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Assessment process for the usability of Diligo 2.0 in preschool

Il processo di valutazione dell'usabilità di Diligo 2.0 nella scuola dell'infanzia

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ABSTRACT The transition from preschool to primary school can be a complex period for children. A good level of cognitive readiness in childhood gives them the ability to cope with learning challenges in future schooling. Diligo 2.0 is an agent-based game developed for Android devices aimed at monitoring two of the main skills related to school readiness in five-year-old children, namely geometric skills, and emotional skills. Diligo 2.0 also evaluates children's psychological and behavioural aptitude for engaging in slow and fast thinking activities. Given the innovative scope of Diligo 2.0 in terms of the survey method employed and how the app is used, this research project aims to verify the tool's usability in the preschool context. This paper presents the structure of the Diligo 2.0 usability assessment process involving teachers and children.

KEYWORDS Assessment; Geometric Skills; Emotional Skills; Preschoolers; School Readiness.

SOMMARIO Il passaggio dalla scuola dell'infanzia alla scuola primaria può essere un periodo complesso per i bambini. Un buon livello di preparazione cognitiva nell'infanzia permette di affrontare più serenamente le sfide di apprendimento della scuola primaria, per tale ragione è importante che tale preparazione sia oggetto di costate monitoraggio da parte dei docenti. Un possibile alleato educativo nei processi di monitoraggio è Diligo 2.0, un gioco per dispositivi Android finalizzato al monitoraggio di due delle principali abilità che fanno parte della preparazione scolastica, le abilità geometriche ed emotive. Inoltre, Diligo 2.0 valuta l'attitudine psicologica e comportamentale a impegnarsi in attività di pensiero lento o veloce. Data la portata innovativa di Diligo 2.0 sia in termini di metodo di indagine che di utilizzo, si è ritenuto utile avviare un'attività di ricerca volta a verificare l'usabilità dello strumento nel contesto prescolare. Questo articolo presenta la struttura del processo di valutazione dell'usabilità di Diligo 2.0 attraverso il coinvolgimento di insegnanti e bambini.

PAROLE CHIAVE Valutazione; Competenze Geometriche; Competenze Emotive; Bambini in Età Prescolare; School Readiness.

1. Introduction

Several studies have identified the transition to school as a potentially complex period for children and families. It involves negotiating and adjusting to several changes, including the new physi-

cal environment, learning expectations, rules and routines, social status and identity, and relationships between children and families (Hirst, Jervis, Visagie, Sojo, & Cavanagh, 2011).

Ensuring educational continuity for children, especially at an early age, also means supporting their well-being and serenity. In addition, continuity in education and schooling is functional to reducing socio-cultural differences and promoting the quality of their overall educational path. Scientific evidence affirms that children who do not have positive early transitions to school are those most likely to become inattentive or disruptive (Ramey & Ramey, 2004).

Working on school readiness can provide important support in this transition phase (Barnett, Lamy, & Jung, 2005).

The centrality of "school readiness" has grown in recent years due to the accumulating evidence revealing that children's performance during the nursery and primary school years has an important bearing on their later success in school and in life (Ladd, 2017).

School readiness is a complex concept that is foundational to early childhood systems and programmes (Majzub & Rashid, 2012).

Different models of readiness interpretation have followed one another over time, influenced by developments in pedagogical and psychological research (Eckert et al., 2008; Mariano et al., 2019; Potmesilova & Potmesil, 2021).

School readiness means that children are ready for school, families are equipped to support their children's learning (Chazan-Cohen et al., 2009) and schools are ready for children. The U.S. Head Start Approach[1] views school readiness as children possessing the skills, knowledge, and attitudes necessary for success in school and later learning and life (Bustamante, White & Greenfield, 2017). Physical, cognitive, social, and emotional development are all essential ingredients of school readiness. A good level of cognitive readiness provides tools for coping with the learning challenges of future schooling.

For the purpose of continuity, children must be given specific, engaging educational activities during preschool.

Literature on the subject (Zanetti & Beccarini, 2022; Raver & Knitzer, 2002) allows you to identify six fundamental areas of development that should be worked on during the preschool period:

1) perceptual skills and creativity;
2) cognitive and logical-mathematical skills;
3) linguistic abilities;
4) learning to learn and use executive functions;
5) socio-emotional and self-regulation skills;
6) psycho-motor development and general well-being.

Integrated development of these competencies gives children the ability to arrive at school cognitively and emotionally 'ready' and to participate in their new educational adventure. Hence, identifying ways to assess these competences is at the core of research in school readiness. Assessment in the early childhood field is not new. Decades of debate are in part summarized in "Reaching potentials: Appropriate curriculum and assessment for young children" (2003) published by the National Association for the Education of Young Children (NAEYC). Some authors stress the importance of prudence in using school readiness measures (Maxwell & Clifford, 2004), because they can derive from instruments featuring different levels of validity.

[1] Head Start programs prepare America's most vulnerable young children to succeed in school and in life beyond school. More details can be found at this web address https://eclkc.ohs.acf.hhs.gov

Other risks are related to crystallize the negative assessment for a long time or to make undue inferences from a single instrument. Finally, some authors also point out that there is great variability in children's abilities, so their performances are multidimensional, episodic and culturally and contextually influenced, which requires special caution in assessment (Coggi, & Ricchiardi, 2014; De Feyter & Winsler, 2009). A further possible limitation of preschool assessment is to make inferences from a single instrument, which cannot adequately account for the multifactoriality of the construct.

Sometimes readiness screenings are used to identify pupils with disabilities, without adopting appropriate tools for this purpose (Keating, 2007).

Although the pedagogical debate on early childhood assessment shows that the topic is currently highly controversial, it is undisputed that assessment is an ongoing process that includes collecting, synthesizing and interpreting information about pupils, the classroom and their instruction (Epstein, Lawrence, Schweinhart, DeBruin-Parecki, & Kenneth, 2004). In addition, the aim of this assessment goes well beyond measuring progress in children – as it may serve for programs evaluation, identifying staff development needs and planning future instruction (Coggi & Ricchiardi, 2014).

Early monitoring of basic skills can indeed help teachers recognise children's strengths and weaknesses, and plan educational interventions aimed at supporting proper development of skills and competencies within the personalized learning processes[2].

Classroom assessment refers to a practice wherein teachers use assessment data from a variety of tools or products to document and enhance student learning (Randel & Clark, 2013). Bonifacci and Tobia (2017) underline the importance to adhere to operating methods that are based on playfulness, interaction and exploration, when identifying the competencies listed above in preschoolers. In this regard, it is useful to recall that excessive use of pre-printed and often unoriginal worksheets dampens the child's creativity and expressiveness.

Observation and assessment of the child's emotional, relational and cognitive development must therefore use different tools and strategies (Bonifacci & Tobia, 2017). Among the many available tools, digital technologies offer significant development prospects for enhancing test administration, test scoring, test reporting and interpretation, and for links with individualised educational proposals (Koomen & Zoanetti, 2018). For example, alongside common survey methodologies supported by technology, many new tools offer interesting opportunities for educational evaluation; these include touchscreens with drag and drop and multi-touch features, augmented reality (AR), virtual reality (VR), mixed reality (MR), robots, and behavioural monitoring (e.g., voice recognition, eye gaze, face recognition, touchless user interface) (Neumann, Anthony, Erazo, & Neumann, 2019). Technology has the potential to improve the assessment process, both when its aim is to facilitate learning processes and when its goal is to summarise the status of students' knowledge and skills (Kashinath, Pearman, & Canales, 2015). In addition, technology offers significant advantages across the different stages of assessment, from test administration to data processing. At the same time a number of privacy concerns have also been raised in regard to technology-based assessment (Kumar, Chetty, Clegg, & Vitak, 2019).

