ICTs in Kindergarten

Athanasios S. Drigas, and Georgia K. Kokkalia

1 NCSR DEMOKRITOS, Institute of Informatics and Telecommunications, Net Media Lab, Athens, Greece

Abstract—Recent development in the role of kindergarten in children's progress includes the use of Information and Communication Technologies (ICTs). ICT nowadays is recognized as a tool that can foster the knowledge and the experiences for this crucial age and the support of specific areas in kindergarten according to the educational perspective is thought significant. In this paper we present a brief overview of the most representative studies of the last decade (2003-2013) which concentrates on the skills that are examined in kindergarten (early literacy ,early mathematics, cognitive, social-emotional, motor, creativity) and are supported by ICTs. The effectiveness of ICT in special education and gifted children in the regular kindergarten is examined. The attitudes of kindergarten teachers towards ICTs are presented.

Index Terms—kindergarten, ICT, interventions, teacher's views, special education

I. INTRODUCTION

Nowadays kindergarten education is considered and realized to be very important in all over the world. As it is known kindergarten students (4-6 years old; depends on the country's regulations) are very curious to their environment, open to learn, eager to try new activities and therefore kindergarten education is assumed meaningful to enable them to understand their environment [1]. It is thought also important for kindergarteners to experience and learn by doing and thus educating young children is vital for future concept development. The key role of early childhood education for improving educational outcomes across the educational system has gained international recognition during the last decade, especially among developing countries [2].

Probably, a key element for this was the fact that it was established as the first goal of UNESCO's Education for All (EFA), initiative adopted by the World Education Forum in 2000. In particular, UNESCO points out that the literature, cognitive and social skills are the foundations for lifelong learning and for this reason considers that the effectiveness and fairness of education system are crucial [3]. According to Vernadakis et al. [4] a very serious issue is what kind of instruction methods could be used in order to promote the development of kindergarten children. Therefore, new teaching methods and instructive teaching materials are suggested to enhance teaching-learning process. During that education process teaching materials and tools should be selected from interesting and challenging areas. However, as UNESCO suggests, new information and communication technologies (ICTs) should be included as a part of formal education in order to achieve the EFA goals [3].

Moreover, is common knowledge that technology and computers are used nearly in all parts of life.As Drigas and Ioannidou [5] state, Information and Communication

Technologies (ICTs) is a general term which refers to all kinds of technologies that enable users to access and manipulate information. Education is one of the fields in which ICT is commonly used and its use in kindergarten education is an important issue investigating frequently in last decades [6]. The effect of ICT in education has been studied since the beginning of the 1970s, where educators started to become increasingly convinced that ICTs could support students in formal education [5].

Recently, there has been an increasing emphasis on educating kindergarten children with the support of ICT and thus this fact has reinforced the use of technology as a mean of overcoming barriers to their learning. There is now a general agreement amongst different specialists that ICT can support a child's skills as well as can create a developmental appropriate learning environment depending on their needs and the curriculum requirements [7]. Many studies have supported the view that ICT can foster the literature, early mathematics, cognitive, emotional-social, motor skills and enhance the creativity of kindergarten children [8]. Existing studies on the introduction of ICTs in kindergarten education argue that can provide children with additional opportunities for rich learning activities that are relevant to their growth characteristics and have positive results in regard to the learning of different subjects [9]. As a result, ICT can play an essential role in achieving the goals of the kindergarten curriculum in all areas and subjects [10] if the provided developmentally appropriate software applications are embedded in appropriate educational scenarios [11].

Our scoping study drew upon national and international publications as well as the research findings of the most representative studies of the last decade which focus on the use of ICT in the regular kindergarten and not to a special kindergarten. According to the Department of Early Years Foundation Stage [12], technology can contribute to three main areas of learning in kindergarten education: (a) develop dispositions to learning that thread through social and emotional development (b) extend knowledge and understanding of the world in the broadest sense of literacy-communication and language- problem solving, reasoning and numeracy and creative development and (c)acquire motor/ operational skills.

Taking into account these specific areas that underlined above and are based on the educational perspective, our study is concentrated on the support of ICT of the most important skills that are thought significant for the development in the kindergarten class (despite the fact that none of these areas can be delivered in isolation from the others, they are equally important and depend upon one another to support a rounded approach to child development,[12]); literature(language, communication, vocabulary), early mathematics (numbers, arithmetic problem solving ,spatial syllogism along with general geometrical

knowledge, concepts),cognitive (problem solving, memory, perception, inhibition, thinking),social-emotional (cooperation, collaboration, emotions),motor (visual, kinaesthetic) and creativity. In addition, the support of ICT for children with special needs and gifted children in the regular kindergarten is presented because these areas are considered of eminently importance. According to recent research [13], European Agency for Development in Special Needs Education suggested a comprehensive study of effective classroom practices in European countries in order to help early childhood teachers to integrate gifted and students with special needs in regular classrooms considering the importance of the inclusion of these categories in the regular class. Finally, the views of kindergarten teachers about the use of ICTs in the classroom is examined because is strongly believed that their attitude towards ICT can affect the quality of teaching and so the need for their further guidance and assistance about the use of ICT in kindergarten settings is emergent.

