert eye tracking therapist**
- **Student**

d) Dialogue

Therapist: "Today we are going to look at an example of using integrated multichannel eye tracking technology to apply it to an observational task in a three year old child with suspected Autism Spectrum Disorder".

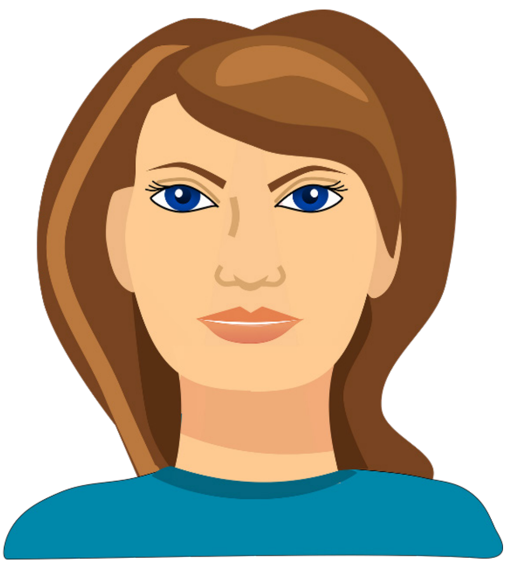
Student: "OK, how do we start?"

Therapist: "First we have to define what we want to observe".

Student: "OK".

Therapist: "Let's suppose that we want to observe the child's interest in the figure of a human face versus the figure of a moving object, for example a car".

Student: "Right, so we would look for the image of a human face and then an object, for example the image of a car, because research indicates that children with ASD afflictions prefer interaction with objects to interaction with people".



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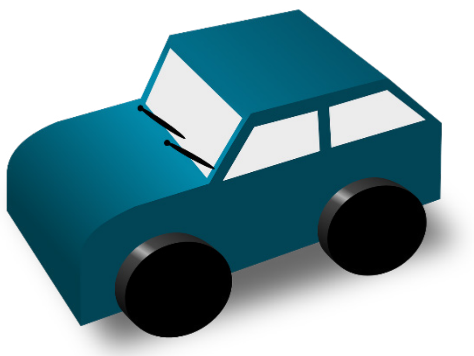

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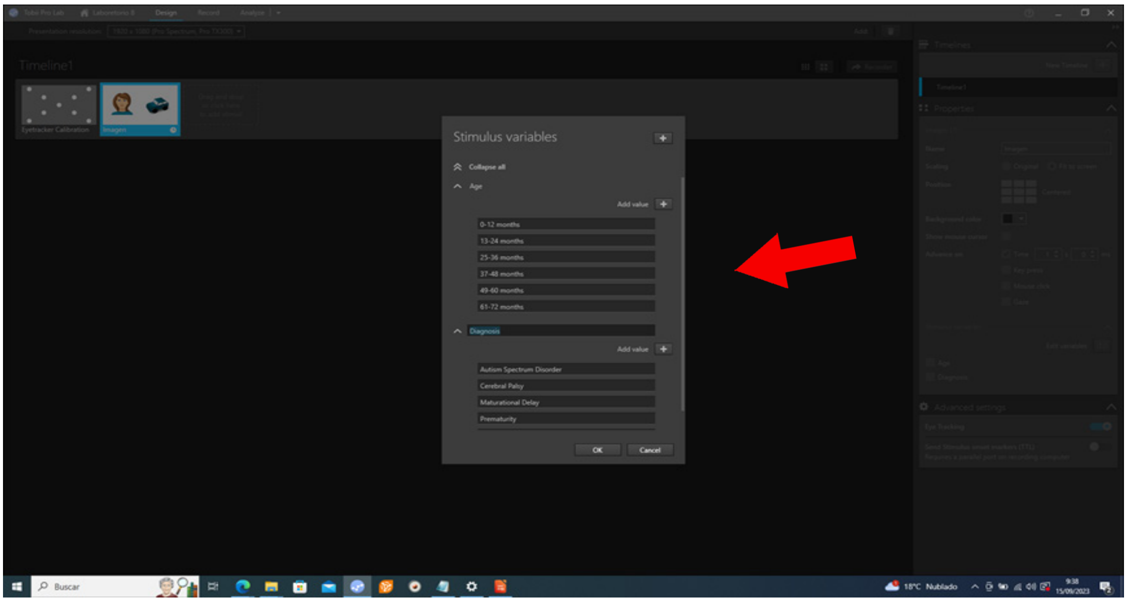
Therapist: "Perfect, very well reasoned. It is a good approach to the task of analysing attention in children with suspected ASD".

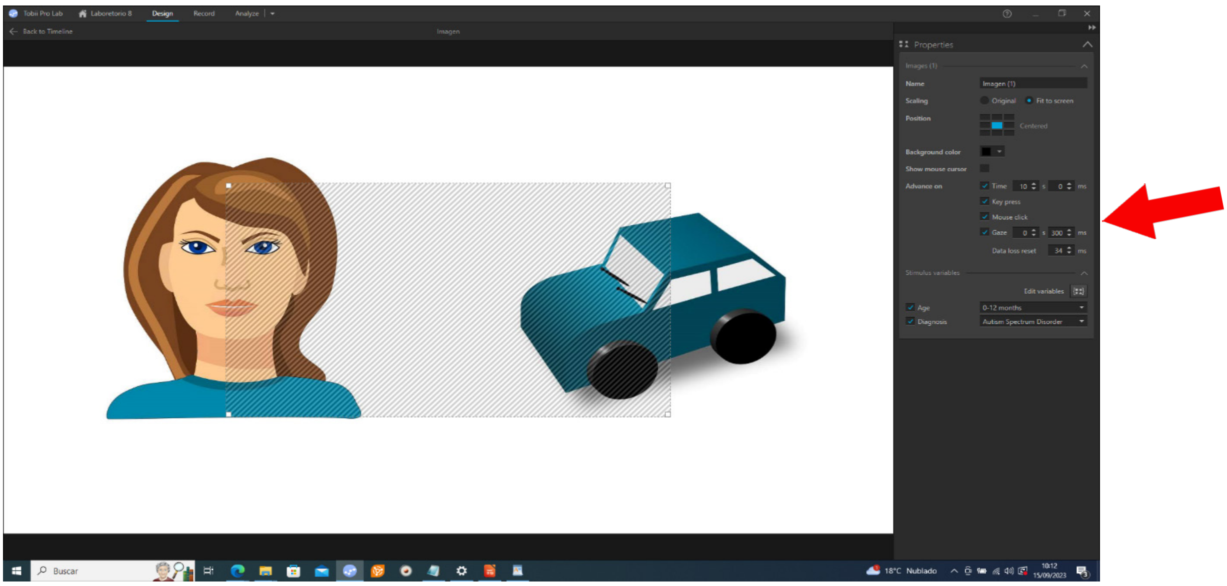
Student: "What do we do next?"

Therapist: "Once the task has been created, we must add—in this case—the image to the eye tracking equipment. However, we should first define the characteristics of the users we are going to work with. In this case they would be children aged 0-6 years, so we would make age intervals of 0-12 months, 13-24 months, 25-36 months, 37-48 months, 49-60 months and 61-72 months. Then we should also define the conditions the attention tests will be for, the most common being Autism Spectrum Disorder, Cerebral Palsy, Maturational Delay, Prematurity and Communication and Language Delay. See an example".



Student: "Very well, and then what should we do next".

Therapist: "Next, we define the duration of the exposure to the stimulus, the time interval may depend on the age and characteristics of the user or the task".



Student: "OK, and then what do we do".

Therapist: "Then we check if the eye-tracking reader and the psychogalvanic skin register sensor (GSR) are working properly".

Student: "Can we use eye tracking technology for other conditions?

Therapist: "Yes, in principle we can use eye tracking technology in all disorders as an aid to diagnostic observation. However, we must carefully plan what we are going to use it for and how we are going to use it and adapt the task to the characteristics of the disorder, including not only visual stimuli but also auditory or both".

Student: "And how can we use eye tracking technology in the therapeutic intervention phase?"

Therapist: "Very good question. In the therapeutic intervention phase, we can use eye tracking technology to accurately analyse the child's attentional level at the beginning of the intervention sessions and how it progresses throughout the therapeutic intervention. It would be advisable to make initial, intermediate and final measurements to compare the results later".

Student: "Right, that's very interesting because then we would have objective data on the progression of attention levels in different tasks".

Therapist: "**Module VII.3** refers to other records that could be incorporated in eye tracking , do you remember what they were?"

Student: "Well, we could also use the Psychogalvanic Skin Response Recorder (GSR) and Electroencephalographic recording".

Therapist: "Very good, do you remember what these records could be used for in early diagnosis and intervention?"

Student: "I believe that the Psychogalvanic Skin Response Register (GSR) measures skin conductance and this relates to different emotional responses".

Therapist: "Excellent, sweating is regulated by the Autonomic Nervous System (ANS), specifically by the Sympathetic Nervous System (SNP), and if both are highly activated, the activity of the sweat glands increases, so we can infer states of stress, tiredness or interest in the user, i.e. the physiological responses associated with the manifestation of different emotions. What data can the EEG provide us with?"

Student: "I believe that EEG recordings provide information about brain activity in the frontal, prefrontal and occipital developmental areas".

Therapist: "That's right, EEG provides records of valence which relate to positive or negative reaction to stimuli, memorisation which measures the workload experienced by the user and the level of attention to the stimulus and engagement which are all attentional indicators and can also relate to information processing. The values in all these metrics are measured in percentages from 0-100. They provide information about information processing during the execution of different tasks. How do you think GSR and EEG recordings could be used in the diagnostic and intervention phases?"

Student: "Well, actually, I think it's the same as eye tracking metrics. All the metrics recorded at the same time could better support the results of the diagnosis and analysis the therapeutic intervention's progress".

Therapist: "That's right, all these indicators in combination will give more reliable information about the therapeutic intervention processes. Now we are going to do a small test to check whether these concepts are clear".

e) Self-testing game of acquired knowledge

The student has to match the questions and answers based on the dialogue.

Question	Answers
How can eye tracking technology help us to make an early diagnosis?	It will give information on the child's level of attention and which stimuli or situations the child shows a greater preference for
Eye tracking technology could be more helpful in the differential diagnosis of	Autistic Spectrum Disorder
	Analysis of preserved intelligence in severe motor impairment
How can eye tracking technology help us in early therapeutic intervention?	It will provide information on the progress and levels of care in the initial, intermediate and final phases.
How can GSR technology integrated with eye tracking help us in early diagnosis?	It can provide information about the child's emotional states when doing different tasks.
How can EEG technology integrated in eye tracking help us in early diagnosis?	It provides information on information processing during different tasks.