Research underlines the use of information and communication technologies (ICT) in preschool settings as an important educational opportunity (Stephen & Plowman, 2003).

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[2] Personalized learning is a teaching and learning approach which is focused on the needs, aptitudes, and interests of those involved in learning process (Campbell, Robinson, Neelands, Hewston, & Mazzoli, 2010).

While the educational proposals for kindergarten are increasingly focused on the use of technologies (Rosa & Niewint-Gori, 2019), the use of technologies for skills evaluation and monitoring is less widespread (Dore & Dynia, 2020).

The theoretical framework and tools used for classroom assessment can have significant implications for teaching practices and student performance (Broadfoot & Black, 2004; Hodges, Eames, & Coll, 2014). Getting the right feedback is an important component of creating positive learning experiences and academic success. Recent American and Australian government reports call for the development of systems that use digital technologies to make educational assessment more effective and useful (Neumann et al., 2019).

This paper examines the use of an app for classroom assessment from the perspectives of students and teachers.

Apps allow you to integrate the powerful affordances of digital technologies with the many advantages of traditional playful activities. Moreover, mobile apps have proved to be familiar (Dini & Ferlino, 2016), highly usable and well accepted among young children (Panesi & Ferlino, 2019).

This paper examines the use of Diligo 2.0, an app for digital assessment of geometric and emotional skills in five-year-old preschool children, from the perspectives of students and teachers. The paper reports on the evaluation of the app usability by going through the whole assessment process of Diligo 2.0 in all different phases where both teachers and students were involved.

2. Diligo 2.0

Diligo 2.0[3] is a monitoring tool that assesses two of the main skills that are part of the school readiness evaluation of five-year-olds, namely geometric skills and emotional skills. Assessments can be both normative and ipsative. In the first case, the collected data can be used for inter-individual comparisons. In the second case, the collected data can be used for intra-individual assessment. The data allow teachers to keep track of an individual child's strengths and weaknesses, so they can support his/her dynamic developmental profile.

Diligo 2.0 also notes the psychological and behavioural aptitude for engaging in slow/fast thinking (Kahneman, 2011).

It is important to briefly explain the decision for Diligo 2.0 to focus on geometric skills and emotional skills, when, of course, other skills are also functional to school readiness. Geometry is the area of mathematics that concerns shape, size, position, direction and movement, and describes and classifies the physical world we live in.

During spontaneous play, children explore and employ a wide range of mathematical ideas and skills (Ginsburg & Seo, 1999). Historically, geometry was one of the first areas of mathematics taught to young children. In the 1850s, Friedrich Froebel designed a curriculum that proposed instructional practices based on the use of geometric forms and their manipulation in space (Balfanz, 1999). Today, extensive research shows that there is poor appreciation of preschool children's geometric skills (Balfanz, Ginsburg, & Greenes, 2003), despite geometric and spatial skills being highly predictive of mathematical skills and related to the development of executive functions (Verdine, Irwin, Golinkoff, & Hirsh-Pasek, 2014).

[3] Diligo was developed by the Natural and Artificial Cognition (NAC) laboratory under the direction of Professor Orazio Miglino. The section on the analysis of socio-relational competences was produced by NAC as part of its collaboration in the INDIRE research project entitled "PON Project Multidisciplinary Education 10.8.4.A2- FSEPON- INDIRE-2017-1, CUP B59B17000020006".

Table 1. Geometric skills monitored by Diligo 2.0 and the corresponding tasks.

Competence	Task
Knowledge of geometric space	Identifying a specific geometric shape in a picture
Acquisition of the concepts of big and small	Selecting big / small objects
Recognizing numbers	Saying whether or not two representations show the same number
Acquisition of the spatial concept of in and out	Selecting an item that is inside / outside a specific area
Acquisition of spatial concept of up and down	Selecting an item that is above / below a specific object
Acquisition of temporal order in terms of before and after	Selecting an item that is before / after another object in terms of arrival order
Acquisition of spatial direction left and right	Selecting an item which direction is left / right
Recognition of visual differences	Telling if two representations of the same object are the same or different

The geometric skills and the corresponding tasks considered by Diligo 2.0 were chosen in order to accomplish the learning goal for the development of the skills of the kindergarten named "Knowledge of the world" (Table 1). This goal, described in the Italian National Guidelines for Kindergarten (C.M. n. 31 April 18, 2012), states that children at the end of the preschool path must be able to: group and sort objects and materials according to different criteria (e.g., colour; shape; quantity) identify some properties, compare and evaluate quantities; use symbols. Perform measurements using instruments within their reach. In addition, children become familiar with the strategies of counting and operating with numbers and of identifying the positions of objects and people in space, using terms such as forward/back, over/under, right/left, etc.; following a path correctly based on verbal indications.

Turning now to emotional skills, the last several years have seen a blossoming of interest in the social and emotional spheres of early childhood development, as they are crucial to both current and later personal well-being, as well as to learning and academic success (Huffman, Mehlinger, & Kerivan, 2000; Peth-Pierce, 2000; Shonkoff & Phillips, 2000). More specifically, the disconnect between, on the one hand, social and emotional development in educational programmes and, on the other, assessment has long been lamented. New empirical research underlines the importance of socio-emotional skills when it comes to school readiness (Carlton & Winsler, 1999). Raver and Knitzer (2002) have conducted important evidence-based research on socio-emotional skills during the preschool years that is relevant to the need for socio-emotional assessment. Denham (2006) summarised Raver and Knitzer's evidence-based corollaries as follows:

1) Young children without appropriate emotional and social skills participate less in classroom activities and are less accepted by their classmates. Consequently, they enjoy school less;
2) Socio-emotional competence in young children predicts their academic performance in first grade;
3) Relational difficulties persist into the later elementary years.

After the Covid-19 pandemic and lockdowns, many teachers believe that it is important to monitor closely the development of social and relational skills (Panesi, Fante, & Ferlino, 2021; Parlatan & Gürler, 2021). The socio-emotional skills monitored by Diligo 2.0 and the corresponding tasks are summarised in the following table.

Table 2. Socio-emotional skills monitored by Diligo2.0 and the corresponding tasks.

Competence	Task
Recognising facial expressions and associating them with emotions	Recognising which pair of children are expressing the same emotion
Using and understanding the vocabulary of emotions	Selecting the face that matches the name of the emotion
Understanding situations that elicit emotions	Selecting the face that matches the emotion that applies to a specific situation
Awareness of emotions (in terms of intensity)	Selecting the face that matches the description of the intensity of a specific emotion
Knowledge of the cultural rules for displaying emotions	Selecting which illustration presents the best solution for a specific situation
Recognising bodily expressions and associating them with emotions	Selecting the illustration that matches the name of the emotion
Awareness of the emotions (and basic connection to specific kinds of thoughts)	Selecting the illustration of the thoughts that match the required emotion
Regulation and management of one's own and other people's emotions	Selecting which illustration presents the best solution for a specific situation

3. Structure of the Diligo 2.0 app

Diligo 2.0 is a serious game built for Android devices on the STELT platform – Smart Technologies to Enhance Learning and Teaching (Miglino et al., 2013).

Diligo 2.0 was designed and developed using an agent-based model (Helbing, 2012), meaning there are two main interactive agents. The first is the child, who performs all the tests while trying to help the main character in the game, that is, the second agent. The second agent is "Leo the Explorer", an artificial agent who guides the user through the different sections of the app, giving tips, instructions,

Figure 1. Diligo Geometric skills Home page.

Figure 2. Diligo Socio-Emotional skills Home page.

feedback and narrating the introduction to each level of the game (see the home pages of Diligo in Figure 1 and 2).

The interaction between the child and Leo the Explorer takes place against a narrative background.

