Expectations and Possibilities of Using IoT in Education

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Abstract— In the contemporary educational landscape, the integration of ICT (Information and Communication Technology) has gained widespread popularity. Recent years have witnessed a significant enhancement in ICT utilization, not only within traditional face-to-face classroom settings but also in the realm of online education, a trend that gained further momentum due to the imperative need to combat the spread of COVID-19. Educational researchers and practitioners are actively exploring diverse methodologies to harness the potential of ICT. They emphasize the need for educators to bolster their ICT skills to create dynamic and engaging learning experiences. Within university teacher training programs, educators are mandated to acquire a multifaceted understanding of ICT implementation in education, encompassing subject-specific pedagogy intertwined with ICT applications and Technology. Despite these advancements, the application of ICT in early childhood education, especially in childcare activities, remains relatively limited. A discernible disparity exists when comparing the utilization of ICT in early childhood education with that in elementary schools and higher education. Many caregivers still harbor reservations about the necessity of ICT in early childhood education, contributing to a gradual integration of technology in childcare practices. International examples from countries like the United States, Norway, and South Korea [1][2] offer valuable insights into successful ICT implementation, whereas Japan's active engagement in ICT remains sporadic, as evidenced by limited reports on the subject. This paper delves into the extensive research activities undertaken by the authors in the realm of ICT implementation in childcare, drawing upon years of dedicated exploration. Additionally, the paper explores a pioneering approach – the "Utilization of IoT (Internet of Things) Education" – and introduces IoT educational materials as innovative solutions to address the challenges encountered in the process. This comprehensive discussion seeks to illuminate the path forward, emphasizing the transformative potential of ICT and IoT (Internet of Things) integration in shaping the future of education.

Keywords—ICT in education, early childhood education, utilization of IoT education,

I. INTRODUCTION

The authors have been conducting research on the use of ICT in childcare education for many years. When examining the curriculum of nursery teacher training schools, subjects such as computer science and the utilization of ICT equipment are necessary to obtain licenses and graduate. However, there is limited incorporation of ICT in early childhood education settings. Is it unnecessary to introduce ICT to young children (infants) in early childhood education. This question serves as the foundation for our research. Some argue that children should interact with friends and teachers, experience nature, and develop their sensibilities during early childhood, rather than relying on digital devices such as computers and tablets. Childcare workers are dedicated to children's development, adhering to the ideal of childcare that connects children with nature and encourages active engagement. While this approach is undoubtedly valuable, the authors recognize its significance in childcare philosophy. Nevertheless, as we anticipate the arrival of the "smart tech society" as referenced in Society5.0 (Society5.0 is a smart tech society.), is it truly appropriate for early childhood education to remain unchanged, avoiding contact with ICT.

The educational environment has changed dramatically by using ICT. That is sure it same could be said of early childhood education. Using ICT to transform the early childhood education environment presents various challenges. However, we believe it is worth addressing these challenges. The authors have challenged themselves to develop suitable ICT materials and more new technologies for early childhood education.

II. STATUS OF ICT USAGE IN EARLY CHILDHOOD EDUCATION

The educational environment has undergone significant transformations due to the integration of ICT. The authors firmly believe that this change is equally applicable to early childhood education. Utilizing ICT to transform the early childhood education environment is a challenge that, despite its complexities, is worth addressing.

In proposing the utilization of ICT in early childhood education, we first conducted interviews targeting kindergartens and nurseries to understand the current use of ICT in early childhood education. Simultaneously, we inquired about the perspectives on the use of ICT devices specifically designed for young children within childcare settings.

A. Utilization of ICT childcare

The introduction of ICT, or digitization, into business operations offers numerous benefits, including improved efficiency, increased productivity, and reduced workload. This trend is prevalent across various industries, and education is no

exception. In primary schools and beyond, each student is provided with an individual device, marking the beginning of educational initiatives utilizing these tools, along with a wide array of prepared learning content. However, early childhood education raises a question: how can ICT be effectively incorporated at this level.

While the implementation of ICT is observed in this context, its applications are predominantly administrative. Tasks such as digitizing diaries, reporting absenteeism, and selling event photos online have been automated, allowing educators to delegate previously manual tasks to systems. This automation not only lightens the workload for educators but also significantly reduces their administrative burdens. The benefits of ICT implementation in this sector are immeasurable, leading to a growing number of institutions adopting these technologies annually. However, the utilization of ICT in early childhood education remains primarily confined to administrative purposes and has not yet extended to applications tailored specifically for young children.