Therapist: "Excellent, now we know how to design a task to be applied using integrated multi-channel eye-tracking technology in the field of early care".

Therapist: "See you in the next Virtual Lab 😊".

5.8.2. Analysis of the metacognitive dialogue applied in Lab 8

The dialogue of lab 8 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Student	"OK, how do we start?"	Orientation	
Student	"What do we do next?"	Planning	
Student	"Very well, and then what should we do next?"	Planning	
Student	"OK, and then what do we do?"	Planning	
Student	"Can we use eye tracking technology for other conditions?"	Planning Elaboration	
Student	"Right, that's very interesting because then we would have objective data on the progression of attention levels in different tasks"	Planning Evaluation Elaboration	
Therapist	"Module VII.3 refers to other records that could be incorporated in eye tracking , do you remember what they were?"	Orientation	
Therapist	"Very good, and do you remember what these registers could be used for in diagnosis and intervention at an early age?"	Orientation Planning	Reinforcement during the resolution process

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"Excellent, sweating is regulated by the Autonomic Nervous System (ANS), specifically by the Sympathetic Nervous System (SNP), and if both are highly activated, the activity of the sweat glands increases, so we can infer states of stress, tiredness or interest in the user, i.e. the physiological responses associated with the manifestation of different emotions. What data can the EEG provide us with?	Orientation Planning Evaluation Elaboration	Reinforcement during the resolution process
Therapist	"That's right, EEG provides records of valence which relate to positive or negative reaction to stimuli, memorisation which measures the workload experienced by the user and the level of attention to the stimulus and engagement which are all attentional indicators and can also relate to information processing. The values in all these metrics are measured in percentages from 0-100. They provide information about information processing during the execution of different tasks. How do you think GSR and EEG recordings could be used in the diagnostic and intervention phases?	Planning Evaluation Elaboration	Reinforcement during the resolution process
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Excellent, now we know how to design a task to be applied using integrated multi-channel eye-tracking technology in the field of early care"	Elaboration	Final reinforcement

5.9. VIRTUAL LABORATORY 9. USE OF SYSTEMATIC OBSERVATION TECHNIQUES APPLIED TO OBSERVATIONAL ANALYSIS OF BEHAVIOUR IN YOUNG CHILDREN.

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5.9.1. Design of the dialogue Self-regulated Virtual Laboratory 9

Technical specifications

a) Objective of virtual lab 9: to study systematic observation techniques applied to behavioural observation in young children.

b) Setting: virtual laboratory for observational work.

c) Characters

- **Professor**
- **Student**

d) Dialogue

Teacher: "Today we are going to work in a virtual laboratory on systematic observation techniques applied to behavioural observation in young children. Do you remember the concepts we saw in Module IV.2?"

Student: "Yes, I remember the theoretical concepts we saw in module IV.2 but I wouldn't know how to apply them to a real context".

Teacher: "OK, don't worry, let's look at an example to remind you of the steps to follow. Imagine that you are observing in an Early Childhood Education classroom with 3 year old children and in the classroom there are two children with developmental impairments, one with a suspected Autistic Spectrum Disorder and the other with a motor impairment, specifically a mild left cerebral palsy and an impairment in the development of expressive language. How would you start the observation process?"

Student: "I think we should make the field of observation more concrete by answering the questions: what, why and when to observe".

Teacher: "Indeed, we must first answer the questions what we are going to observe and why. The answers to these questions will help us to specify the objectives of the observation and from those we will be able to define the research questions and hypotheses. Next, we will be able to answer the question of when to evaluate, and from the answer we will define the time intervals for the observation. We must remember that we can't observe everything that happens in natural spaces and therefore we have to outline the object of the observation. In this case, what do you think we could observe, for what purpose and when?"

Student: "We could observe the children's performance in an assembly task. In the assembly the teacher asks the children questions about a focus of interest and they respond. This observation would be to analyse interaction especially in children with ASD and motor impairments with problems of verbal expression. The results of the observation would give us information about the aids that these children might need to improve their participation in the assembly".

Teacher: "I think it is a very good suggestion. However, the assembly can last half an hour every day of the week and we should record it for at least a month. These recordings will provide a lot of data, how could we reduce them?"

Student:"Perhaps by categorising the information recorded on the recordings?".

Teacher: "Right, we can visualise the recordings and sort all the information into categories. To do this, we could use computer-assisted qualitative data analysis software (CAQDAS) such as Atlas.ti, MAXQDA, NVivo, etc. The qualitative data will then be sorted and transformed into the categorisation criteria, which can then be analysed as frequencies and applied to co-occurrence analysis, or code-document analysis. What else do you think should be done to ensure reliability and validity in interpreting the results?”

Student: “I think that the categorisation should be done by three people in order to perform a triangulation process and to be able to find indices of agreement or contingency between the assessments. This would make the generalisation of the results more reliable. Within CAQDAS, the intercoders and intercoders agreement mode can be activated”.

Teacher: “That’s right, now let’s answer the following questions by selecting one or more answers as appropriate. Go ahead!”

e) Self-testing game of acquired knowledge

Questions are presented and the student must choose one or more of the possible answers.

Questions	**Answers**	**Correct answers**
In order to study the development of compre-hensive language we will have to use	1. Audio recording	1, 2 and 3
In order to study the development of expressive language we will have to use	2. Video recording	1, 2 and 3
In order to study cognitive development we will have to use	3. Application of integrated mul-ti-channel eye tracking technology	1, 2 and 3
Questions	Answers	Correct answers
In the observational scenario of dysfunctional behaviour in the classroom, how often should we plan observation intervals?	1. Daily 2. Weekly 3. Monthly	1
In the observational scenario of dysfunctional behaviour in the classroom, which activities should we plan the observation for?	1. In the assembly 2. During personal work tasks 3. At recess 4. Where dysfunctional behaviour has been found to happen	4

Teacher: “Perfect, now we know the systematic observation techniques applied to behavioural observation of young children”.

Teacher: “See you in the next virtual lab 😊”.

5.9.2. Analysis of the metacognitive dialogue applied in Lab 9

The dialogue of lab 9 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Teacher	"Today we are going to work in a virtual laboratory on systematic observation techniques applied to behavioural observation of young children. Do you remember the concepts we saw in Module IV.2?"	Orientation Planning Evaluation Elaboration	
Teacher	"All right, don't worry, let's give you an example to remind you of the steps to follow. Imagine that you are observing in an Early Childhood Education classroom with 3 year old children and in the classroom there are two children with developmental impairments, one with a suspected Autistic Spectrum Disorder and the other with a motor impairment, specifically a mild left cerebral palsy and an impairment in the development of expressive language. How would you start the observation process?"	Orientation Planning	
Student	"I think we should make the field of observation more concrete by answering the questions: what, why and when to observe".	Planning	
Teacher	"I think it is a very good suggestion. However, the assembly can last half an hour every day of the week and we should record it for at least a month. These recordings will provide a lot of data, how could we reduce them?"	Planning Evaluation Elaboration	Reinforcement during the resolution process
Teacher	"Right, we can visualise the recordings and sort all the information into categories. To do this, we could use computer-assisted qualitative data analysis software (CAQDAS) such as Atlas.ti, MAXQDA, NVivo, etc. The qualitative data will then be sorted and transformed into the categorisation criteria, which can then be analysed as frequencies and applied to co-occurrence analysis, or code-document analysis. What else do you think should be done to ensure reliability and validity in interpreting the results?"	Planning Evaluation Elaboration	Reinforcement during the resolution process
Teacher	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Teacher	"Perfect, now we know the systematic observation techniques applied to behavioural observation of young children"	Elaboration	Final reinforcement

5.10. VIRTUAL LAB 10. APPLICATION OF DATA MINING TECHNIQUES IN THE BEHAVIOURAL ANALYSIS OF YOUNG CHILDREN.

Dr. María Consuelo Sáiz Manzanares
eEarlyCare-T Project Coordinator. University of Burgos

5.10.1. Design of the Self-regulated Virtual Laboratory dialogue 10

Technical specifications

a) Objective of virtual lab 10: to learn how to apply Data Mining in a specific case of Early Childhood Care.

b) Scenario: virtual laboratory.

c) Characters:

- **Teacher**
- **Student**

d) Dialogue

Teacher: "Today we are going to work in a laboratory to learn how to apply Data Mining to a specific case of Early Childhood Care. Do you remember what the process was like?"

Student: "Well, not very well, because Module IV.1 was very complex for me and I didn't understand the concepts very well".

Teacher: "Well, don't worry, we are going to go over some examples so that you can see the application. First let's define the application problem. In this case we assume that we have data collected through a scale assessing the development of cognitive skills in children aged 3 to 6 years. Imagine that we have collected a sample of 60 participants in three measurements (initial, intermediate and final) separated by three months. These participants are spread over three different Early Childhood Education classrooms where three types of teaching intervention are applied (self-regulatory, traditional, Montessori methodology). Our aim is to find out the effect of the variable "type of teaching methodology" on the development of children's metacognitive strategies. So, we have defined the problem and we assume that we have the records in a database. Then, we have cleaned this database, which is available in .xlsx format, for example. What should we do next?"

Student: "I guess we have to define the hypothesis of what we want to study and what the variables are. In this assumption I think the independent or treatment variable would be to see the effect of the type of teaching on the development of cognitive and protometacognitive skills in young children".

Teacher: "Exactly, and the verification can be done applying different statistical tests, but also with the application of data mining algorithms. In this case we could apply the supervised learning technique of prediction. This would need a linear regression algorithm. Note that the multiple regression coefficient multiplied by 100 gives the prediction percentage of the variable "type of teaching methodology". But we could also use supervised classification learning techniques, which one could be applied in this case and for what purpose?"

Student: "I seem to recall that supervised learning techniques for classification were used to train a model on a labelled dataset to assign data points to classes or to classify new data points. In this case, perhaps the nearest neighbour algorithm could be applied".

Teacher: "Indeed, with nearest neighbour we can see the situation of each participant with regard to the development of cognitive and protometacognitive skills. Each participant will have an identification number and can be assigned a colour related to their assignment to the applied methodology group. So we will be able to see the distribution of participants in terms of their use of cognitive and protometacognitive skills in each applied methodology. In addition, we should be able see a longitudinal comparison through the initial, intermediate and final measurements. This functionality is very important for studying groups' and individuals' comparative development. And what could unsupervised learning techniques be used for in this example?"