As the explorer's assistant, the player is engaged in a treasure hunt on eight different islands. As the child begins the game, Leo the Explorer explains how to play it and the basic functions of the buttons. This modelling approach engages the child in the game, motivates him/her and provides constant feedback and reinforcement. The narrative approach enables the introduction of complex content to children (Smorti, 1994; Bruner, 1986; Casey, Erkut, Ceder, & Young, 2008).

In both cases for the geometric skills and the socio-emotional skills, the game is structured in eight steps (one for each skill for a total of 16 skills).

Each step (represented by an island) focuses on a different competence and the same gameplay but has four alternative forms differing in terms of setting, background story, and requests made by the player. In this way, the child can repeat the game several times without getting bored.

Finally, each step gives the child the option to choose between a fast or slow play mode. In fast mode, the player faces a "point-and-click" task, where Leo the Explorer asks him/her to touch a certain element on the screen. In slow mode, each evaluative item is followed by a narrated interval, in which the child is asked to make decisions that have no impact on the score, but which add to the narrative background of the activities he/she is involved in. This makes the game longer, when played in slow mode, and more challenging for attention spans. Scores are not affected by fast or slow mode: 1 point is assigned for every correct answer and 0 points for every wrong one. Children cannot choose the order in which they face the levels because the route of the game is pre-set. This design choice guarantees the validity of the test, since every child follows the same route.

The current prototype is also able to communicate with a server, linking the data from the children's test to a GUID (Globally Unique Identifier), a number used to identify the children anonymously

and protect their privacy. Only teachers are able to associate the identification codes with the children's names. Teachers can log into the child's profile in Diligo 2.0 using the GUID sent to them previously. The app tracks and stores the data of all the sessions of the child. The "Profile" button shows the teacher feedback about children's behavioural preferences and their slow or fast thinking. Aggregate data about geometric or emotional skills can be viewed in an analytics app for teachers and researchers.

4. Structure and instruments of the assessment process of the usability of Diligo 2.0

In this section the structure of the specific objectives of the research activity, the process of evaluating the usability of Diligo 2.0 and the chosen tools are presented.

4.1. Aims

Given the innovative scope of Diligo 2.0 in terms of the survey method employed and how the app is used, the aim of the research project was to verify the tool's usability in the preschool context.

In order to investigate the usability of the app the following objectives were identified:

- to determine what aspects of the app to improve based on the teachers' suggestions;
- to identify the compatibility of Diligo 2.0 with the technological and physical facilities in the nursery schools involved in the research;
- to detect issues and inefficiencies when Diligo 2.0 is used in the field;
- to analyse children's reactions to and opinions about the tool.

4.2. Participants

Taking part in this analysis were preschools in the Istituto Comprensivo "G. Solari" school cluster in Loreto, Italy, namely: Scuola dell'Infanzia "F.lli Volpi", Scuola dell'Infanzia "B. Gigli" and Scuola dell'Infanzia "San Francesco", each located in a different part of town.

Ten teachers (all women between 25 and 50 years old) took part in the project and all 66 of the five-year-olds in the listed schools were involved (30 females and 36 males, details for each school in Figure 3).

4.3. Evaluation process

To collect data on the usability of Diligo 2.0 it has been prepared an evaluation plan that involved both teachers and children. The evaluation plan was divided into two macro phases, each of which was articulated in different actions (Figure 4).

The first macro phase of evaluation was carried out during the finalization of the app and involved only teachers.

Teachers were asked to test the application, not yet definitive, and to suggest any adjustments by filling out an "evaluation card" (Figure 5) provided by the researchers, containing a checklist to be compiled.

The feedback collected through the evaluation card compiled by the teachers became the subject of a focus group that aimed to better understand the information provided and to support the com-

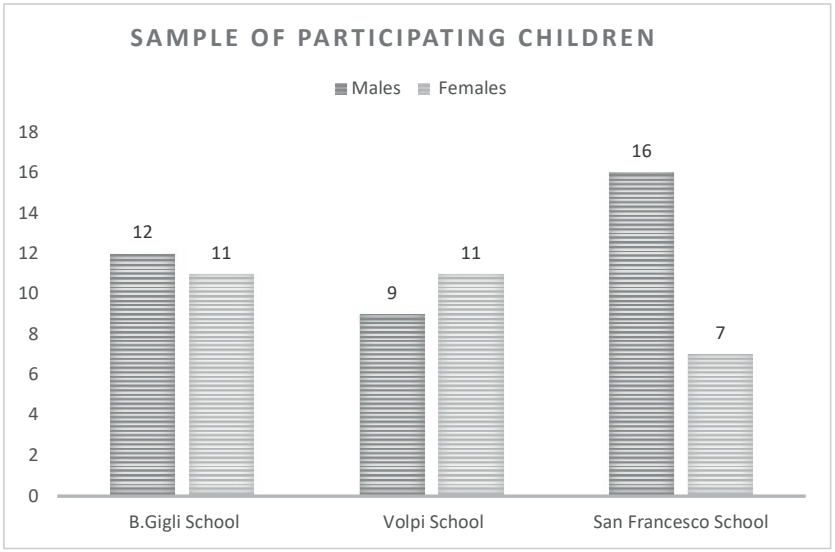

Figure 3. Sample of children participating in the study.

parison between teachers in the implementation areas. Through the discussion in the focus groups, it was possible to identify, as we will highlight later, a list of changes shared by the group of teachers, and used for the developers' implementation of the app. This part of the evaluation process is described in the next section, paragraph 4.3.1.

The second macro-phase had the objective of determining the conditions of organizational and educational use of Diligo 2.0 in the school context and both children and teachers were involved.

Diligo 2.0 was tested with children through 3 play sessions followed (in the case of the first and third session) by an activity (described in the paragraph 4.3.2) aimed at providing feedback to researchers. After the first game session, the children took part in focus groups (one for each class, involving around 66 kids total), later on during the second game session no feedback to children was required. After the third game session, the children were asked to draw a picture of the game session.

At the end of children's play sessions teachers were invited to a focus group finalised to gather information about the organisational aspects of the project. This second part of the evaluation process is described in the next section, paragraph 4.3.2. The research activity led to the systematisation of the app according to the indications gathered from the main users and to the definition of a usage protocol as a guide for other teachers that may use Diligo 2.0 in other classes and to facilitate the app's introduction into schools.

Figure 4 shows the steps of the whole evaluation process.

4.3.1. First macro phase: testing the application by teachers

Initially, the teachers were asked to test the app and suggest possible adjustments. To pursue this objective an evaluation checklist (Diligo 2.0 Card) had defined by researchers.

Creating an evaluation checklist for an educational application is not an easy process because the educational value of an application is not only related to its content, but also to the design, methods, and analysis used to meet the needs of the target group (Judge, Floyd, & Jeffs, 2014). This is even more difficult when the target is preschool children; as Chau (2014) underlines, to meet young children's