Reflecting on this current state of utilization, we believe it is crucial to take a step forward and explore strategies for incorporating ICT into childcare, even in the slightest manner possible. We consider this initiative vital for shaping the future of our society

B. Using ICT for Childcare Education

The authors surveyed current childcare providers to gather their perspectives on opportunities for infants to interact with ICT in childcare settings and on implementing ICT in childcare practices. Some participants acknowledged the necessity of incorporating ICT, especially in a swiftly evolving society. However, there was a general hesitancy, possibly due to concerns about costs; no strong opinions emerged regarding immediate adoption of ICT in childcare. Additionally, many respondents expressed discomfort with ICT or had never used it before, yet did not perceive any significant inconvenience or disadvantage in their work. The authors believe that this issue could potentially be addressed by providing sample teaching materials and allowing childcare providers to experience them firsthand.

When creating ICT materials for childcare, our approach was to design resources that seamlessly integrate into everyday childcare practices, rather than inventing entirely new or unfamiliar materials. We also ensured that there was no requirement for specialized equipment or applications. Simultaneously, we recognized the importance of crafting a childcare environment that could be uniquely enhanced through the utilization of ICT. Building upon these principles, we introduced an "Electric Picture-story Show (ePicture-story show)" as an ICT resource and actively engaged in its development [3][4].

C. ePicture -story show

The ePicture-story show (Fig. 1.) was developed utilizing Microsoft PowerPoint (Fig. 2.), a commonly available software installed on computers used in preschools and kindergartens. PowerPoint is frequently used in various events such as Parents' Day, entrance ceremonies, and preschool/kindergarten

graduations. Hence, we deemed the difficulty in using PowerPoint to be minimal.

In addition to developing the ePicture-story show internally, we incorporated it into the instruction of students enrolled in the nursery teacher training course. As the nursery school curriculum includes a computer science, we integrated this topic into the syllabus. The authors firmly believe that "ICT education utilization" encompasses the ability to create ICT teaching materials. Private kindergartens and nursery schools, in particular, have diverse childcare policies. Therefore, the authors consider it essential for individuals to possess the skills to develop educational materials that align with the policies of each preschool when implementing ICT education in childcare.

The students who created the presentation had prior experience with PowerPoint, making the introduction of production relatively seamless. However, it required a different set of skills and knowledge compared to creating typical presentation materials. Specifically, concerning animations, whereas regular presentations often utilize the "start" function extensively, in the ePicture-story show, it is necessary to judiciously employ "start," "emphasis," and "end." Furthermore, since the desired animations are not always readily available, the ability to combine multiple animations to create the desired effect becomes crucial.

Storytelling is a ubiquitous activity in everyday life. By substituting traditional picture books and picture-story shows with ePicture-story shows, it is possible to establish a childcare

Fig.1. Example of ePicture-story show (Brush the teeth)
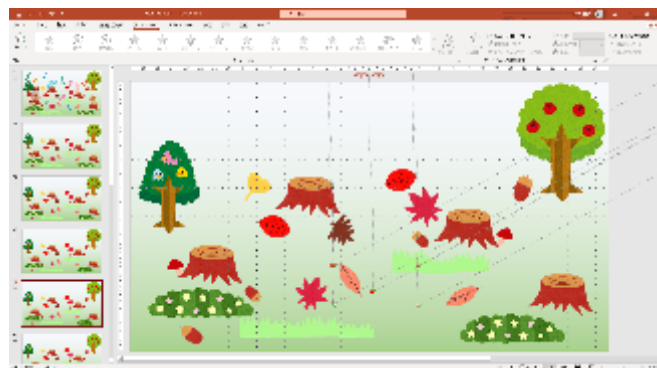

Fig.2. Example of ePicture-story show
(Using Microsoft PowerPoint ePicture-story show editing)

environment that seamlessly integrates ICT into daily routines. One of the key attractions of ePicture-story shows lies in their animated features, a unique aspect that distinguishes them from conventional picture storytelling and picture books.

The authors initially considered digitizing conventional picture books and picture story shows. During the computer science lessons, particular attention was paid to copyright issues; the students were instructed to contact the copyright holders, which proved to be a time-consuming process. Eventually, the creators (students) developed their own original stories centered around themes such as "traffic safety," "tooth brushing," and "eating." Subsequently, they crafted an ICT educational material in the form of an ePicture-story show based on these concepts.

III. PRACTICAL APPLICATION

The authors actively implemented ePicture-story shows in real-life scenarios by visiting collaborative preschools and engaging in reading sessions with the children (Fig. 3.). Given that ePicture-story shows are intended as educational tools, it was paramount to assess the reactions of the primary audience, the children themselves. During these sessions, close attention was paid to the children's responses, capturing their engagement, interest, and overall interaction with the ePicture-story shows. Additionally, feedback was sought from caregivers to gain comprehensive insights into the impact of these ICT educational materials. Understanding the genuine reactions of both the children and their caregivers played a vital role in evaluating the effectiveness and suitability of ePicture-story shows in the context of early childhood education. This practical implementation phase allowed the authors to observe firsthand how these innovative materials were received and utilized in real childcare environments.