Student: "I remember that unsupervised learning techniques are used to see groupings without a prior assignment variable. Is that right?".

Teacher: "That's right, we could use different algorithms such as k-means, k-means ++. These algorithms will allow us to determine the grouping of the participants regardless of the variable "type of teaching methodology ". However, once clusters are found, we can use a contingency table to study the relationship between the original group and the type of cluster assigned. All this will allow us to identify differences in the groups and to carry out teaching activities to develop cognitive and protometacognitive strategies. In addition, the clusters found in the three measurements could be matched, which would allow us to determine the individual progress of each child from a longitudinal developmental analysis . Having seen the practical application of data mining techniques, what do you think about their usefulness in the field of early childhood care?"

Student: "I think they are very important resources for studying human development in general and knowledge of individual development in particular. Applied to the field of early childhood care, I think they facilitate understanding intra- and inter-group development in both educational and clinical contexts".

Teacher: "I agree with you. Applying machine learning techniques in early care opens up a range of possibilities for professionals' work. To finish off, I am going to ask a series of questions about different practical cases of early care in which supervised and unsupervised machine learning techniques can be used".

e) Self-testing game of acquired knowledge

"Answer the following questions by selecting one or more answers as appropriate. Go ahead!".

Question	Answers	Correct answer
1. To study the predictive value of the chronological age variable.	Regression analysis	1, 2 and 3
2. To study the predictive value of the variable type of affectation.	2. Support Vector Machine	1, 2 and 3
3. To study the predictive value of the variable degree of impairment.	Decision Trees	1, 2 and 3
Question	**Answers**	**Correct answer**
Studying groupings of children with respect to functional development without a prior assignment variable	1. k-Means	1 and 2
Studying groupings of children with respect to socio-emotional development without a prior assignment variable	2. k-Means ++	1 and 2

Teacher: "Great, now we know how to apply data mining in a specific case of early childhood care".

Teacher: "See you in the next virtual lab 😊".

5.10.2. Analysis of the metacognitive dialogue applied in Lab 10

The dialogue of lab 10 is then presented, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Teacher	"Today we are going to work in a lab to learn how to apply Data Mining to a specific case of Early Childhood Care. Do you remember what the process was like?"	Orientation Planning Evaluation Elaboration	
Teacher	"Well, don't worry, we are going to do examples so you can see the application. First let's define the application problem. In this case we assume that we have data collected through a scale assessing the development of cognitive skills in children aged 3 to 6 years. We assume that we have collected a sample of 60 participants in three measurements (initial, intermediate and final) separated by three months. These participants are distributed in three different classrooms of Early Childhood Education in which three types of teaching intervention are applied (self-regulatory, traditional, Montessori methodology). Our aim is to find out the effect of the variable type of teaching activity implemented on the development of metacognitive strategies in children. Thus, we have defined the problem and we assume that we have the records in a database. Then, we have cleaned this database, which is available for example in .xlsx format, what would we do next?"	Orientation Planning Evaluation Elaboration	
Teacher	"Exactly, and the verification can be done applying different statistical tests, but also with the application of data mining algorithms. In this case we could apply the supervised learning technique of prediction. This would need a linear regression algorithm. Note that the multiple regression coefficient multiplied by 100 gives the prediction percentage of the variable "type of teaching methodology". But we could also use supervised classification learning techniques, which one could be applied in this case and for what purpose?"	Planning Evaluation Elaboration	Reinforcement during the resolution process

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Teacher	"Indeed, with nearest neighbour we can see the situation of each participant with regard to the development of cognitive and protometacognitive skills. Each participant will have an identification number and can be assigned a colour related to their assignment to the applied methodology group. So we will be able to see the distribution of participants in terms of their use of cognitive and protometacognitive skills in each applied methodology. In addition, we should be able see a longitudinal comparison through the initial, intermediate and final measurements. This functionality is very important for studying groups' and individuals' comparative development. And what could unsupervised learning techniques be used for in this example?"	Planning Evaluation Elaboration	Reinforcement during the resolution process
Student	"I remember that unsupervised learning techniques are used to look at groupings without a prior assignment variable. Is that right?".	Evaluation Elaboration	
Teacher	"That's right, we could use different algorithms such as k-means, k-means ++. These algorithms will allow us to determine the grouping of the participants regardless of the variable "type of teaching methodology ". However, once clusters are found, we can use a contingency table to study the relationship between the original group and the type of cluster assigned. All this will allow us to identify differences in the groups and to carry out teaching activities to develop cognitive and protometacognitive strategies. In addition, the clusters found in the three measurements could be matched, which would allow us to determine the individual progress of each child from a longitudinal developmental analysis . Having seen the practical application of data mining techniques, what do you think about their usefulness in the field of early childhood care?"	Planning Evaluation Elaboration	Reinforcement during the resolution process
Teacher	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Teacher	"Great, now we know how to apply data mining in a specific case of early childhood care".	Elaboration	Final reinforcement

5.11. VIRTUAL LAB 11. DESIGN AND USE OF CONVERSATIONAL ASSISTANTS IN EARLY CHILDHOOD CARE

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5.11.1. Design of the Self-regulated Virtual Laboratory dialogue 11

Technical specifications

a) Objective of virtual lab 11: to analyse the features to be considered when designing and using intelligent assistants.

b) Setting: classroom or office with the therapist and a student discussing the design and use of these intelligent assistants.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: "Today we are going to look at the features to consider when designing and using intelligent assistants".

Student: "OK, what is the first thing we need to consider?"

Therapist: "First, let's define what we mean by an intelligent personal assistant or "bot" in our context. Are you clear about the concept?"

Student: "Right now there are so many products considered "intelligent" and with the name "bot", "chatbot" or assistants, based on Artificial Intelligence (AI), offering such diverse services, that it is very difficult to answer that".

Therapist: "Of course. From an early care point of view, in our case we look for conversational elements that guide and help people to reach a goal or clarify a question. It should give the feeling of interacting with a person, not giving answers to everything in a general way, but getting to more personalised, precise or specific information".

Student: "And that covers both the therapist and the patient?"

Therapist: "Yes, useful conversations can be established for both profiles, although they are not a perfect solution in all situations. Are you clear about their benefits and drawbacks?"

Student: "I hadn't really thought about it".

Therapist: "They are very easy to use, in many cases by entering short texts or asking questions aloud. But the latter may produce a certain fear of loss of privacy and social embarrassment having to speak out loud".

Student: "Well, I guess it's a matter of both the therapist and the patient getting used to using it".

Therapist: "Yes, it's good to do some pilot testing with both in the early stages to lose the initial fear. You know what's very important in the beginning?"

Student: "No, I thought it was just a conversation starter".

Therapist: "The first welcome or *onboarding* message must be very clearly defined, this message must be friendly, explaining what the *bot* can really answer and commenting on the natural way of interacting with it. If it is not clear from the beginning how to use it and what to expect from it, people will stop using it as they might feel uneasy or think it's not being very useful".

Student: "OK, I'll keep that in mind. And then just, should we start asking questions and answers?"

Therapist: "Yes, although it is very important to have the conversations and the expected flow of the conversation defined beforehand in order to arrive at an accurate response. We will call this 'intention'. Do you think it is enough to define a question and answer for each step of the conversation?"

Student: "It seems like yes, that would establish a conversation, which is basically what we're looking for, right?"

Therapist: "Although it may seem so, we would create a conversation that would always be the same and be quite repetitive. If we want to give a more human nuance, we have to define a set of questions and answers that are slightly different but mean the same".

Student: "Why is this so important?"

Therapist: "People do not always ask and answer questions in exactly the same way. Depending on the day and our mood, we change both slightly, even if we basically say the same thing. It is important for the assistant to have this ability to accept different, equivalent questions, and to able to give answers with slight variations".

Student: "Sure, otherwise it would feel like a 'robot' answering us and we would lose that feeling of talking to a person. But do you have to define the whole set of question and answer variants? That seems an almost impossible task".

Therapist: "Most assistants learn and deduce which sentences are equivalent and can learn from an initial set. However, it can be useful to give them a reasonable, although not exhaustive, set of examples".

Student: "So, for each intention, is it a good idea to have an initial set of equivalent questions and answers?"

Therapist: "Exactly, that is the way to produce "conversations". When we define the intentions with their variants of questions and answers, it is also important to bear in mind that we will not always know how to answer all the questions".

Student: "And in those cases what do we do? Do we make up the answer?"

Therapist: "No, you should never do that. You have to define the conversation, to redirect it towards an intention that you do know how to resolve, or else admit that you do not know how to respond and advise consultation with a human agent. Redirecting at the beginning of the conversation, or closing the conversation, is not recommended, because it creates frustration".

Student: "OK, and if we see that in general the conversations are not running smoothly or they don't respond appropriately, what do we do?"

Therapist: "In these cases, the definition of the intentions, their questions and response should be reviewed afterwards, expanding the possible set of questions. And provide corrections to our assistant's provider. The system itself usually learns from these small corrections. In this way, you refine it and end up with a more useful intelligent assistant".

e) Self-testing game of acquired knowledge

Therapist: "Now I'd like you to answer the following questions by selecting the answer as appropriate. Go ahead!"

Question 1. If the patient initiates a conversation for the first time in an assistant they have never interacted with before, what would be a recommended first message:

1. "Hi, we›re going to have a great time, and I›ll be able to answer anything you want to ask me. I can answer practically any question, and you should trust my answers".

2. "Hi, we›re going to have a great time, and I›ll be able to answer anything you want to ask me. I can answer practically any question, and you should trust my answers".

3. "Hello, I am your assistant. I will guide you through your questions about this particular scenario. Ask short, specific questions, either by text or voice, and I will try to find the best possible answer".

3. "Hello, I am your assistant. I will guide you through your questions about this particular scenario. Ask short, specific questions, either by text or voice, and I will try to find the best possible answer".

Feedback: no false expectations should be created, the scope and expected outcome of the assistant should be made as clearly and specifically as possible. The conversation should simulate a conversation with a person, avoiding jargon or "robotic" phrases. Clear and precise instructions should be given on how to interact with the assistant.

Question 2. If the patient or therapist establishes a conversation with the assistant, and a precise answer is not known, which of the following steps would be most advisable:

1. Restart the conversation.

2. Make up an answer.

3. Redirect to a human agent.

4. Close the conversation.

Feedback: If you do not know how to give an answer or redirect the conversation, it is better in these cases to redirect the consultation to a person trained in these topics. Restarting or closing the conversation creates frustration and leads to people not using the assistant in the future. Under no circumstances should random or invented answers be generated just for the sake of answering, as this leads to a loss of credibility for the assistant.