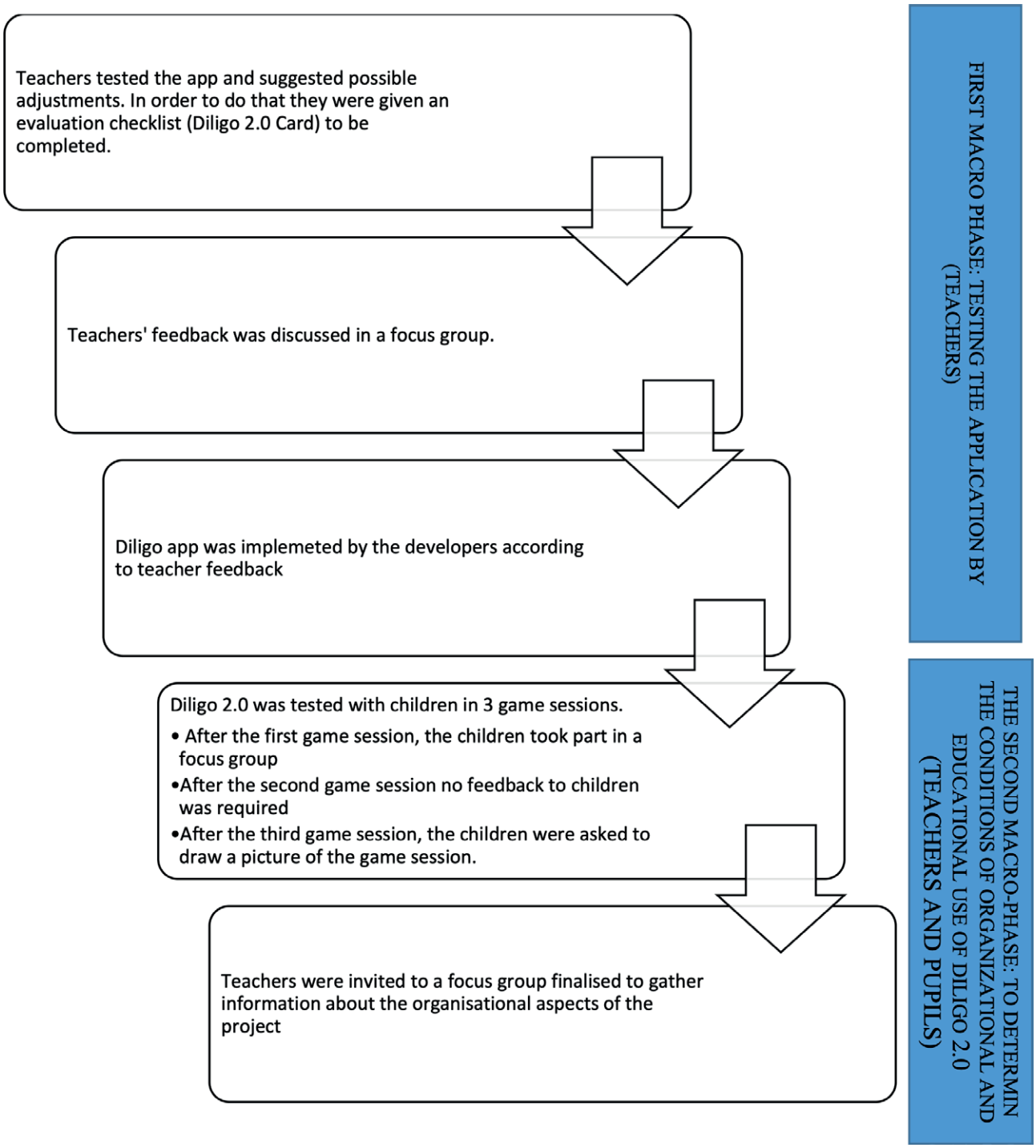

Figure 4. Structure of the assessment process.

developmental stage and cognitive abilities, apps need to adopt specific practices because these age groups have very specific characteristics and needs (Anthony et al., 2014). Based on the literature on the design and evaluation of educational apps, (Lee & Cherner, 2015; Papadakis, Vaiopoulou, Kalogiannakis, & Stamovlasis, 2020; Papadakis, Kalogiannakis, & Zaranis, 2018) seven areas of analysis

were identified. The checklist included thus the following areas: ease of use, functional design, graphics, the balance of difficulty, duration, efficacy, and overall quality. The purpose of the analysis card is to encourage evaluators to focus systematically on all the important aspects of the software's design. Using the analysis card prevents evaluators from inadvertently forgetting to address parts of the assessment. The evaluation process requires teachers to review the software and, from their knowledge of how they would present the software to pupils and how they learn, judge its suitability for the intended educational purpose, taking into consideration the interplay between usability and learning.

For each considered area guiding open questions were provided. These areas were chosen to give central and timely feedback without overloading the teachers with analysis work. The teachers responded to the guiding questions by writing their notes down and gave the card back to the researchers. Answers were carefully read by the researchers and were used to define the focus group track. The answers were divided into two groups: a first with the statements on which there was agreement between teachers and a second group with the statements highlighting disagreement. The contents of both areas were taken up and discussed with the teachers within a focus group which has been video recorded for subsequent analysis. The focus group's goal was to collect a list of changes shared by the group.

Researchers watched the recordings and transcribed the conversations. Teachers' statements were organised within the same macro areas of the analysis form (listed from 1 to 7 in Figure 5). There were no points of disagreement between the teachers and the various proposed changes were agreed by the whole group (for example, the change of the main character's metal voice). Then the actual proposals were outlined (for example, use a human voice, use the voice of a young adult and so on). The scheme thus built was entrusted to the computer experts who implemented the Diligo 2.0 App.

In evaluation research focus groups may be used to gather different kinds of evidence (e.g., opinion, tacit knowledge) (Ryan, Gandha, Culbertson & Carlson, 2014), in this case the focus group was functional to understand better the changes to the app required by the teachers and allow them to confront each other.

After that the changes indicated by the teachers were made in Diligo 2.0 it was possible to start the second macro-phase that will be described in the following sub-paragraph.

4.3.2. The second macro-phase: investigating the conditions for organizational and educational use of Diligo 2.0

When it came to verifying whether the proposed technology was compatible with the specific organisational and structural set-up of the schools, reference was made to the structure of the action research, whereby the teachers were the main stakeholders involved in defining the conditions of use and identifying issues and non-functional aspects affecting autonomous use of the tools. To understand the organizational conditions through which it is possible to use a technological product such as Diligo 2.0 within a kindergarten, the researchers provided guidelines to teachers that guided them in the game administration to children.

As for the game path the use of Diligo 2.0 was organized as follows: Diligo 2.0 was tested with children at school from February 2021 to June 2021 through a sequence of three game sessions that involved the same children, for a total of 66 pupils. In each school, pupils were placed in small groups and three game sessions were organised lasting 30 minutes each (including start-up). Each group contained about five 5-year-olds. Before the start of the activity, the teachers gave each child a nickname

DILIGO 2.0 CARD

1. Ease of use
Is Diligo 2.0 easy to use?
- For children aged 5 years (last year of preschool)?
- For children with early signs of SEN, SLA or physical and cognitive disabilities?
- For supervising teachers?

2. Functional Design
Do Diligo's activities and the flow of play have these characteristics? If so, to what extent?
- Are they usable (see the previous point)?
- Are they enjoyable? (also consider the graphics and multimedia content)
- Are they understandable? (for the age group and any atypical pathways)
- Does playing with Diligo 2.0 cause physical or sensory fatigue? (e.g. fonts are too small, annoying background music)
- Does playing Diligo 2.0 create cognitive overload? (e.g. too much information, unclear information, flow is too fast)

3. Graphics
- Are the graphics in Diligo 2.0 attractive to children?
- Are there elements that could be improved and/or replaced?

4. Balance of difficulty
- Is the difficulty of fast and slow activities comparable?

5. Appropriateness of duration
- Is the duration of individual activities and the game as a whole appropriate for the age group?
- Given the duration, is it possible to maintain a high level of attention and interaction?

6. Ability to assess the child's skills
- In your experience, are the proposed activities suitable for determining the level of competence in relation to the age group (secondary aspect) and the player's preference for fast vs slow activities (main aspect)?

7. Overall assessment
- State other relevant aspects that do not fall under the previous categories and give an overall evaluation of the game (select one of the emoticons)

Figure 5. Evaluation Card.

to use during the sessions of the game so to ensure anonymity. At this stage, the children's play preferences were also investigated in an interview with the children themselves and a questionnaire for their parents[4]. After the first game session, the children took part in a focus group whose purpose was to find out about their use of video games and their related preferences, as well as their expectations of Diligo 2.0.