II. ICT AS A SUPPORT OF EARLY LITERACY SKILLS

In kindergarten education, there have been conducted several studies that claim that properly designed digital educational activities can become an important educational tool for efficient and effective learning especially in the field of the early literacy skills [14]. A wide variety of ICT applications have become increasingly accepted as developmentally appropriate education resources for children's spoken and written language development requiring teacher assistance at some cases [15].

Existing studies support the effectiveness of the cd -rom electronic books (e-books) in early literacy skills as independent e-book reading by the child [16]. Korat [16] notes the advantages of the e-books in vocabulary, word reading and phonological awareness in kindergarten children. The research reveals the fact that children are able to remember better the meaning of new words, to segment words into their sub-syllable parts and are able to read frequent words from the story compared to the control group. Also, in a similar study (17), the author points out the fact, that providing children with the written text together with synchronized narration, animated pictures and sound effects, children's literacy development(vocabulary, story comprehension and word reading) is supported significantly using the e-books .

According to Segers and Verhoeven [15] a new manner of enhancing vocabulary learning, is reported, enabling the presentation of more new words within a short period of time and with very little teacher assistance. The experimental software (three cd roms) includes stories with pictures- but not words- with vocabulary games. The study noted that the curriculum-dependent test showed positive effects of the training but the curriculum-independent test had not significant effect, underlying that a training with even more cd-roms and less time per cd-rom may increase the effect size.

Furthermore, a number of researchers have studied the benefits of the computer assisted instruction (CAI), as an independent intervention, to support reading development in kindergarten children [18]. Many of the CAI programs have targeted phonological awareness, rhyming sound, segmenting, blending, alphabet skills, and concepts of print [19]. Cassady and Smith [20] found advantages of the Waterford Early Reading Program Level 1(WERP-1) in kindergarten classes. Their study claims that kinder-

gartners in classes using WERP-1 obtained higher scores in phonological awareness and word reading than kindergartners in control groups. Also, in a recently completed study, Macaruso et al. [19] explored the benefits of a phonics-based CAI program for kindergartners, called Early Reading. The program provided systematic and structured exercises for developing phonological awareness and basic letter– sound correspondences and indicated that it offers an engaging format for all children to practice literacy skills and progress, independently at their own rate.

Moreover , in a recent study that is focused on the impact of the PictoPal initiative (technology supported intervention system), important learning gains are investigated in the function of written language, in the relationship between spoken and written language and in the purposeful reading and writing by young children [21]. The research also indicates that only when pupils are provided with guidance and the integration with off-computer activities is present, the use of the PictoPal system can foster literacy knowledge such as comprehension of different text types, and understanding of the relationship between spoken and written language [21].

III. ICT AS A SUPPORT OF EARLY MATHEMATICS SKILLS

It is well known that early years are the important years to develop children concepts and also critical and creative scientific thought [22]. A kindergarten child also needs the opportunity to apply its skills in a variety of learning environments, and is strongly recommended that the digital learning media can contribute to the learning of mathematical skills. Many aspects of early informal learning of mathematical concepts, such as numbers, arithmetic problem solving, and spatial syllogism along with general geometrical knowledge, are developed during the kindergarten age [23].

In recent years, with the appearance of smart applications and programmes several researchers have proposed the use of many devices such as tablets and mobiles [23]. Particularly in the subject of mathematics, Zaranis [24] made a comparison between the learning outcomes of computer based teaching and mathematical thematic teaching, aiming the teaching of "Realistic Mathematics" for kindergarten children. Compared to the traditional teaching method, results showed that computer-assisted learning enhance the development of mathematical skills and the cultivation of a deeper perceptual ability for the pupils.

Additionally, Sarama and Clements [25], designed a development project, "Building Blocks", in order to enable all young children to build a solid foundation for mathematics, organised into two areas: (a) spatial and geometric competencies and concepts and (b) numeric and quantitative concepts. The research-based computer tools that stand at the base support the view that this program can connect children's informal knowledge to more formal school mathematics and can foster their mathematics skills with activities that need teacher's guidance and the partial use of the computer.