Therapist: "Perfect, we know how the assistant should behave in these cases".

Therapist: "See you in the next Virtual Lab 😊 "

5.11.2. Analysis of the metacognitive dialogue applied in Lab 11

The dialogue of lab 11 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Student	"OK, what's the first thing we need to consider?"	Orientation	
Therapist	"First, let's define what we mean by an intelligent personal assistant or "bot" in our context. Are you clear on the concept?"	Orientation Planning	

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Student	"And that covers both the therapist and the patient"?	Orientation	
Therapist	"Yes, useful conversations can be established for both profiles, although they are not a perfect solution in all situations. Are you clear about their benefits and drawbacks?"	Orientation Planning Elaboration	Reinforcement during the resolution process
Therapist	"Yes, it is a good idea to do some pilot testing with both in the early stages to lose the initial fear. You know what is very important in the beginning?"	Orientation Planning	Reinforcement during the resolution process
Student	"All right, I'll keep that in mind. And then we'll just start asking questions and giving answers?"	Orientation Planning	
Therapist	"Yes, although it is very important to have the conversations and the expected flow of the conversation defined beforehand in order to arrive at an accurate response. We will call this 'intention'. Do you think it is enough to define a question and answer for each step of the conversation?"	Orientation Planning Evaluation	Reinforcement during the resolution process
Student	"It seems like yes, that would establish a conversation, which is basically what we're looking for, right?"	Orientation Planning	
Student	"Why is this so important?"	Elaboration	
Student	"Sure, otherwise it would feel like a 'robot' answering us and we would lose that feeling of talking to a person. But do you have to define the whole set of question and answer variants? That seems an almost impossible task".	Orientation Planning Elaboration	
Student	"So for each intention, is it useful to have an initial set of equivalent questions and answers?"	Orientation Planning Elaboration	
Student	"What do we do in those cases, do we make up the answer?"	Planning Elaboration	
Student	"OK, and if we see that in general the conversations are not running smoothly or they don't respond appropriately, what do we do?"	Planning Evaluation Elaboration	
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Teacher	"Perfect, we know how the assistant should behave in these cases".	Elaboration	Final reinforcement

5.12. VIRTUAL LABORATORY 12. RESOLUTION OF A CASE OF BRAIN DAMAGE.

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5.12.1. Design of the dialogue Self-regulated Virtual Laboratory 12

Technical specifications

a) Virtual laboratory objective 12: to study the clinical case of a 4-year-old girl who is suffering from brain damage as a consequence of herpetic encephalitis (herpes simplex).

b) Scenario: simulation centre.

c) Characters

- **Therapist**
- **Student**

d) Dialogue

Therapist: "Today we have a case of a four-year-old girl who has suffered from herpetic encephalitis with right hemispheric involvement".

Student: "All right, where are we going to start examining the case?"

Therapist: "Let's review the child's medical records. What does the data tell us?"

Current chronological age. 4 years and 6 months

Medical history:

- At the age of 4, the girl suffered from herpetic encephalitis which caused a right hemispheric haemorrhage, specifically in the temporal lobe, leading to atrophic retraction of the ventricular system with consequent diffuse dilatation.
- On discharge, neurological examination showed disconnection with the environment, deviation of the gaze to the right, dysphagia, spasticity and hypertonia, bilateral positive Babinski.
- The electroencephalogram (EEG) showed a disorganised and diffusely slow basal tracing.

Current development:

Subsequently, the child's cognitive state was assessed using the Weschler Intelligence Scale for Infants and Primary School (WPPSI), giving the following results. The Total IQ was calculated from the main scales. This score expresses the child's overall level of intelligence (mean of 100 and standard deviation of 15) Total IQ: 53.

- **Manipulative area: CIM: 45**
- **Psychomotor development:** Approximately 36 months of development.
    - *Gross psychomotor skills*: Gait disturbance. Can move with difficulty. Can turn and lean on forearms.
    - In terms of *fine psychomotor skills*: She has difficulties with precision, she mainly uses her left hand, with some mobility in her right hand. Hypertonia and spasticity.
- **Communication and language development:** Within the expected range for her chronological age.
- **Cognitive development:** Low cognitive level.
    - Impairment in sustained attention and concentration.
    - Visual perception.

- ○ Memory.
- ○ Low processing speed.
- ○ Fatigue.

- **Socialisation and personal autonomy:** The developmental age is approximately 36 months.
    - ○ *Personal autonomy:*
        - Proper postural control.
        - Does not move independently. Needs help to move around and gets tired if she walks a lot.
        - Adequate sphincter control.
        - Eats autonomously, but takes mashed food. Needs thickener. Dysphagia. Slowness.
        - Dressing. Dependent when dressing and grooming. Needs help to fasten buttons, use zips and snaps.
    - ○ *Social interaction:*
        - Interaction with both adults and her peer group is adequate.

Therapist: "What do you think we need to do next?"

Student: "Well, I'm afraid I'm not sure".

Therapist: "Let's analyse what the observed difficulties are".

Student: "How are we going to do that?"

Therapist: "First let's analyse the findings from the child's assessment".

"Look, in the area of psychomotor development, she has a developmental age of approximately 36 months, how old is she chronologically?"

Student: "She is 48 months old chronologically".

Therapist: "So what's the difference?"

Student: "The difference is 12 months".

Therapist: "OK, write the developmental age and the chronological age in a table along with the differences in the areas of development".

Student: "OK".

Therapist: "Moving on, in language development, is there a gap?"

Student:"No, she is a similar chronological age, so there is no mismatch".

Therapist: "Good, and in Cognitive Development?".

Student: "She has a developmental age of 36 months, so the difference is 12 months".

Therapist:"Excellent, moving on to Development of Socialisation and Personal Autonomy?"

Student: "She has a developmental age of approximately 36 months, so the difference is 12 months".

Therapist:"Very well, let's order this child's development areas from most to least affected".

"After initial normal development, the child suffered a brain injury that has left sequelae that focally or diffusely affect development".

1. Motor skills (manual dexterity, right-left orientation, orofacial praxias, verbal motor control). Difficulties in independent walking. High risk of falling.
2. Visual perception (difficulty in perceiving and interpreting shapes, fundamental for cognitive processing and reasoning).
3. Memory (verbal and non-verbal, short and long term).

4. Selective and Sustained Attention (Vigilance)

5. Language (comprehension and expressive language skills) Slight difficulty in accessing the lexicon. Better semantic than phonological performance.

e) Self-testing game of the acquired knowledge

Now you have to associate A with B.

Issues	Answers
Difficulties encountered	From the results of the assessment it was possible to establish a characteristic cognitive profile with a lower intellectual performance than expected for her age, together with the presence of deficits in basic and higher cognitive processes that are accentuated when the information is visual.
Mnesic	Difficulties in acquiring (retaining) and/or recalling (retrieving back) previously stored information
Attentional	Difficulties in maintaining concentration. Frequent absent-mindedness (assess cognitive fatigue).
Processing speed	Slowness in processing information.
Fatigue	Decrease in cognitive performance when mental effort is excessive over a prolonged period of time.

Therapist: "Perfect, so now we know which are the most and least affected areas and within them the most relevant aspects to start the therapeutic intervention".

Therapist: "See you in the next Virtual Lab 😊".

5.12.2. Analysis of the metacognitive dialogue applied in Lab 12

The dialogue of lab 12 is presented below, as well as the metacognitive strategies and reinforcement applied.

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"Let's review the child's medical records. "What does the data tell us?"	Orientation	
Therapist	"What do you think we need to do next?"	Planning	
Student	"How are we going to do that?"	Orientation	
Therapist	"First let's analyse the findings from the child's assessment". "Look, in the area of psychomotor development, she has a developmental age of approximately 36 months, how old is she chronologically?"	Orientation Planning	
Therapist	"So what's the difference?"	Planning Evaluation	
Therapist	"Moving on, in language development, is there a gap?"	Planning Evaluation	

Character	Self-questions/sentences	Metacognitive Strategy	Reinforcements
Therapist	"Good, and in Cognitive Development?"	Planning Evaluation	Reinforcement during the resolution process
Therapist	Self-testing game of acquired knowledge	Final evaluation	Positive reinforcement (success) Feedback to try again (error)
Therapist	"Perfect, we now know which are the most affected areas from most to least affected and within them the most relevant aspects to start the therapeutic intervention".	Elaboration	Final reinforcement

VI. Pilot study of the usability of the virtual laboratory structure

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6.1. INTRODUCTION

A pilot evaluation was carried out in order to test the usability of the virtual laboratories. In the first phase, it was tested with final-year Health Sciences students. Then in the second phase, it was validated with practising early care professionals.

6.1.1. Student sample

We worked with 8 students aged between 18 and 25, all women. Figure 14 shows the data disaggregated by age.

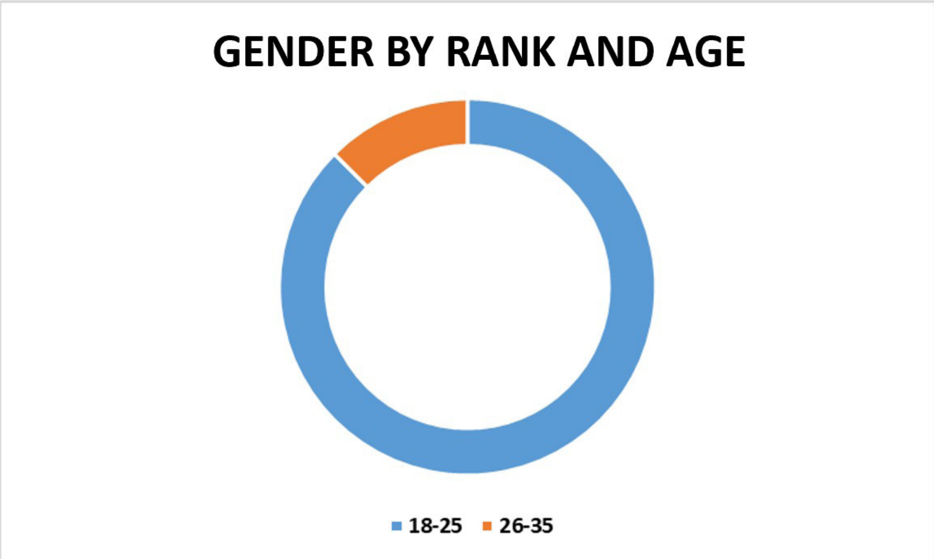

Figure 14. *Distribution of the sample of students by sex and age group.*

6.1.2. Student assessment results

A scale was specially created to assess the usefulness and usability of the virtual laboratories. The scale is composed of 10 closed-response items. Responses are measured on a Likert-type scale from 1 to 5, (with 1 being not at all satisfied or completely disagreeing and 5 being very satisfied or completely agreeing). The mean rating for each item and the standard deviation (SD) are given in Table 1.