In the focus group the following questions were asked:
- Did you expect us to play on a tablet at school?
- Do you play on a tablet at home? If yes, whose is it?
- And on mobile phones? (If yes, whose is it?)
- What games do you play on mobile phones?

[4] Analysis of their play preferences serves to answer the research hypothesis that there is an underlying relationship between the children's preference for fast and slow thinking and their propensity to play. Indeed, it has been hypothesised that children tend to choose the type of activity that is most similar to their everyday experiences. This paper does not analyse this aspect.

- What don't you like?
- Which do you prefer between playing in the park and using a tablet?

After the second game session no feedback to children was required, following the third game session the children were asked to draw a picture of the app. They could choose whether to draw something they liked about it or something they did not like. The teachers wrote up the children's information and opinions about the drawing activity. Qualitative instruments as unstructured interviews were used in order to gather as many details as possible. These were used to understand the content of children's drawings and their motives. Unstructured interviews are by definition open-ended tools. This flexibility can help gather detailed information on your topic, while still allowing you to observe participants' reasons. This survey instrument was chosen because it is a free-flowing and flexible type of interview. The questions and the order could not be set in advance because the interview should flow spontaneously, based on the participant's answers. Interviews were realised by the teachers because it was important (for the context and the child's age) to gather a deep connection between participants, encouraging them to feel comfortable revealing their true opinions and emotions.

The researchers were thus able to understand the contents of the drawings more explicitly and above all to read the reasons for the choices made by children. Finally, after the children's last game session, teachers were involved in another focus group, to gather information about the organisational aspects of the project and their opinions about how easy it was for the children to use the tool.

This focus group had aimed to collect information on the peculiarities and conditions of use of Diligo 2.0. The choice to use the focus group and not another tool was determined by the desire to support the comparison between teachers both to highlight different aspects of use and to identify different possible solutions.

5. Results

This section presents the data collected throughout the validation process described in the previous section. The data collected are organized in this presentation according to the subjects involved, teachers and children, to better focus the points of view and perspectives.

5.1. Teachers' considerations about Diligo 2.0

The analysis of Diligo 2.0 by the teachers, whose considerations were collected through the analysis form and the first focus group, was a very important step in the process. Their suggestions were accepted by the research team and the NAC (Natural and Artificial Cognition) professionals, that incorporated a large number of modifications. The teacher's suggestions were organised within the macro areas of the analysis form. Regarding easaboute of use, there was complete agreement among the teachers that the product is suitable for five-year-old children. User-friendliness for children with special educational needs was evaluated by two teachers in the group who had specific training and found the app to be suitable. However, they stressed that this depends on the individual child. The teachers pointed out that, on its own, the app was not sufficient for them to oversee the activity. Real observation needs more structured and more organised feedback. Their misgivings were resolved when it was explained precisely how the documentation collected by the app would display the information to teachers.

Most of the requests for changes and additions concerned the 'Functional Design' area, meaning for instance, in some cases, the images used to guide the children were considered inadequate. For

example, a cloud and a lightning bolt were initially chosen to represent the slow and fast routes but were not considered sufficiently understandable for children. The teachers recommended using pictures of animals the children can easily identify as being slow or fast, such as a tortoise for the slow route and a hare or leopard for the fast route. The hare and the tortoise are also familiar to children from traditional fairy tales. Thus, an attempt was made to establish continuity between more traditional activities, such as reading fairy tales, and more innovative activities supported by technology. In some cases, vocal reinforcement of the images proposed was needed from Leo the Explorer. Another example was the red round symbol with a cross and the green symbol with a tick, providing negative and positive feedback respectively. The teachers judged these symbols to be non-intuitive for the children and therefore in need of explanation.

Overall, the group found the graphics to be clear and usable, although not everyone liked the style. The protagonist's voice was considered too tinny and was asked to be changed. Regarding the flow of play and the tasks given to the children, the teachers identified which sections should be changed and what terms would be more understandable to five-year-olds. It also emerged that it would be useful to allow children to hear the recordings a second time. The teachers also recommended simplifying the "go back" and "exit" buttons. According to the teachers' feedback, playing with Diligo 2.0 does not cause any physical or sensory fatigue. The tone and volume of the background music were particularly appreciated. The cognitive load was also considered as sustainable in terms of content and game dynamics. Furthermore, the teachers appreciated the fact that the children are given plenty of time to respond.

During the review process, the teachers stated that some children would not know some of the proposed content, such as the semicircle or the pentagon, because the geometric shapes usually studied at preschool level are the circle, square, triangle and rectangle.

In the teachers' opinion, this first activity was particularly important, because it allowed them to reflect on aspects they had not previously considered. In fact, the updates and changes to Diligo 2.0 based on the teachers' recommendations and their involvement in the review process made the preparation activities for using Diligo 2.0 with the children more analytical. The research team was particularly impressed with the care and precision with which the task was completed, and was thus able to provide timely analytical feedback, which made the work proceed more smoothly. The teachers were very active and interested in using Diligo 2.0 also in the second focus group in which they were involved. In this case the focus group was oriented to evaluate usability of Diligo in the school. The difficulty reported by the teachers was finding co-presence sessions where they could work in a small group on the tablets. Another issue was the schools internet connection, which was not always efficient. Interestingly, teachers noted that the children were always very patient, even when they had to start the game session all over again because of a Wi-Fi connection failure. One difficulty encountered was related to sound: as the children did not use headphones, there was a lot of noise.

On the positive side, the teachers said all the children eagerly and without any tension did the test and asked several times to repeat the activity. Furthermore, the children's ability to concentrate was generally very high. It was interesting to note that, after being informed of the project, the children's families welcomed the opportunity to assess their readiness skills.

Thus, the teachers generally gave positive feedback on the experience and mentioned no further difficulties in the practical use of Diligo 2.0. Moreover, they considered the opportunity to obtain readiness data like those provided by Diligo 2.0 to be a valuable resource which they would like to extend to many other competencies and add to their observation tools and documentation practices already in use.

5.2. Children's feedback on Diligo 2.0 through the analysis of focus groups and drawings

During the focus groups, that were held only with 5 years old children in each single class, the teachers got all the children to talk, as they all had something to say about their experience doing an activity that was particularly interesting to them.

The answers given were organised within the same schools, as significant differences were detected that were potentially due in part to mutual conditioning and in part to the catchment area of the individual schools. Figure 6 summarises the children's statements. Expectations (Did you expect us to play on tablets at school?) were different in the three schools. This finding is particularly interesting because, although all three schools have extensive experience of using technology (e.g., 3D printers), at Gigli School, only a small number of the children were not surprised. The difference is that tablets provide a one-to-one relationship between the device and the child, whereas other technology-based learning activities involve group work.

The children had no issues using tablets during the Diligo 2.0 sessions, although only those at San Francesco School said they were accustomed to playing on a tablet at home. In all the schools, more than 50% of the children said they played video games on their mobile phones. However, only a small number of children said they had a mobile phone and all those who did were referring to old mobile phones used solely for playing games. When asked 'What games do you play on your mobile phone?', a small number of children mentioned games designed for children of the age group in question and, in several cases, these games were not rated on the PEGI system. Interestingly, the children carefully analysed the aspects of video games they disliked, especially at Gigli and Volpi schools. A small number of children said they liked everything about playing video games. Finally, almost all the children at Gigli School said they preferred playing outdoors to playing virtual games (96%) and the percentage was also very high in the other schools involved (62% at San Francesco and 74% at Volpi respectively).

This focus group involved a lot of children who said they were fairly familiar with video games. One interesting finding is the children's appreciation of and engagement with the logic and proposals of Diligo 2.0, which are different from the commercial games they mentioned.

Thus, as is evident from the descriptions and analyses made by children on their drawings and collected by teachers (through the annotation of children's comments) appreciation of Diligo 2.0 by children was not due to the consideration of video game as something new or unusual, but precisely because of the game itself.