Fig.3. Practical application of the ePicture-story shows in preschool

A. Children's Reactions

During the practical implementation phase, the ePicture-story shows utilized a combination of sounds, including various sound effects, and captivating animations. The authors had recognized animations as a pivotal aspect of ePicture-story shows, and these animations were adeptly employed to create immersive sound effects, elevating the overall storytelling experience. For instance, phrases like "That fell out!" or "I found that!" were synchronized with corresponding animations, enabling children to visually follow the story's progression and respond to the unfolding events.

Notably, the children displayed a high level of engagement, closely tracking the on-screen movements with their eyes while simultaneously listening intently to the accompanying sounds. This heightened level of involvement indicated the effectiveness of incorporating multimedia elements like animations and sound effects in maintaining children's interest and attention throughout the storytelling process.

Additionally, the natural communication between the children and their caregivers, along with their responses to calls for assistance—a common occurrence during storytelling sessions—remained unaffected. This observation highlighted a significant achievement: the integration of animations and sound effects into ePicture-story shows did not disrupt the traditional interactive dynamics between children and their caregivers. This seamless blend of technology and conventional storytelling methods showcased the successful fusion of innovative multimedia elements and traditional engagement strategies within the realm of early childhood education.

B. Evaluation from caregivers

The caregivers appreciated the opportunity to display picture books on a large screen, a departure from the conventional format of physical picture books and story shows. They specifically praised the inclusion of animations and sound effects in electronic storytelling, a feature that was highly commended, especially when engaging infants. Unlike traditional storytelling methods, where achieving a high level of perfection, particularly in sound integration, proved challenging, this electronic medium showcased the potential to overcome these limitations.

On the other hand, for the projection of ePicture-story shows, a projector and a screen are necessary. As a result, it requires preparation time and is by no means as easily accessible as conventional storytelling. Due to the necessary equipment, its practical use in regular nursery rooms is challenging, prompting suggestions for improvements in this area. However, in another preschool, the presence of a projector and a screen was regarded as a "special place" among the children, creating excitement during story readings in this unique setting. Some also viewed this as a positive aspect.

IV. ISSUES OF THE ICT TEACHING MATERIAL EPICTURE-STORY SHOW

During the practical implementation detailed in Chapter III. and the subsequent examination and research, the authors identified two significant challenges related to ICT teaching materials. The issues currently perceived by the authors as the primary challenges for ICT teaching materials are as follows.

1. One challenge arises when a person other than the creator reads the story to the audience. This individual needs to have a clear understanding of where and when the animations and sounds are to be included. Unlike

traditional picture books and picture story shows, it requires more time for advance practice.

2. Another challenge emerges when using ePicture-story shows, as young children typically assume a passive "watching (viewing)" posture. This behavior is no different from their engagement with traditional picture books and picture story shows. Unless this passive attitude is somehow altered, it becomes difficult to effectively integrate ICT into early childhood education.

Several measures can be implemented to address the challenge of non-producers handling ePicture-story shows, such as thorough practice in advance and consulting the creator for guidance. However, the ePicture-story shows devised and developed by the authors, while receiving praise for their animations and sound effects, are essentially a digitalized version of existing picture story shows and picture books. Despite their positive reception, the practical environment for their use poses difficulties in preparation, preventing them from truly becoming a new standard in childcare settings.

Although the ePicture-story show was conceptualized with the flexibility to integrate into childcare, this adaptability has led to the perspective that "forcing ICT usage is unnecessary." Comparing ePicture-story shows with typical ICT teaching materials used in elementary schools and beyond, which predominantly consist of viewing-type materials, it becomes essential to reevaluate the positioning of ePicture-story shows. They should be seen not merely as viewing tools but as comprehensive educational materials designed specifically for childcare contexts.

V. IoT Education Utilization

In order to address the challenges posed by audience-oriented educational materials like ePicture-story shows, a departure from this approach becomes imperative. To tackle this issue, we have introduced an innovative solution: the integration of IoT in education. We believe that learning experiences are more memorable when they are interactive. Hence, our aim was to create teaching materials that not only offer audio-visual content but also encourage active participation and engagement.

Rather than discarding the painstakingly developed ePicture-story shows, we conceived the idea of incorporating response-oriented sensing teaching materials that could work in parallel. For instance, in a scene where a wizard swings a wand to cast a spell, an accelerometer is attached to the wand's shape. When a child watching the story mimics the action by waving their own wand, the accelerometer senses the movement and prompts the ePicture-story show to transition to the next scene. This interactive teaching material enables children to actively participate in the story while listening to it, transforming the reading experience from passive listening to an engaging and participatory activity.