Table 1. *Items in the scale for perceived satisfaction with the use of Self-regulated Virtual Laboratories.*

Ítems	Media	DT
1. The virtual laboratories help me to understand the theoretical aspects of the subject.	3.6	0.9
2. The virtual labs help me to understand the practical aspects of the subject.	4.0	0.8
3. The virtual labs help me to easily understand the content.	3.8	0.9
4. The virtual laboratories encourage my participation in the subject.	4.0	1.2
5. I feel anxiety when using the virtual laboratories.	1.6	0.9
6. Virtual laboratories liven up the content.	3.9	1.0
7. Virtual laboratories are easy to use.	4.3	0.9

Ítems	Media	DT
8. I would recommend the virtual lab as a learning tool to my colleagues.	4.3	0.9
9. I would like to learn with virtual laboratories in other subjects.	4.1	0.8
10. My overall satisfaction with the use of the laboratories is	4.4	0.7

The lowest mean was 3.6 out of 5 and the highest was 4.4 out of 5. The disaggregated data are analysed in Figure 15.

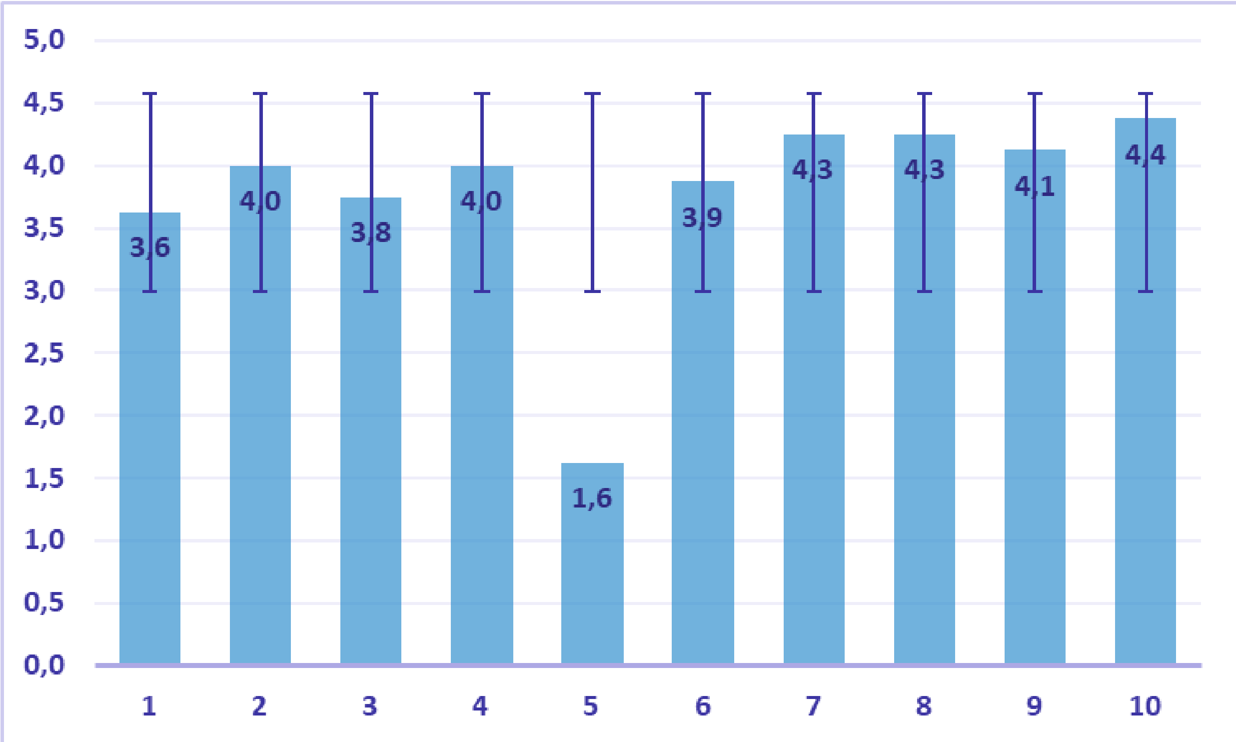

Figure 15. *Disaggregated results on the usability scale of the virtual laboratory structure.*

The mean for item 1 was 3.6 out of 5, students indicated that the Self-Regulated Virtual Labs helped them to focus on the subject's conceptual concepts. They gave a higher score (*M* = 4 out of 5) in relation to practical concepts, which is logical, since the laboratories are designed to work on procedural content. Also, students felt that this instructional methodology was useful for improving ease of understanding (*M* = 3.8 out of 5). In addition, using the laboratories increased their motivation to participate in the subject (*M* = 4 out of 5). Another notable aspect is that they did not feel anxious using the labs (*M* = 1.6 out of 5). In contrast, the virtual labs made the content more enjoyable for them (*M* = 3.9 out of 5). They also found the Self-Regulated Virtual Labs easy to use (*M* = 4.3 out of 5),would recommend the labs to their peers (*M* = 4.3 out of 5), and would like them to be used in other subjects (*M* = 4.3 out of 5).

In terms of overall satisfaction with the activity, the students' average perceived satisfaction was 4.4. It is worth noting that 50% of the students gave the pilot virtual lab the highest score while none scored it lower than 3.

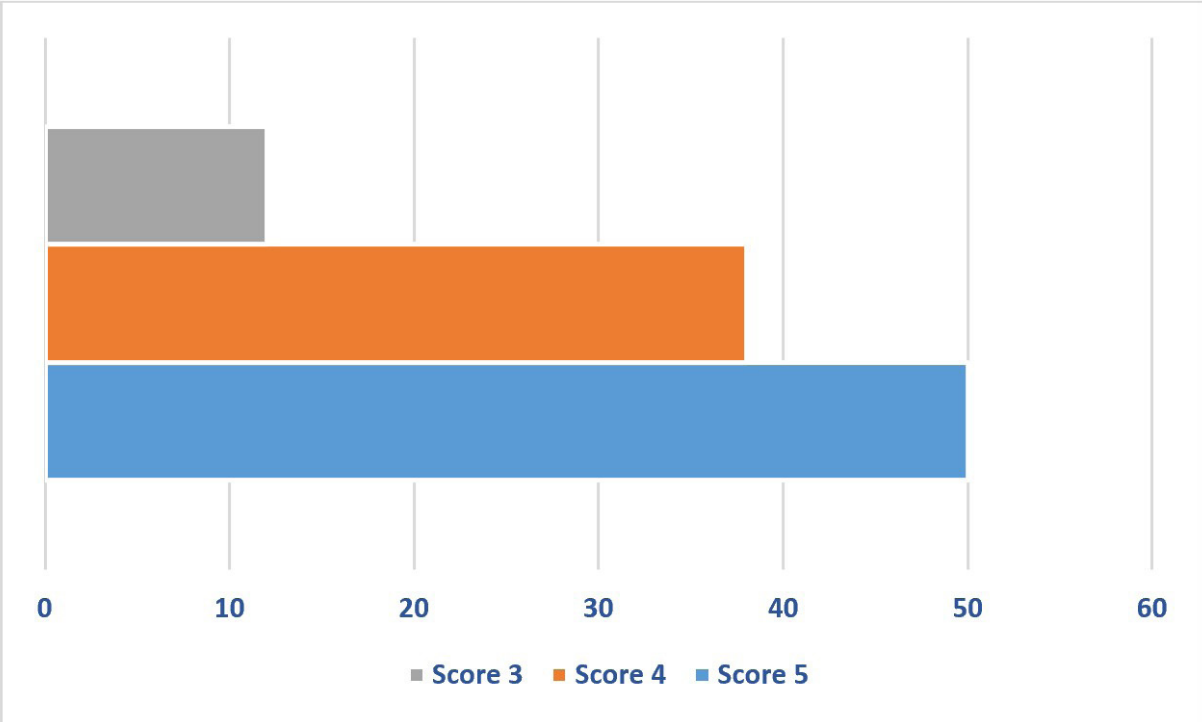

Figure 16. *Percentage of overall satisfaction with the use of virtual laboratories.*

The usability scale also included an open-ended question, "Which elements would you add or increase in the virtual laboratory? Why?" The responses to the open-ended question were categorised using the qualitative analysis software Atlas.ti version 23. The results are shown in Figure 2.

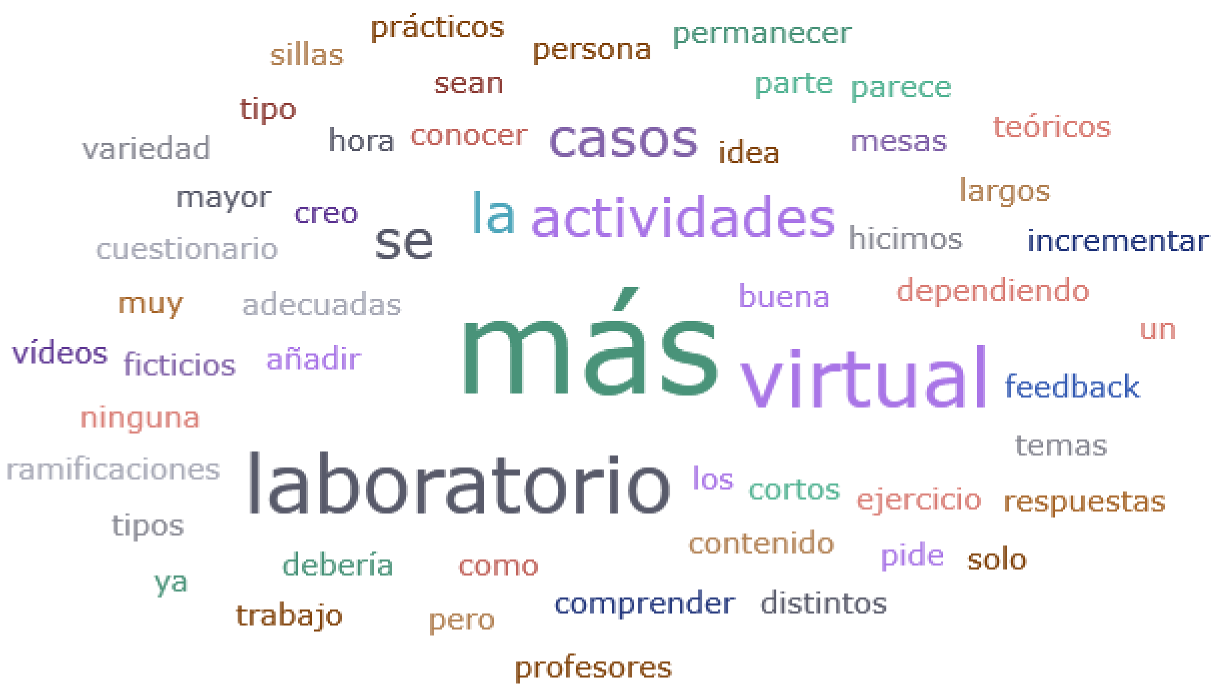

Figura 17. . *Word cloud from the open response.*

6.1.3. Sample of early childhood professionals

We worked with 15 practising early childhood professionals, aged between 30 and 65, 93% of whom were women and 7% men. Figure 17 shows the data disaggregated by gender and age. Of the 15, 5 were specialists in Special Education, 5 were specialists in Hearing and Language, 4 were physiotherapists, and 1 was an Occupational Therapist. 10 had more than 10 years of experience and 5 had between 4-7 years of professional practice.