The children's drawings were used as an aid for them to give their opinions about Diligo 2.0, which is why the task was general. "Draw something you liked or something you did not like". None of the children chose the option to draw something they did not like, and they all drew the things they liked the most or at least that amazed them. It is interesting to note that, except for two very similar drawings, all the others were the result of the children's independent work and reworkings capturing different aspects and perspectives. Two drawing examples in Figures 7 and 8.

The contents of the drawings were aggregated under labels (Figure 9). A total of 64 drawings were considered, as two children were absent during the activity. In agreement with the teachers, it was decided not to repeat the activity for these individuals, as they would be playing in a very different context (background noise, the possibility of getting the teacher's attention, etc.). Only 3% of the children drew Leo the Explorer without contextualising him within the game action, while 44% portrayed him within the context of the game as he completed the different adventures. About half of the chil-

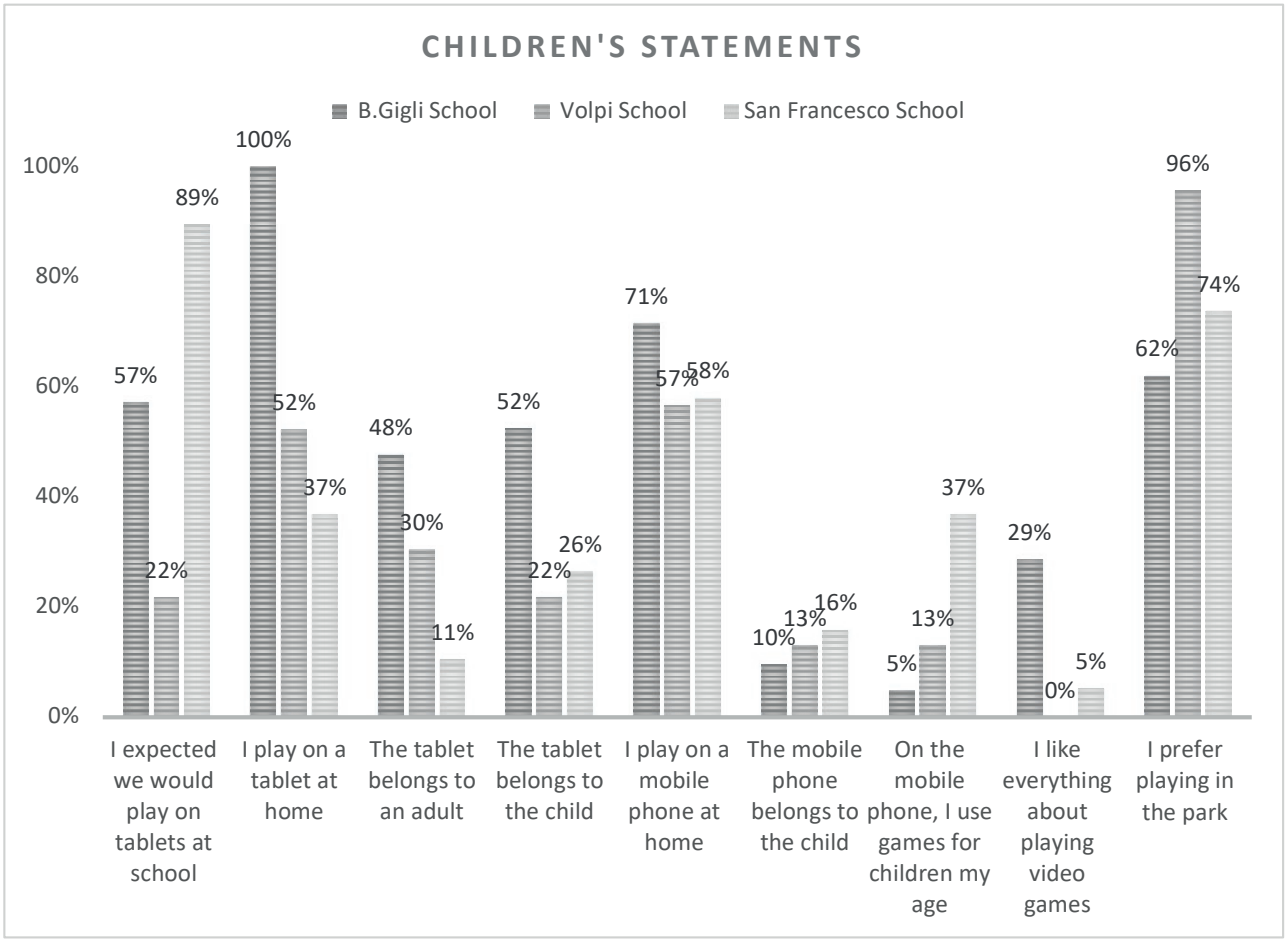

Figure 6. Children's statements.

dren drew Leo the Explorer in the final step as he found the much-anticipated treasure. The teachers reported some excitement from the children as they described what they had drawn, as Leo's victory represents the child's victory.

When the children drew Leo the Explorer during the game, they used one of two criteria to make their choice: the game they liked best or the game that was more complicated. A total of 6% of the children drew themselves in the role of helpers supporting Leo the Explorer's efforts to complete his adventures. It is also noteworthy that three children drew the action inside the tablet, from their own point of view. A total of 39% of the children preferred not to draw the protagonist; rather, focusing on the setting, they drew the islands, animals, geometric shapes and treasure. Much of the children's attention was on the background settings, both with and without the character in action, and their use of colour accurately reflected the game. Finally, two drawings showed characters from a different video game that was not Diligo 2.0 and were therefore considered irrelevant.

As they commented on their drawings, the children talked about the problems the game had posed and the solutions they had found, accurately recalling the various steps to arrive at the solutions, in a process of metacognitive reflection. On the whole, the children reflected enthusiastically on the activity. It is interesting to note that they asked for sections to be added to the game, but not for further

Figure 7. Leo the Explorer.

Figure 8. Children drew themselves in the role of helpers.

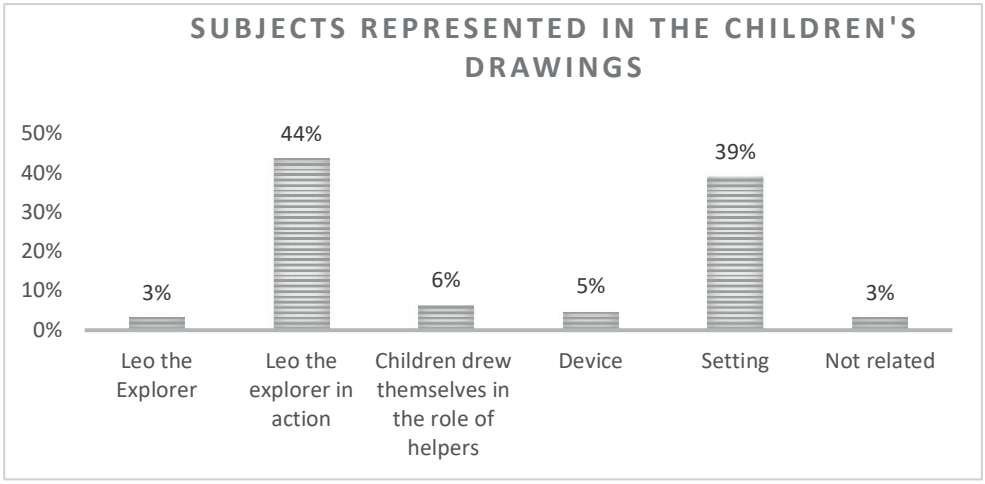

Figure 9. Subjects represented in the children's drawings.

diversification of the adventures, which retained a high level of interest for them, even though they had already been completed.