We have employed the BBC micro: bit v2 (Fig.4.) as our sensor device. This micro: bit integrates various sensors into a single compact board. Its relatively low procurement cost made it a practical choice. Connected to the computer via Bluetooth, the micro: bit accelerometer detects movement. By converting this movement into a signal indicating the press of the computer's Enter key, it advances the PowerPoint-based ePicture-story to the subsequent animations and scenes. Teaching materials that empower children to use their bodies to influence the story's progression encourage an active learning environment, fostering a different kind of engagement compared to traditional methods.

The development of a sample IoT device has recently been completed, marking the initial stages of this innovative teaching approach. Practical applications and further refinements stand as our forthcoming tasks. We are enthusiastic about the potential of this IoT-enabled educational material, believing that it will not only transform the way children learn but also contribute significantly to the evolution of interactive and participatory education methods.

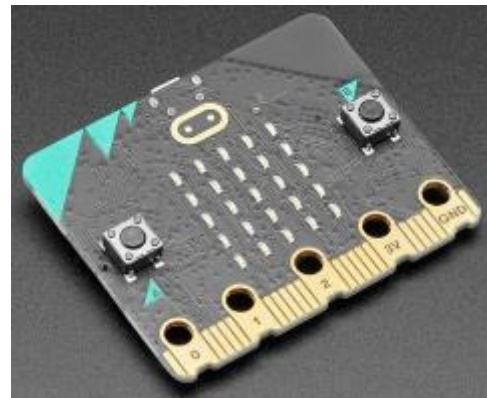The fig.5. is the image about the IoT educational material what that works.

Fig.4. BBC micro:bit v2

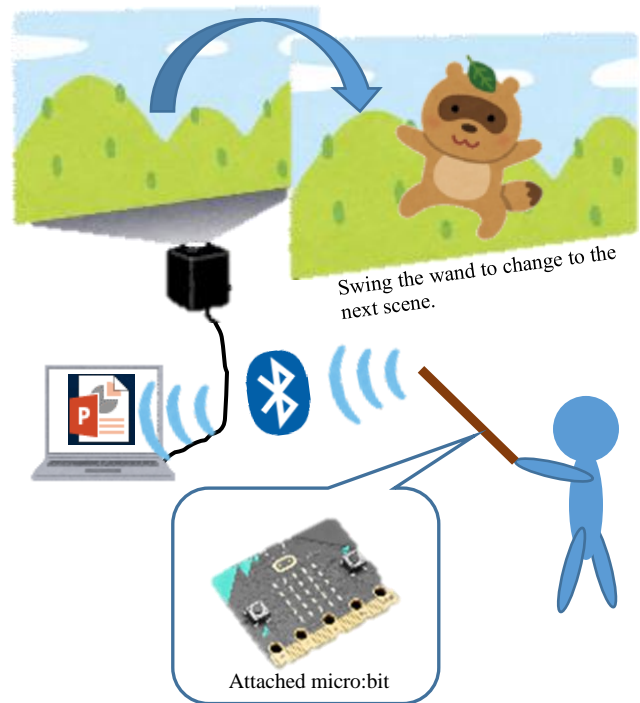Swing the wand to change to the next scene.

Attached micro:bit

Fig.5. Image about the IoT educational material work

VI. CONCLUSION

This paper explores the realm of ICT education in early childhood education and introduces a groundbreaking concept: the "Utilization of IoT Education." This innovative proposal envisions a transformative educational landscape, seamlessly integrating ICT and IoT to create a novel learning environment. While it is acknowledged that there are inherent risks associated with the use of ICT in education [5], it is essential to move beyond fear and embrace the potential for growth and innovation.

The IoT educational materials developed by the authors, currently employing acceleration sensors, hold immense potential. As the technology advances, incorporating a diverse array of sensors, including illumination and compass sensors, promises to further enhance their capabilities. Moreover, our vision extends beyond preschool education; we aim to expand these materials into the realm of elementary and higher education. Looking ahead, our resarch is committed to blending IoT materials, fostering experiential learning, with traditional ICT resources, typically presented in a visual format. This fusion represents a paradigm shift, challenging the status quo and reshaping the educational landscape.

We firmly believe that these IoT educational materials will revolutionize the educational environment, introducing interactive and immersive learning experiences. Simultaneously, we acknowledge the importance of ongoing efforts to enhance teachers' digital literacy. By addressing concerns and mitigating risks, we can pave the way for responsible and effective integration of IoT education in early childhood education. The potential for growth, learning, and positive change in the educational sector is vast, and we are excited to contribute significantly to this transformative journey.

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