Furthermore, Ayvac and Devecioglu [26], in their study compare the learning achievement of contrast concepts (big-small, long-short, new-old, hard-soft) of kindergarten children regarding computer assisted instruction (CAI)

with little teacher assistance and traditional learning settings. The results of their research show that the experimental group became more successful compared to control group and that CAI is effective in kindergarteners to teach contrast concepts.

Also, Weiss et al. [27] indicate that multimedia support affect positively in kindergartener's mathematical skills. Specifically, their experiment suggest that multimedia's engagement is valid in number recognition, grouping and estimating especially when children work within an individual learning style. On the other hand, the authors conclude saying that there is a need to structure learning mathematics in small groups and that trait of communication must be practiced and reinforced.

IV. ICT AS A SUPPORT OF COGNITIVE SKILLS

Knowledge can become meaningful and purposeful if it is related to children's daily life and experiences. Through computer – based tasks children cope with a simulation of the real-world, make use of cognitive mechanisms and gradually construct knowledge because technology provides situational and visual cues that allow children to think, work out, interact, collaborate, create and finally learn [28].

Supporting the above view, Nikiforidou & Pange [29] developed a probabilistic computer game, named "Shoes and Squares" for kindergarten children in order to test whether they can perceive the most probable outcome in conditions of unequal possibilities of events. The findings of the study support the fact that children's personal engagement and the use of the computer as a tool, affected their estimations positively emphasizing its contribution to more effective thinking, problem solving and learning.

In a similar study [30] is presented the effects of the Roamer Robot in children's cognitive development. The researchers indicate that the interaction with the robot, which is an autonomous, programmable toy, allow the child to study his ideas, construct a strategy and take decisions as well as improve problem solving answers.

Towards this direction, an exploratory study that was conducted [31] showed the advantages of a Logo-based environment on an Interactive White Board in children's cognitive skills and especially in the development of problem solving strategies and simple programs. The children followed for problem solving, either a planning strategy or a trial and error model, with teacher's guidance and developed a variety of cognitive strategies including attention and perception.

Despite the fact that not many studies have explored the role of ICT in working memory and inhibition, in kindergarten children, Thorel et al.,[32] report the role of a computerized training of visuo- spatial working memory and inhibition. The findings of their study suggest that children who trained on working memory improved significantly on trained tasks and children who trained on inhibition showed a significant improvement over time on two out of three trained task paradigms compared to the control group.

Additionally, digital manipulatives often use context-sensitive sensors embedded within learning materials, according to Andrews and Catwell [33] in order to enhance children's problem solving, reasoning, and deeper understanding. Taking into account the findings of their

research, it is obvious that digital media help young children to put forward thoughtful and justifiable theories about the events supporting at the same time their meta-cognitive skills.

V. ICT AS A SUPPORT OF SOCIAL-EMOTIONAL SKILLS

Collaborative learning and social-emotional skills can be enhanced with well designed digital technology. Existing studies [39] note, that young children who share computers, work in an equitable and cooperative manner showing a preference for working with peers cooperatively. Moreover, according to O'Hara [40], when young children use ICT are encouraged to discuss the stories, share their ideas and move characters around using the touch sensitive screen accompanied by much advice from their peers. The findings of his research claim that when settings include ICT into imaginative and role play areas, the fact of social behaviour and communication is notably high when also teacher's guidance is present.

Similarly, social conventions and interpersonal skills - such as turn-taking- is a part of the learning objectives as Plowman and Stephen [41] investigated. The researchers observed that children sometimes work together, helping each other to interpret error messages or discussing which option to select, but they stressed that the issue of guided interaction is thought significant. Additionally, a study demonstrates the powerful role of collaborative dialogue between learners and teachers to help scaffold knowledge of how to function in a technology-rich learning environment [42]. The survey claims that the active encouragement of collaboration when using ICT has benefits for the helper as well as the helped. Research also states that computer learning activities can elicit high levels of interest on the learning task and that young children report high levels of enjoyment and engagement [41].

Recently Fridin [43] said that the storytelling robot successfully promotes children's emotional involvement in the learning process emphasizing that kindergartners show benefits from playing educational games with the robot. As the author supports, Kindergarten Social Assistive Robotics (KindSAR) is a novel technology that offers kindergarten staff an innovative tool for achieving educational aims through social interaction promoting communication and great enjoyment between the children.

VI. ICT AS A SUPPORT OF CREATIVITY

Creativity involves imagination with purpose and has originality in the sense that something is unique, has value, is useful, offers a valid solution to a problem, or is aesthetically pleasing [40]. Computer programs that are open-ended and offer the child some control over learning activities can provide opportunities for creative choices and imaginative expression. A current study reports that young children who are exposed regularly to open-ended computer-based learning show more curiosity, creativity and motivation, compared to the children who are engaged in more structured computer-assisted instruction with very little user control [44].