6. Conclusions

This paper reports on the results of a usability test of the Diligo 2.0 app carried out with 66 5-years old students in three different schools. The data were collected from teachers and students and led to fine-tuning the app before and after use. The results corroborate the app usability and future work will aim at evaluating its ability to assess students' school readiness.

The assessment of readiness skills can be a foundation for designing and creating the conditions for children to develop their individual physical, cognitive and emotional potential. This was the premise guiding the design of Diligo 2.0.

As Gonski (2018) states, it is important to "use new technology not for its own sake, but to adopt ways of working that are more efficient and effective" (p. 99). In this perspective innovative education theory, psychology, computer science and engineering can come together to optimise classroom assessment practices and provide clear links between assessment, teaching and learning.

Although the data presented on the usability of Diligo 2.0 refer to a small number of subjects and cannot be claimed to apply outside this sample set, they do represent a first step in the app's implementation.

Through this initial research work it was possible to involve teachers in the tool definition phase. This step was defined within the focus group by the teachers themselves, who appreciated its importance, realizing how decisive their experience was in defining the educational product intended for children. Often teachers try out different products offered by the market, but they are rarely involved in the tool construction phase.

The role of the teachers was then fundamental in testing the conditions of use of Diligo 2.0. Kindergarten is characterized by very different times and working methods from subsequent levels. Therefore, it was important to acquire information from those who work in this kind of reality every day and know the educational dynamics well.

In addition to this, children were comfortable and freely expressed themselves with the teachers, and for this reason researchers were able to acquire different information.

For instance, the patience shown by children, the involvement in the dynamics of the game and their affection towards the main character, were not dynamics that could have been taken for granted before using Diligo 2.0

The data on game dynamics are currently being reworked, along with the correlation between the games preferred in a family context and the game dynamics (slow or fast) chosen through Diligo 2.0. These data will guide future developments of the app.

In conclusion we can say that the only way to acquire direct information from real users is to involve children and teachers. The possibility of monitoring children's competencies through playful tools that are fun and reflect the state-of-the art knowledge of a multidisciplinary team lays the foundation for new and varied research applications. Since one of the aims of the app was to sustain teachers in assessing young children in geometry and emotional skills, in the future, researchers will explore whether the teachers felt that the assessment provided them with information about young children's learning and whether it could discriminate among children.

7. References

Anthony, L., Brown, Q., Tate, B., Nias, J., Brewer, R., & Irwin, G. (2014). Designing smarter touch-based interfaces for educational contexts. *Personal and Ubiquitous Computing*, *18*(6),1471-1483.

Balfanz, R. (1999). Why do we teach young children so little mathematics? Some historical considerations. In J. Copley (Ed.), *Mathematics in the early years* (pp. 3-10). Reston, VA, US: NCTM.

Balfanz, R., Ginsburg, H., & Greenes, C. (2003). The big math for little kids early childhood mathematics program. *Teaching Children Mathematics, 9*(5), 264–268. doi: 10.5951/TCM.9.5.0264

Barnett, W. S., Lamy, C., & Jung, K. (2005). *The effects of state prekindergarten programs on young children's school readiness in five states*. New Brunswick, NJ, US: National Institute for Early Education Research.

Bonifacci, P., & Tobia, V. (2017). *Apprendere nella scuola dell'infanzia. Lo sviluppo dei prerequisiti*. Roma, IT: Carocci Editore.

Broadfoot, P., & Black, P. (2004). Redefining assessment? The first ten years of Assessment in Education. *Assessment in Education*, *11*, 7-26. doi: 10.1080/0969594042000208976

Bruner, J. (1986). Play, thought and language. *Prospects: Quarterly Review of Education*, *16*(1), 77-83.

Bustamante, A. S., White, L. J., & Greenfield, D .B. (2017). Approaches to learning and school readiness in Head Start: Applications to preschool science. *Learning and Individual Differences*, *56*, 112-118. doi: 10.1016/j.lindif.2016.10.012

Campbell, R. J., Robinson, W., Neelands, J., Hewston, R., & Mazzoli, L. (2010). Personalised learning: ambiguities in theory and practice. *British Journal of Educational Studies*, *55*, 2135-154. doi: 10.1111/j.1467-8527.2007.00370.x

Carlton, M. P., & Winsler, A. (1999). School readiness: The need for a paradigm shift. *School Psychology Review, 28*, 338–352. doi: 10.1080/02796015.1999.12085969

Casey, B., Erkut, S., Ceder, I., & Young, J. M. (2008). Use of a storytelling context to improve girls' and boys' geometry skills in kindergarten. *Journal of Applied Developmental Psychology, 29*(1), 29-48. doi: 10.1016/j.appdev.2007.10.005

Chau, C. (2014). *Positive technological development for young children in the context of children's mobile apps*. [PhD Dissertation. Tufts University, US]. Retrieved from http://gradworks.umi.com/3624692.pdf

Chazan-Cohen, R., Raikes, H., Brooks-Gunn, J., Ayoub, C., Pan, B.A., Kisker, E., … Fuligni, A. S. (2009). Low-income children's school readiness: parents' contributions over the first five years. *Early Education & Development*, *20*(6), 958-977. doi: 10.1080/10409280903362402

Coggi, C., & Ricchiardi, P. (2014). La «school readiness» e la sua misura: uno strumento di rilevazione per la scuola dell'infanzia. *Journal of Educational: Cultural and Psychological Studies (ECPS Journal), 1*(9), 283-309.

De Feyter, J. J., & Winsler, A. (2009). The early developmental competencies and school «readiness» of low-income, immigrant children: Influences of generation, race/ethnicity, and national origins. *Early Childhood Research Quarterly*, *24*, 411-431.

Denham, S. A. (2006). Social-emotional competence as support for school readiness: What is it and how do we assess it? *Early Education and Development*, *17*(1), 57-89. doi: 10.1207/s15566935eed1701_4

Dini, S., & Ferlino, L. (2016). *Knowledge at their fingertips: kids' learning and playing in the app age*. TD Tecnologie Didattiche, *24*(3), 147-155. doi: 10.17471/2499-4324/930

Dore, R. A., & Dynia, J. M. (2020). Technology and media use in preschool classrooms: Prevalence, purposes, and contexts. *Frontiers in Education*, *5*. doi: 10.3389/feduc.2020.600305

Eckert, T. L., McIntyre, L. L., Di Gennaro, F. D., Arbolino, L. A., Perry, L. J., & Begeny, J. C. (2008). Researching the transition to kindergarten for typically developing children: A literature review of current processes, practices, and programs. In D. H. Molina (Ed.), *School psychology: 21st century issues and challenges* (pp. 235-252). Hauppauge, NY, US: Nova Science Publishers.

Epstein, A. S., Lawrence, J., Schweinhart L. J., DeBruin-Parecki A., & Kenneth, B. R. (2004). *Preschool assessment: A guide to developing a balanced approach*. NJ, US: National Institute for Early Education Research.

Ginsburg, H. P., & Seo, K. H. (1999). Mathematics in children's thinking. *Mathematical Thinking and Learning, 1*(2), 113-129. doi: 10.1207/s15327833mtl0102_2

Gonski, D. (2018). *Through growth to achievement: report of the review to achieve educational excellence in Australian schools*. Commonwealth of Australia: Department of Education and Training. Retrieved from http://files.eric.ed.gov/fulltext/ED586130.pdf

Helbing, D. (2012). Agent-based modeling. *Understanding Complex Systems*, 25-70. doi:10.1007/978-3-642-24004-1_2

Hirst, M., Jervis, N., Visagie, K., Sojo, V., & Cavanagh, S. (2011). *Transition to primary school: a review of the literature*. Canberra, AU: Commonwealth of Australia.