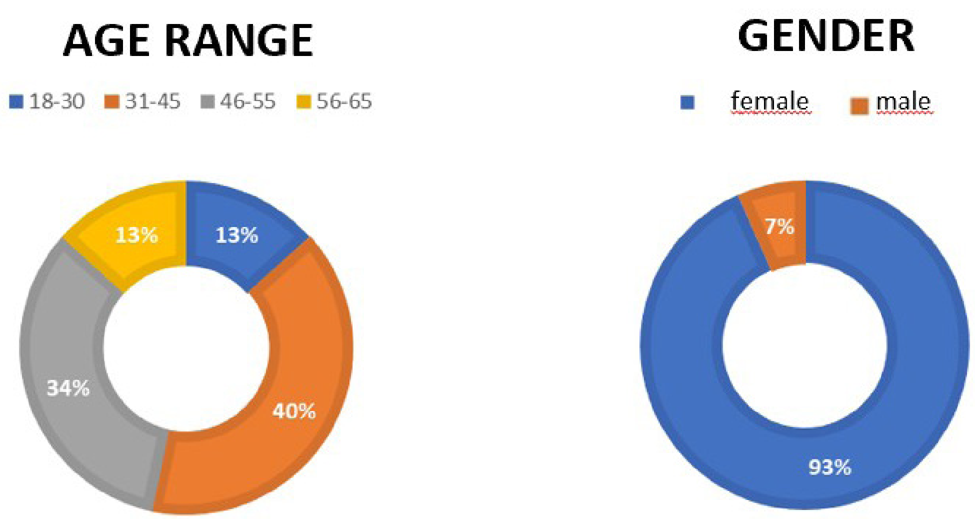

Figure 18. *Distribution of the sample of professionals by sex and age group*

6.1.4. Results assessment of early care professionals

A scale for perceived satisfaction with the use of virtual laboratories was produced for this study. This scale consists of 22 items scored on a Likert-type scale from 1 to 5 (with 1 being not at all satisfied or completely disagreeing and 5 being very satisfied or completely agreeing). Table 2 shows the mean and SD for the scores from practising early childhood professionals on the scale of perceived satisfaction with the use of virtual laboratories.

Table 2. *Perceived satisfaction with the use of Self-regulated Virtual Labs among practising professionals*

Ítems	Media	DT
1. The language used in the virtual laboratories is clear.	4.0	1.2
2. Virtual laboratories are easy to use.	4.2	1.2
3. I feel anxiety or stress while using the virtual laboratory.	2.3	1.6
4. The platform on which the virtual laboratories are located is intuitive.	3.8	1.2
5. I would like to continue working with virtual laboratories in other subjects.	3.4	1.3
6. I would recommend learning with virtual laboratories to my colleagues.	3.2	1.4
7. The virtual laboratory has facilitated my understanding of the theoretical aspects addressed in it.	3.2	1.3
8. The virtual laboratory has facilitated my understanding of the practical aspects covered in it.	3.2	1.1
9. Virtual labs increase my motivation to learn.	3.4	1.2
10. Virtual laboratories are an important complement to the modules included in the learning platform.	3.4	1.2
11. I am clear about the steps I need to take to assess and initiate intervention for clinical cases of prematurity.	3.3	1.3
12. I am clear about the steps I need to take to assess and initiate intervention for clinical cases of developmental delay.	3.3	1.2
13. I am clear about the steps I need to take to assess and initiate intervention for clinical cases of communication and language delay.	3.3	1.3
14. I am clear about the steps I have to follow to assess and initiate intervention for clinical cases of West Syndrome (Lennox-Gastaut).	3.1	1.2
15. I am clear about the steps I need to take to assess and initiate intervention in clinical cases of cerebral palsy.	3.3	1.2
16. I am clear about the steps I need to take to assess and initiate intervention for clinical cases of autism spectrum disorder.	3.2	1.2
17. I am clear about how eye tracking technology works and how it can be applied in the field of early childhood care.	3.3	1.4
18. I am clear about which systematic observation techniques I can apply in behavioural observation of young children.	2.9	1.1
19. I am clear on how to apply data mining techniques in specific early care cases.	2.4	1.3

Ítems	Media	DT
20. I am clear about how I can use conversational assistants in early care.	3.1	1.3
21. I am clear about the steps I need to take to assess and initiate intervention for clinical cases of brain damage in children who have suffered from herpes encephalitis.	3.3	1.2
23. 10. My overall satisfaction with the use of the laboratories is	3.5	1.2

The mean satisfaction scores ranged from 3.1-4.2 for all of the items except item 3 (in this case a mean below 3 indicates that the use of the laboratories does not cause anxiety for the users), 18 (in this case suggesting that the performance of the laboratory related to the use of observation techniques should be reviewed and revised to improve understanding), and item 19 (in this case suggesting that the performance of the laboratory related to the use of data mining techniques should be reviewed and revised to facilitate understanding). Figure 19 presents the items' mean scores and standard deviations. The standard deviation was greater than 1.3 for all items, indicating greater variability of responses from the surveyed population.

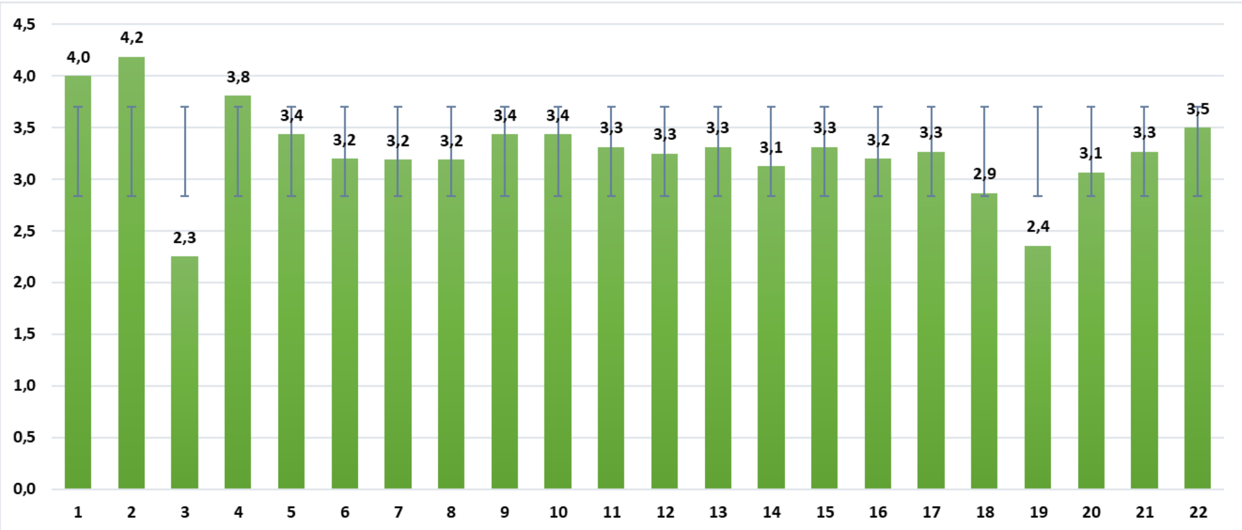

Figure 19. *Disaggregated results from the scale asking practising professionals about usability of the virtual laboratory structure.*

The satisfaction scale also included two open-ended questions, "Which elements would you add or increase in the virtual laboratories? Why?" and, "Which elements would you remove from the virtual laboratories? Why?". The answers to the open-ended question were categorised using the qualitative analysis programme Atlas.ti version 24. The results are shown in Figure 20 and Table 3. In the Sankey diagram (see Figure 20), elements to be kept are green, elements to be removed are red, and elements to be added are ochre. In summary, practising early childhood care professionals felt the virtual case study laboratories to be simple from their professional point of view. However, a third of respondents (29%) would not remove anything. The aspects they most wanted to remove were related to the avatars with voices that regulate the problem-solving process. They also suggested revising some of the questions for checking content and the answers given. The most highly valued aspect was the explanation of the development of the eEarlyCare web application as an aid to diagnosis and intervention. The professionals rated labs 10 and 11 very highly, but indicated that they needed more practical examples, as these refer to the use of data mining techniques and *eye tracking* technology, which they felt to be more innovative.