Also, Montemayor et al. [45] note that digital media can teach skills for artistic and imaginative expression in domains such as music, drawing, painting, animation, writing, story-telling, and poetry. As they mention, there are digital tools that engage young children in making stories using multimedia and tools that help them learn

about colours and how to mix them. Chromarium is a mixed reality environment that combines digital media displays and hands-on materials to enable young children ages 4 to7 to experiment with and learn about colour mixing. Research has found that it is an effective learning environment that teaches a range of concepts about colour and colour mixing [46].

Additionally, O'Hara[40] mentions that new technologies can provide new opportunities for children to meld imagination with purpose. He continues saying that even with limited use of ICT and a lot of imagination (imaginary play) children can demonstrate a surprising level of creativity and knowledge. According to his study, children are demonstrating their creative potential using the interactive whiteboard to build storyboards inserting colour pages and special effects.

VII. ICT AND SPECIAL EDUCATION

A significant number of children experience mild to moderate developmental delays that may have long-term implications for their academic and functional evolution. One specific option supplied to children who experience physical, language, cognitive, and behavioural delays is kindergarten special education [47].

One of the most widely used software tools in special education is the Cognitive Profiling System (CoPS), a computerized psychometric assessment system which identifies the cognitive strengths and difficulties for children 4-8 years old. CoPS is consisted of eight tests in the form of games and can assess children in sequential and associative memory, auditory and colour discrimination and phonological awareness [47].

According to Kegel et al. [48], computer programs can be used to stimulate early phoneme skills of poorly performing kindergarten children and can help children with poor regulatory skills(inhibitory control, working memory and cognitive flexibility). Although their current results show that children with poor regulatory and literacy skills did not benefit from the computer intervention they used (internet program 'Living Letters), conclude saying that this program can be used as a diagnostic tool to detect poor regulatory skills in kindergarten children as well as a valuable teaching aid. Also, another experiment [49], reports the effect of the audio-visual training of voicing on a word recognition task among children with phonological disabilities with the teacher's guidance. Their findings suggest that the intervention improves the pre-reading skills of the experimental group and the children make progress in word recognition.

Additionally, "The Number Race" software trains children on an entertaining numerical comparison task, by presenting problems adapted to the performance level of the individual child, supporting children with mathematical learning difficulties[50] .The performance of the software was evaluated and the results indicate that the software adapts well to varying levels of initial knowledge and learning speeds as well as can be used to help children at risk for mathematical learning disabilities or with identified dyscalculia.

Furthermore, teaching kindergarten children with autism requires special set of tools and methods due to children with autism are all characterised by impaired social interaction and communication, and by repetitive, self-stimulating restricting behaviours. Hulusic and Pis-

toljevic[51] developed the LEFCA framework for teaching children with autism basic skills and concepts. The results of their preliminary study showed that the specific software in native language is completely clear and user friendly for kids with Autism and other special needs, and that is systematically and developmentally appropriate for learning without any needed training.

Also, in order to assist children with memory problems and with Attention Deficit Hyperactivity Disorder (ADHD), a tool called Cogmed was created. This program is used in schools to assist students' performance and is available as clinical practice for treatment of ADHD. The program includes several visuo-spatial and verbal memory tasks that have been embedded in videogames and is suggested to improve attention and working memory capacity of children [52].

VIII. ICT AND GIFTED CHILDREN

Young gifted children perform in the top 10% in assessments of cognitive, social, expressive or other abilities. Researcher stated that gifted performance is based on interactions between above average general abilities and high levels of task commitment and creativity [53]. Mooij [53] emphasises, that ICT educational programmes for gifted pupils should focus on fostering multilevel instructional and organisational characteristics underlying that for kindergarten gifted children important conditions are the direct and integrated availability of curricular resources and materials suitable for the full spectrum of development and learning levels of all pupils.

According to Mooij [54] internet-based information and communication technology (ICT) can assist in registering, integrating, evaluating, and reporting instructional, learning, and evaluation processes in various ways gifted children in kindergarten. Mooij also [54] , developed a psychometrically controlled screening procedure-for both parents and teachers-that estimates a child's level by comparing the child's behaviour with the behaviour of same-age peers. The resulting information can be used to check and compare the parents' and kindergarten teachers' views of the child as well as to select and design appropriate play materials or instructional lines according to child's level.