Hodges, D., Eames, C., & Coll, R. K. (2014). Theoretical perspectives on assessment in cooperative education placements. *Asia-Pacific Journal of Cooperative Education, 15*, 189-207.

Huffman, L. C., Mehlinger, S. L., & Kerivan, A. S. (2000). Risk factors for academic and behavioral problems at the beginning of school. In *Off to a good start: Research on the risk factors for early school problems and selected federal policies affecting children's social and emotional development and their readiness for school*. Chapel Hill, NC, US: University of North Carolina FPG Child Development Center.

Judge, S., Floyd, K., & Jeffs, T. (2014). Using mobile media devices and apps to promote young children's learning. *Young Children and Families in the Information Age*, 117-131. doi: 10.1007/978-94-017-9184-7_7

Kahneman, D. (2011). *Thinking, fast & slow*. New York, NY, US: Farrar, Straus and Giroux.

Kashinath, S., Pearman, A., & Canales, A. (2015). Using technology to facilitate authentic assessment of bilingual preschool children. *Perspectives on Communication Disorders and Sciences in Culturally and Linguistically Diverse (CLD) Populations*, *22*(1), 15-24. Retrieved from doi: 10.1044/cds22.1.15

Keating, D. P. (2007). Formative evaluation of the early development instrument: Progress and prospects. *Early Education and Development, 18*(3), 561-570.

Koomen, M., & Zoanetti, N. (2018). Strategic planning tools for large-scale technology-based assessments. *Assessment in Education: Principles, Policy & Practice*, *25*(2), 200-223. doi: 10.1080/0969594X.2016.1173013

Kumar, P. C., Chetty, M., Clegg, T. L., & Vitak, J. (2019). Privacy and security considerations for digital technology use in elementary schools. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19).* Association for Computing Machinery, New York (pp.1–13). doi: 10.1145/3290605.3300537

Ladd, W. (2017). *School readiness: Preparing children for the transition from preschool to grade school. In Encyclopaedia on early Childhood Development School readiness*. Retrieved from https://www.child-encyclopedia.com/pdf/complet/school-readiness

Lee, C-Y., & Cherner, T. S. (2015). A comprehensive evaluation rubric for assessing instructional apps. *Journal of Information Technology Education: Research*, *14*, 21-53. Retrieved from http://www.jite.org/documents/Vol14/JITEV14ResearchP021-053Yuan0700.pdf

Majzub, R. M., & Rashid, A. A. (2012). School readiness among preschool children. *Social and Behavioral Sciences*, *46*, 3524-3529.

Mariano, M., Santos-Junior, A., L. Lima, J., Perisinotto, J., Brandão, C., J. Surkan, P., … C. Caetano, S. (2019). Ready for School? A systematic review of school readiness and later achievement. *Global Journal of Human-Social Science*, 57-71. doi: 10.34257/gjhssgvol19is10pg57

Maxwell, K. L., & Clifford, R. C. (2004). Research in review: School «readiness» assessment. *Young Children*, *59*(1), 42-46.

Miglino, O., Di Ferdinando, A., Schembri, M., Caretti, M., Rega, A., & Ricci, C. (2013). STELT (Smart Technologies to Enhance Learning and Teaching): una piattaforma per realizzare ambienti di realtà aumentata per apprendere, insegnare e giocare. *Sistemi Intelligenti, Rivista Quadrimestrale di Scienze Cognitive e di Intelligenza Artificiale*, *2*, 397-404. doi: 10.1422/75364

National Association for the Education of Young Children and National Association of Early Childhood Specialists in State Departments of Education (2003). *Early childhood curriculum, assessment, and program evaluation: Building an effective, accountability system in programs for children birth through age 8.* Washington, DC. Retrieved from https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/position-statements/pscape.pdf

Neumann, M. M., Anthony, J. L., Erazo, N. A., & Neumann, D. L. (2019). Assessment and technology: Mapping future directions in the early childhood classroom. *Frontiers in Education*, *4*. doi: 10.3389/feduc.2019.00116

Panesi, S., & Ferlino, L. (2019). Using apps in formal education to improve executive functions in preschoolers. Proceedings *INNODOCT/19*, *International Conference on Innovation, Documentation and Education*. doi: 10.4995/inn2019.2019.10117

Panesi, S., Fante, C., & Ferlino, L. (2021). Online learning in kindergarten during Covid-19: Teachers' experience and perception in Italy. *Qwerty-Open and Interdisciplinary Journal of Technology, Culture and Education*, *16*(2), 69-86.

Papadakis, S., Vaiopoulou, J., Kalogiannakis, M., & Stamovlasis, D. (2020). Developing and exploring an evaluation tool for educational apps (ETEA) targeting kindergarten children. *Sustainability*, *12*(4201). doi: 10.3390/su12104201

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2018). Educational apps from the Android Google Play for Greek preschoolers: A systematic review. *Computers & Education*, *116*, 139-160. doi: 10.1016/j.compedu.2017.09.007

Parlatan, M. E., & Gürler, P. (2021). Social and Emotional Skills of Pre-School Children After Distance Learning from Teacher's Perspective. *Eğitim Kuram ve Uygulama Araştırmaları Dergisi*, *8*(1), 59-71. doi: 10.38089/ekuad.2022.98

Peth-Pierce, R. (2000). *A good beginning: Sending America's children to school with the social and emotional competence they need to succeed.* Chapel Hill, NC, US: The Child Mental Health Foundations and Agencies Network.

Potmesilova, P., & Potmesil, M. (2021). Temperament and school readiness – A literature review. *Frontiers in Psychology*, *12*. doi: 10.3389/fpsyg.2021.599411

Ramey, C. T., & Ramey, S. L. (2004). Early learning and school readiness: Can early intervention make a difference? *Merrill-Palmer Quarterly*, *50*(4), 471-491. doi: 10.1353/mpq.2004.0034

Randel, B., & Clark, T. (2013). Measuring classroom assessment practices. In J. H. McMillan (Ed.), *Handbook of Research on Classroom Assessment* (145-163). Thousand Oaks, CA, US: SAGE. doi: 10.4135/9781452218649

Raver, C. C., & Knitzer, J. (2002). *Ready to enter: What research tells policymakers about strategies to promote social and emotional school readiness among three- and four-year-olds*. New York, NY, US: National Center for Children in Poverty.

Rosa, A., & Niewint-Gori, J. (2019). Competenze in 3D. Costruire un percorso per competenza attraverso la stampante 3D nella scuola dell'infanzia. *Qwerty - Open and Interdisciplinary Journal of Technology, Culture and Education*, *14*(1). doi: 10.30557/qw000010

Ryan, K. E., Gandha, T., Culbertson, M. J., & Carlson, C. (2014). Focus group evidence: Implications for design and analysis. *American Journal of Evaluation*, *35*(3), 328-345. doi: 10.1177/1098214013508300

Shonkoff, J. P., & Phillips, D. A. (2000). *From neurons to neighborhoods: The science of early childhood development.* Washington, DC, US: National Academy Press.

Smorti, A. (1994). *Il pensiero narrativo: costruzione di storie e sviluppo della conoscenza sociale.* Firenze, IT: Giunti.

Stephen, C., & Plowman, L. (2003). Information and communication technologies in pre-school settings: A review of the literature, *International Journal of Early Years Education*, *11*(3), 223-234. doi: 10.1080/0966976032000147343

Verdine, B. N., Irwin, C. M., Golinkoff, R. M., & Hirsh-Pasek, K. (2014). Contributions of executive function and spatial skills to preschool mathematics achievement. Journal of Experimental Child Psychology, *126*, 37-51. doi: 10.1016/j.jecp.2014.02.012

Zanetti, M. A., & Beccarini, F. (2022). *Materiali SR 4-5 School Readiness. Percorsi di potenziamento delle abilità di base per il passaggio alla scuola primaria*. Trento, IT: Erickson.