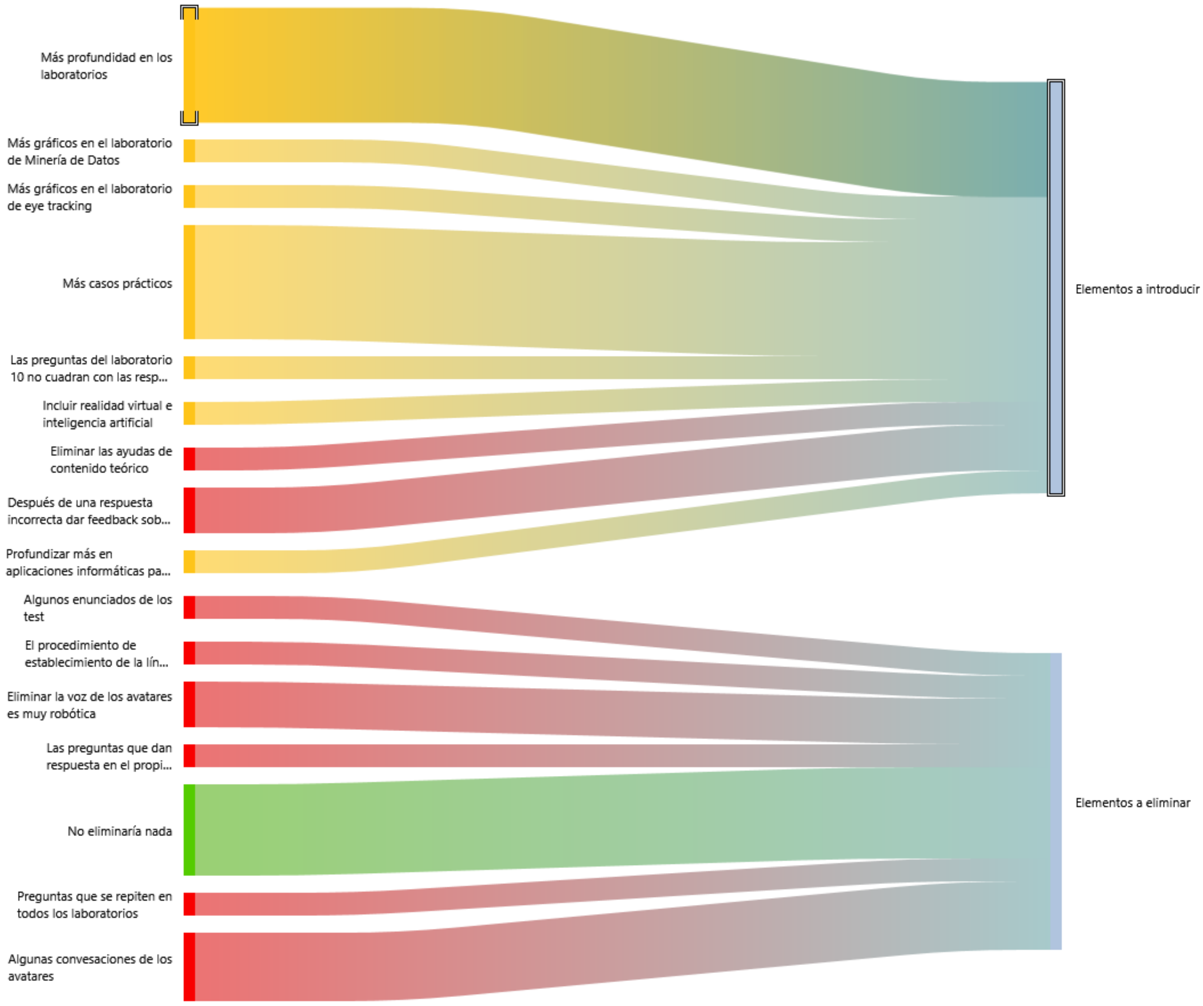

Figure 20. *Sankey diagram of elements to be added or removed*

Table 3. *Frequency of categorisation codes in responses to open-ended questions*

		1: Elementos a introducir 15	2: Elementos a eliminar 13	Totales
Algunas convesaciones de los avatares	3		3	3
Algunos enunciados de los test	1		1	1
Después de una respuesta incorrecta dar feedback sobre la correcta	2	2		2
El procedimiento de establecimiento de la línea base	1		1	1
Eliminar la voz de los avatares es muy robótica	2		2	2
Eliminar las ayudas de contenido teórico	1	1		1
Incluir realidad virtual e inteligencia artificial	1	1		1
Las preguntas del laboratorio 10 no cuadran con las respuestas	1	1		1
Las preguntas que dan respuesta en el propio enunciado	1		1	1
Más casos prácticos	5	5		5
Más gráficos en el laboratorio de eye tracking	1	1		1
Más gráficos en el laboratorio de Minería de Datos	1	1		1
Más profundidad en los laboratorios	5	5		5
No eliminaría nada	4		4	4
Preguntas que se repiten en todos los laboratorios	1		1	1
Profundizar más en aplicaciones informáticas para el diagnóstico y la intervención	1	1		1
Totales		18	13	31

Comparing the satisfaction reported by the students and the practicing professionals in practice, as Figure 15 and Figure 19 show, it was higher in the students (M = 4.4) than in the professionals (M = 3.5). The dispersion of the responses also differed (student SD = 0.7 vs. professionals SD = 1.2). This indicates that the student responses were more homogeneous than the professionals' responses. This variability may be due to experience in professional practice. Professionals with more than 10 years of experience probably have more complex needs for updating practical aspects than those with less professional experience.

For this reason, future editions will use two types of practical virtual laboratories, one aimed at students and another, more difficult lab, aimed at practising professionals, taking into account the number of years of professional practice.

VII. Conclusions

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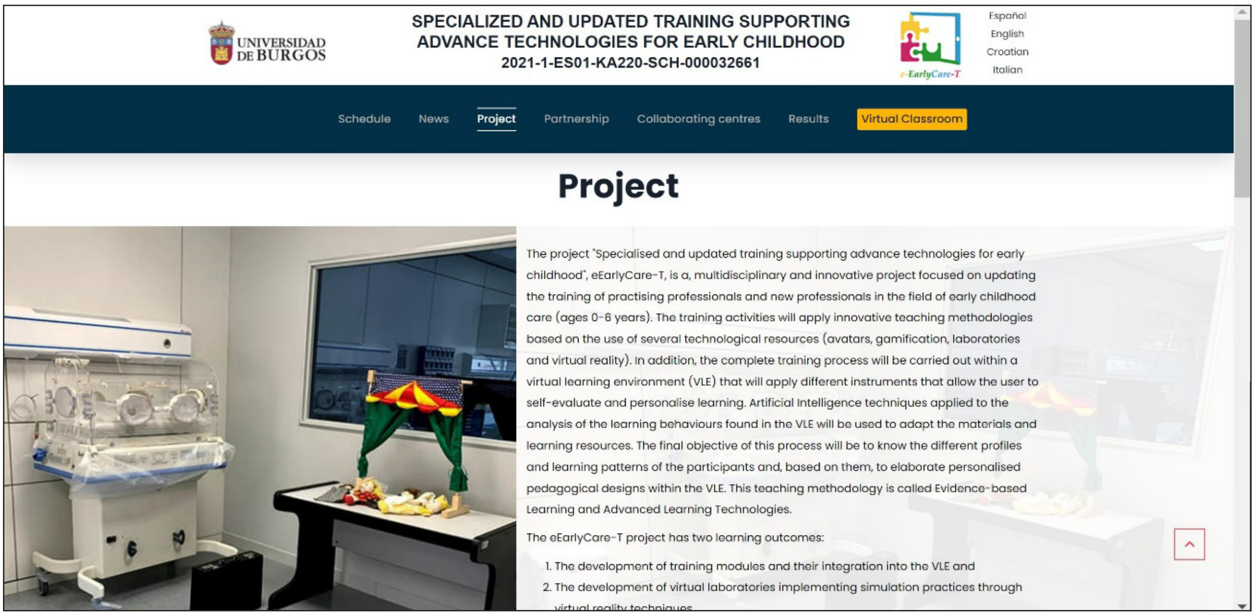
Self-regulated Virtual Laboratories using avatars that apply self-regulated dialogues facilitate the acquisition of practical concepts and the consolidation of theoretical concepts, as they can be applied to practical resolution scenarios. In addition, the inclusion of serious games that ask questions seeking association or discrimination of content seen in the dialogues enhance self-assessment. Likewise, giving students feedback on their answers allows them to analyse their own answers and learn from their mistakes.

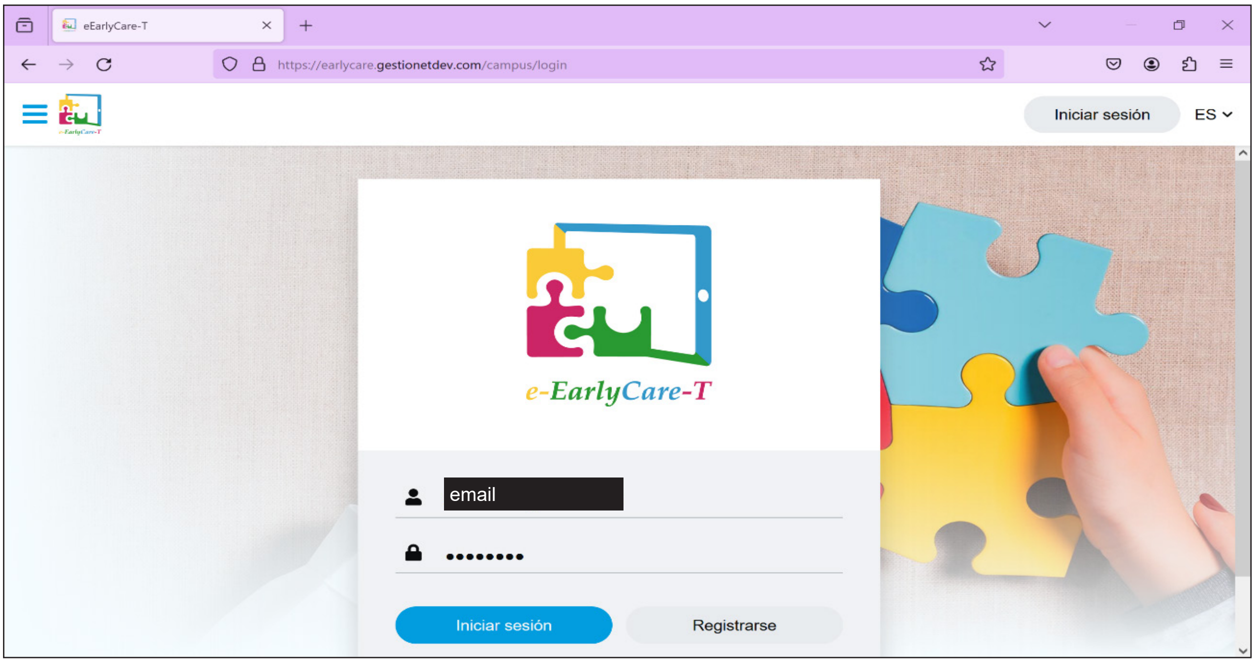
How to access the eEarlyCare-T platform

Step 1: Go to the project website and click on the Virtual Classroom icon https://www2.ubu.es/eearlycare_t/