Additionally, Cukierkorn et al [55] suggest that gifted children should synthesize their learning, proposing that children's work may be scanned and placed into a Power-Point presentation, allowing the student to choose slide design styles, create slide titles, and add text. They continue saying that these presentations can then be shared with other students and parents or published on the Web; this is why gifted children can improve their skills and feel comfortable when they exchange information with each other.

Finally, the view of Clark [56] is that young gifted children respond well to multiple learning centres such as art, science, reading, writing, and building. Bright wall displays, multimedia technology, animals, and plants should also be featured in a combination of both private spaces and shared public spaces in order to foster their learning.

IX. ICT FOR TEACHERS (USE AND ATTITUDES)

Many research works have emphasized the study of teacher's attitudes towards the use of new technologies in the classroom. The results show very positive attitudes and

the common acceptance that their use will be soon completely expanded among teachers [3].

According to a recent study [57] there is the belief that teachers have positive attitudes towards new technology with regard to the use of ITC as teaching tools. However, the findings indicate the high disposal to use technologies compared with the real use teachers give to ICT in class; they report that they hardly use ICT on a regular basis. According to the authors, this fact suggests that new training alternatives should be included in teacher education programs in order to enhance their confidence about technological issues.

In a similar study [58], is presented that teachers require support and professional development to integrate technologies effectively in their programs despite their positive view towards ICT. Early childhood teachers are considered a particularly important influence on children's development and therefore teacher's confidence and competence in using technologies in meaningful.

On the other hand, research indicate that some teachers feel their status is threatened because they find themselves in a situation where the pupil is more skilled and knowledgeable than they are [59].This current gap in teachers' knowledge, understanding and awareness of technologies remains a cause for concern. Additionally, Askar & Olkun [60] come to the conclusion that both teacher's age and the period of use of ICT affect the quality of teaching. That means that exists the perception that those who are new to the profession are more experienced with ICT and are more committed to its use than longer-serving teachers but as Condie et al. [59] have observed, the majority of teachers in the classroom today trained before ICT became a significant development in education.

Furthermore, as Morris [61] reports, the main obstacles to the use of ICT, according to teacher's views, are the lack of teacher awareness about what technologies are available and how they can be used to support the delivery of the curriculum. In particular, evidence from the literature and case studies suggests that the successful aspects of teaching in the kindergarten with the support of technology involves teacher training which is customised to both teachers' individual needs, their setting and the technologies that are available to them [61].

Moreover, Anglei [62] states that dealing effectively with ICT is related not only with the knowledge of ICT, but also with the individuals' beliefs and perceptions towards ICT tools. The results of the study demonstrate that teachers are not free of personal beliefs about the role of ICT in education and thus they look sceptical and reluctant about teaching with ICT. Similarly, a study [58] argues that teachers' beliefs are good predictors of nearly all types of ICT uses as well as Gialamas and Nikolopoulou [63] who believe that professional development must address the views of teachers and present them with opportunities for positive computer experiences within the context of their practices in the classroom.

X. CONCLUSIONS

The scope of this study was to present if and how new technology can support specific skills in the kindergarten. The findings of the studies we examined, which are the most representative studies over the last decade, showed that kindergarteners can benefit of the use of new technology and can gain many advantages and profits using the

appropriate educational tools that offers the use of ICT. However, the role of the teacher in such situations is thought significant and demands elaboration and clarification especially when the use of ICT is incorporated with traditional teaching methods. The use of ICTs in special education and gifted children is considered crucial in the early years however further research in this domain is thought necessary. Finally, we consider that the field of kindergarten education and the interventions that ICTs can contribute in many areas of child's development calls for more research hoping that the results of the current study are encouraging as there is the general consensus that ICTs do play a significant role in both ensuring and enhancing learning skills of kindergarten children in a regular class.

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AUTHORS

Athanasios Drigas is a Senior Researcher at N.C.S.R. Demokritos. He is the Coordinator of Telecoms Lab and founder of Net Media Lab since 1996. From 1985 to 1999 he was the Operational manager of the Greek Academic network. He has been the Coordinator of Several International Projects, in the fields of ICTs, and e-services (e-learning, e-psychology, e-government, e-inclusion, e-culture etc). He has published more than 200 articles, 7 books, 25 educational CD-ROMs and several patents. He has been a member of several International committees for the design and coordination of Network and ICT activities and of international conferences and journals. (e-mail: dr@iit.demokritos.gr).

Georgia Kokkalia (MSc in Specific Learning Difficulties) is a Special Education Teaching Professional. She has participated in various research projects regarding the use of Information and Communication Technologies (ICTs) in Special Education and in Kindergarten. (e-mail: gioulina@hotmail.com).