Step 2: Choose the language: English, Spanish, Croatian or Italian

Step 3: Click on the Virtual Classroom icon and log in

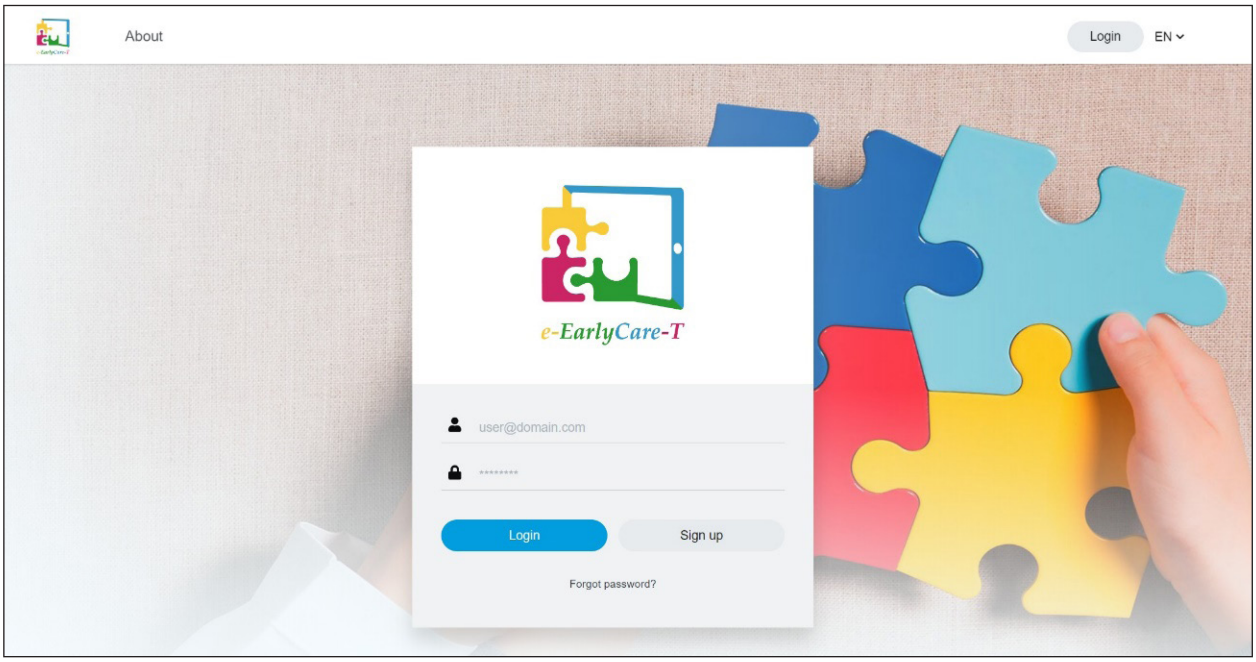


Choose an email address and password.

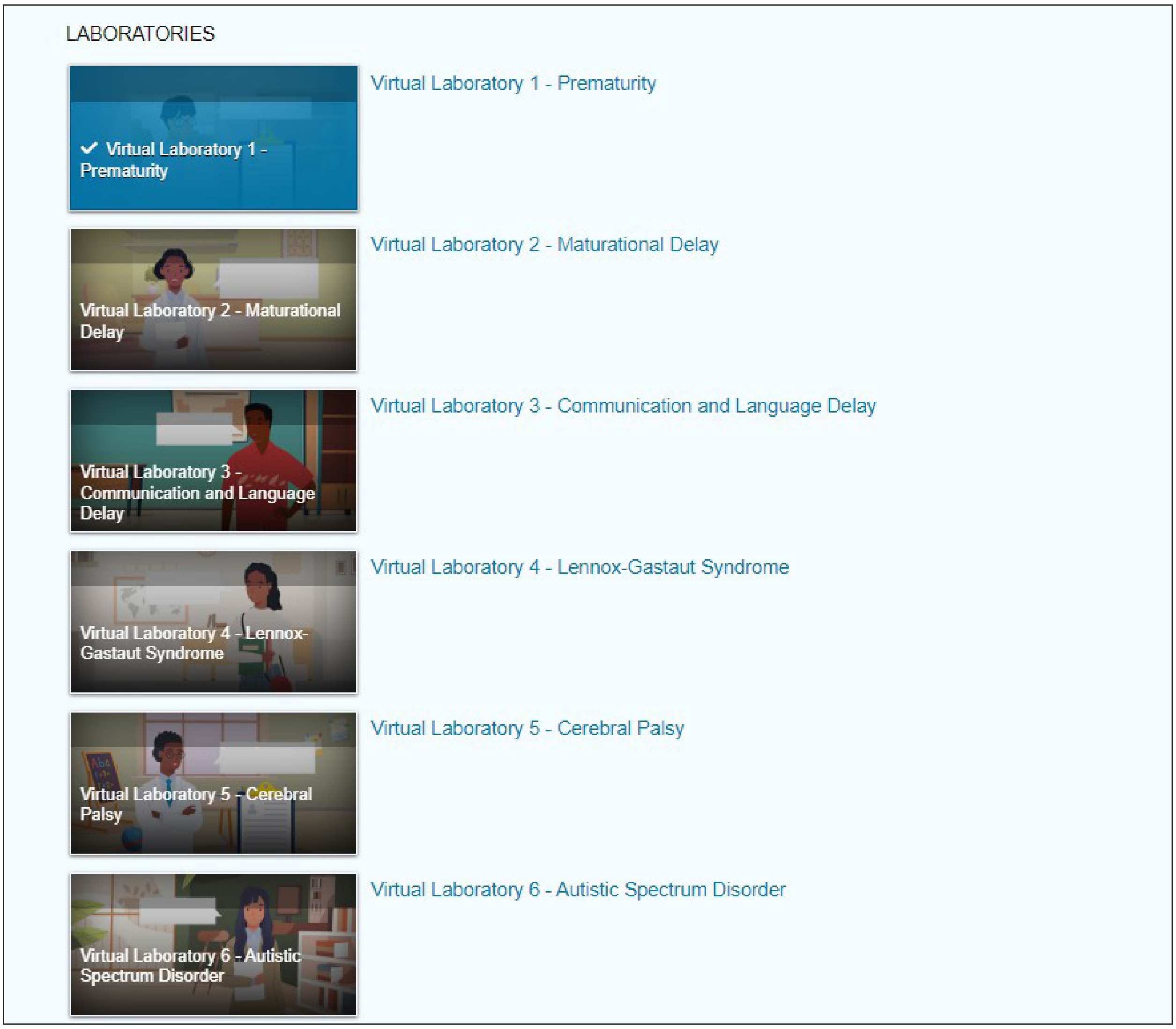
Step 4. Fill in the form and click on the "Submit" button.

Step 5. An email is sent with the name "Activate account" (check your Spam folder if it does not appear in your inbox).

Paso 6. Open the "Activate account" link in the email and click the "Activate account" button in the browser



Step 7. After logging in with the chosen email and password, make sure that in the top right corner the appropiate language is chosen, scroll down and enter the labs



Glossary of concepts

Advanced Learning Technologies **(ALT):** refers to the use of technological advances to facilitate and enhance the learning process in virtual learning platform environments.

Evidence-Based Learning: is a learning methodology based on using learning guides based on problem solving or tasks.

Self-Regulated Learning: refers to a learning methodology that is based on developing autonomous learning through self-questioning that guides or enhances the use of metacognitive strategies for orientation, planning, evaluation and elaboration.

Deep learning: refers to a way of learning in which the learner conceptually constructs knowledge beyond memorisation. To do this, the learner must implement metacognitive strategies, especially evaluation and elaboration.

Self-awareness: in the learning environment refers to the knowledge of and/or reflection on how to learn or solve a problem.

Self-reflection: refers to the context of learning to think about the practice or execution of a concept.

Self-questioning: used to facilitate development or enhance acquisition of metacognitive strategies for orientation, planning, evaluation and elaboration.

Avatars: animated characters that facilitate the implementation of different roles that are very useful in self-regulated dialogues.

Personal voice assistants: or *chatbots* or *bots*, are technological resources that can have a physical or non-physical appearance and can be voice or text-based. Their function is to assist or help in different processes, in this project they are aimed at facilitating the teaching or intervention process.

b-Learning (b-L): refers to learning that takes place in blended environments, i.e. in face-to-face and virtual spaces.

Cognitive load: refers to indicators that report the effort a learner makes to perform a particular task.

e-Learning (e-L): refers to learning that takes place in non-face-to-face learning environments such as virtual platforms.

Metacognitive Strategies: these refer to higher order strategies that facilitate reflective learning. These strategies are those of orientation towards the task or problem, planning the solution or solutions to a task or problem, evaluating the resolution process throughout, and elaboration—referring to a reflection on the resolution process and the final solution achieved.

Feedback :

Internal feedback: refers to the reinforcing feedback that a subject gives internally.

External feedback: refers to the reinforcing feedback that a subject receives from the outside.

Game-Based Learning Environments (GBLEs):refers to the use of serious games to facilitate learning in virtual environments.

Gamification: refers to the use of serious games in the teaching process in order to facilitate learning for the learners.

Artificial Intelligence – AI: refers to a part of computer engineering that uses mathematical algorithms to simulate human thought processing for many processes (learning, perception, diagnosis and therapeutic intervention, psychology, agriculture, etc.).

Serious game: refers to games that are based on a pre-designed structure for learning different concepts.

Self-regulated Virtual Laboratories: refers to the development of virtual laboratories that apply self-regulated dialogues to facilitate learning based on the implementation of metacognitive strategies.

Extrinsic motivation: refers to a subject's motivation based on external rewards.

Intrinsic motivation: refers to a subject's motivation based on internal rewards.

Learning patterns: refers to the resolution pathways a learner takes to solve a task or problem.

Teaching-learning process (PEA): refers to the process established between the learning methodology implemented by the teaching staff and the students' learning.

Sequential pattern mining algorithm: data mining algorithms that are used to detect the learning paths taken by learners.

Teacher dashboard: refers to dashboards available to teachers within virtual learning platforms.

Teaching Based on Training Simulation (TBTS): refers to learning based on a methodology in simulation environments.

Machine learning techniques: refers to Machine Learning algorithms, which can be supervised or unsupervised.

***Eye tracking* technology:** refers to the technology that is applied to record the visual tracking of the subject while performing different tasks or activities.

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